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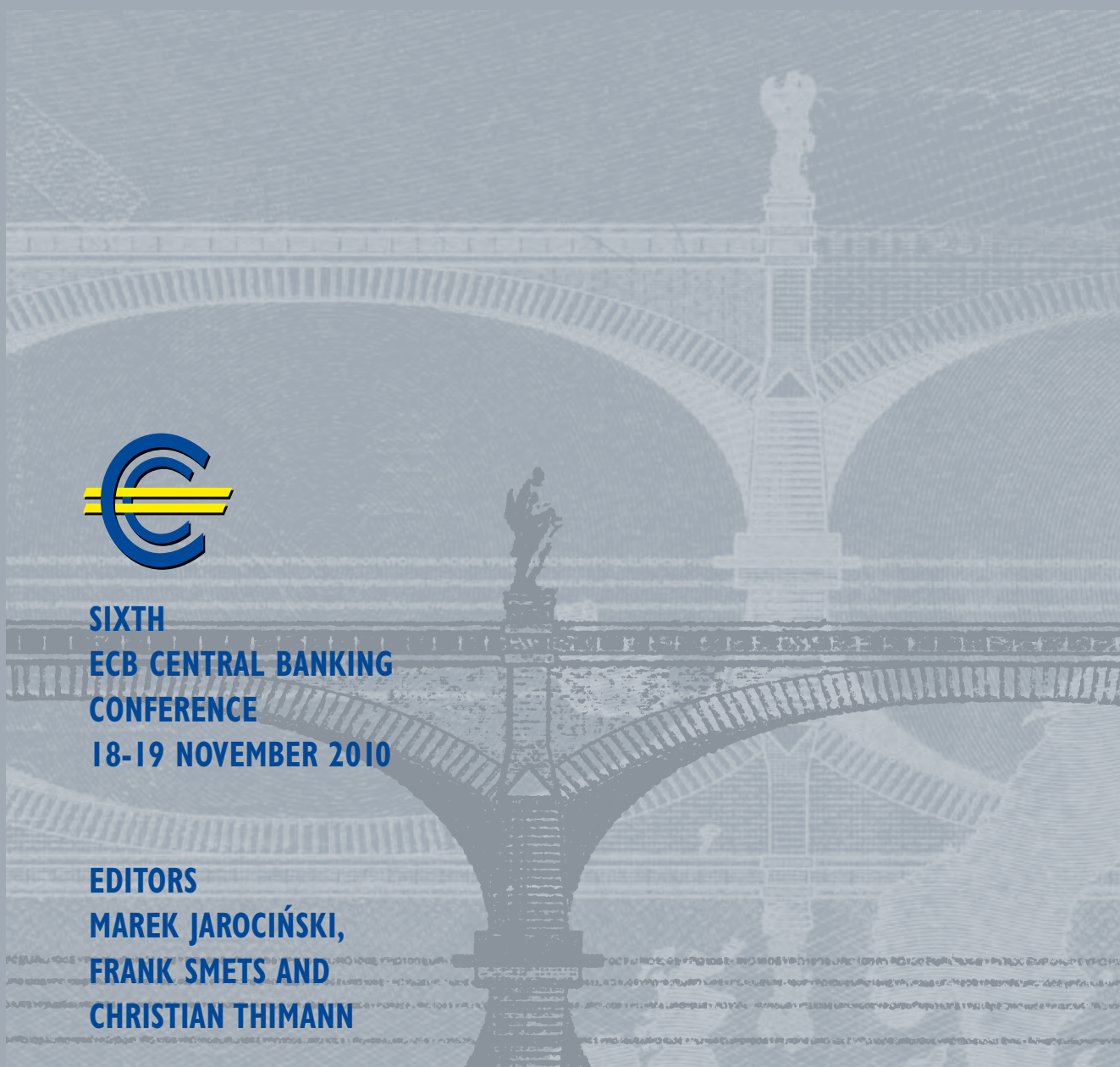
EUROSYSTEM

APPROACHES TO MONETARY POLICY REVISITED – LESSONS FROM THE CRISIS



SIXTH
ECB CENTRAL BANKING
CONFERENCE
18-19 NOVEMBER 2010

EDITORS
MAREK JAROCIŃSKI,
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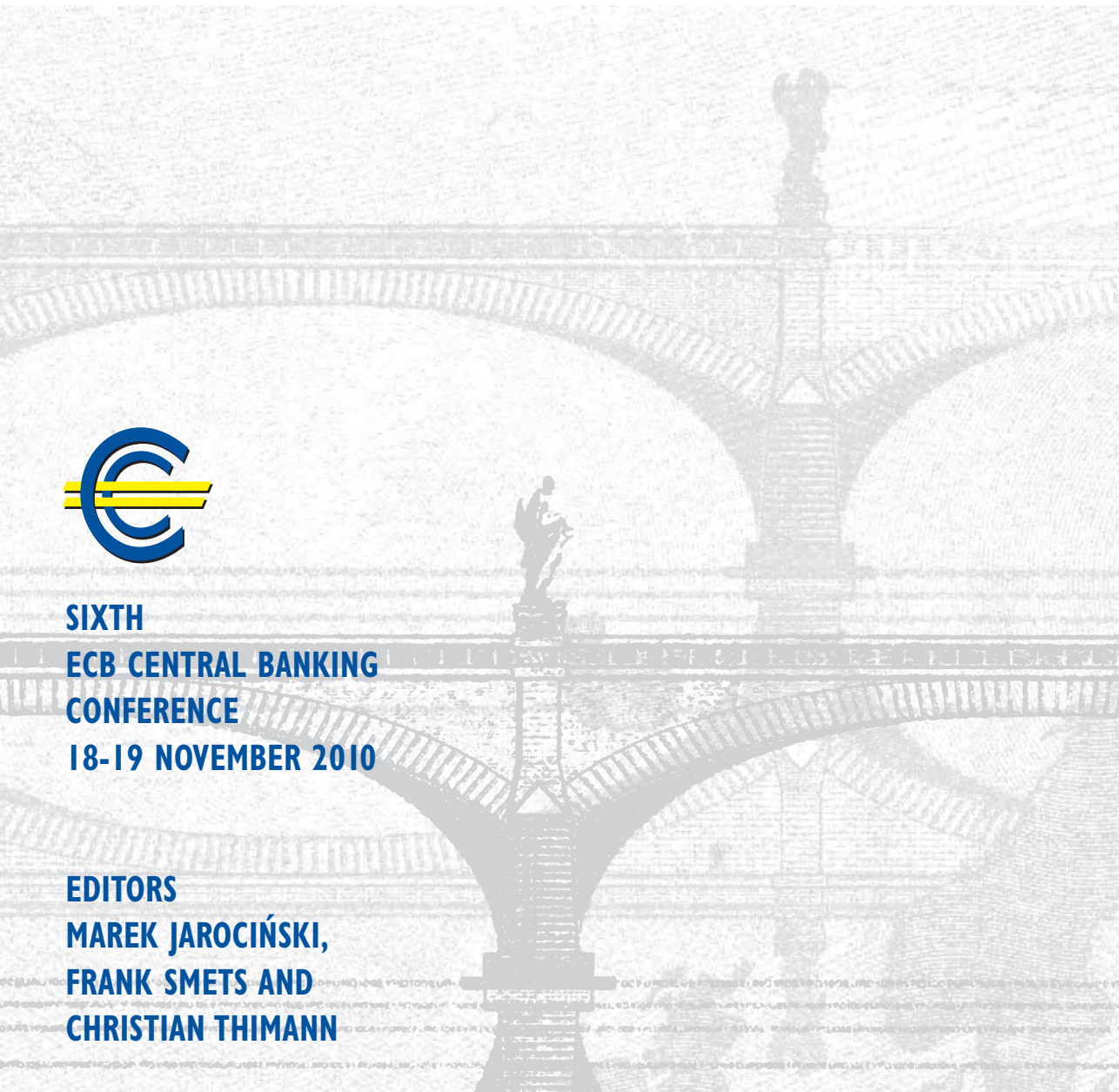

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INTRODUCTION[1]

BY MAREK JAROCIŃSKI, ECB
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CHRISTIAN THIMANN, ECB

Two years after the outbreak of the global financial crisis, the ECB considered it opportune to review the strategic and operational decisions that central banks had taken to combat the crisis, counter the fallout for real economies and stave off the worst economic scenarios. The sixth biennial ECB Central Banking Conference, organised under the auspices of the Executive Board, provided an opportunity to look back at the dramatic years following the Lehman bankruptcy and to reflect on the resulting lessons for central banking.

The conference was titled "Approaches to monetary policy revisited – lessons from the crisis" and held on 18 and 19 November 2010 in Frankfurt am Main.

This volume contains the papers presented at the conference, as well as the related discussions and speeches.

The contributions are grouped around five broad topics:

- monetary policy strategy,
- lessons from historical experiences,
- challenges for macroeconomic and finance theory,
- the international dimension of the crisis, and
- operational frameworks for monetary policy.

The financial crisis and the deep recession that followed have, in the eyes of some, raised doubts about the appropriateness of what Mishkin calls "flexible inflation targeting" strategies, which until recently were credited with bringing about in many countries a long period of nominal and real stability, known as the "Great Moderation". The first session of the conference, entitled "Monetary policy strategies: experiences during the crisis and lessons learnt", raises a number of questions in this context, namely: what is and what should be the role of money, credit and other financial indicators in monetary policy frameworks? What is the appropriate horizon for the inflation target? Should central banks manage risk and act pre-emptively? Should they lean against asset price bubbles?

1 We would like to thank all participants of the 6th ECB Central Banking Conference for their contributions; the staff of the ECB's Publishing, Events and Protocol Division for the conference organisation; and the staff of the ECB's English Translation and Editing Section for the editing of this volume.

In their paper Stephan Fahr, Roberto Motto, Massimo Rostagno, Frank Smets and Oreste Tristani (all from the ECB) discuss the ECB experience. Their simulations with a structural model show the importance of the ECB's monetary pillar and the advantage of the ECB's medium-term orientation. They also present evidence that the non-standard policy of "enhanced credit support" has been successful in overcoming financial market impairments. The paper by Rick Mishkin takes a broader view and discusses more generally the strategic monetary policy issues exposed by the crisis. He argues that "none of the lessons from the financial crisis in any way undermine or invalidate the nine basic principles of the science of monetary policy developed before the crisis". However, the crisis experience does warrant a rethinking of inflation targeting strategies, especially with regard to managing tail risks and leaning against credit bubbles.

Insightful and, at times, provocative discussions of both papers are provided by Guido Tabellini (Bocconi University) and William White (OECD).[2] White questions some of the implicit complacency in Mishkin's arguments, while Tabellini queries the motivation behind the ECB's monetary pillar. They both agree, however, on the need to develop a framework in which financial stability is managed with policy tools other than the interest rate.

The speeches by Jean-Claude Trichet (President of the ECB) and Jürgen Stark (Member of the Executive Board of the ECB) provide a policy-maker's perspective with regard to the strategy of the ECB. Among other things, President Trichet stresses the role of the ECB's quantitative definition of price stability in anchoring inflation expectations, which materially helps to avoid large fluctuations of inflation even in the most turbulent of times. Stark reiterates the key elements of the ECB's monetary policy framework: "a quantitative definition of price stability, a medium-term orientation and a broad analytical framework, with money and credit playing an important role". He also notes that central bankers' past scepticism towards "leaning against the wind" should be reassessed.

Session 2, entitled "The financial crisis: what did central bankers forget and what did they learn? A historical perspective", compares the current crisis with the 19th century banking crises and the Great Depression, drawing analogies and highlighting contrasts. Harold James (Princeton University) notes that history provides both constructive lessons, which were well learned (e.g. the need for monetary expansion in a crisis), and serious warnings (for example with regard to the large cost of banking crises, and the resurrection of economic nationalism). Carl-Ludwig Holtfrerich (Freie Universität Berlin) calls for more regulation of financial markets. Marc Flandreau (Graduate Institute Geneva) points out that, in contrast to the present practice, 19th century lending of last resort was extended at a high interest rate in order to avoid stifling the interbank market. He also contrasts the Bank of England's insistence in the 19th century on only the best collateral in crisis periods with the widening of collateral eligibility by many central banks in recent years.

2 The third discussion presented at the conference, by Jean Pisani-Ferry (Bruegel), could not be included in this volume.

The panel discussion in Session 3 focuses on the following question: "what shortcomings in macroeconomic and finance theory has the crisis revealed, and how should they be addressed?" Jean-Philippe Bouchaud (Capital Fund Management and École Polytechnique) argues that fundamentals play a relatively small role in asset price dynamics. Instead, these dynamics are mostly endogenous, emerging from a chaotic interaction of uninformed heterogeneous agents. He advocates the use of physics models of complex systems in modelling financial markets. Martin Eichenbaum (Northwestern University) responds to the post-crisis criticism of macroeconomic theory. He points out that pre-crisis DSGE models did not include financial markets because these were not needed to explain the pre-crisis macro data of advanced economies. He calls for the use of more heterogeneous samples, including emerging markets data. John Geanakoplos (Yale University) characterises the crisis as an exceptionally pronounced leverage cycle. He argues that the analysis of leverage cycles should be a central element of macroeconomics and finance.

The international dimension of the crisis is covered by Session 4's policy panel – with contributions from Ben Bernanke (Chairman of the Board of Governors of the Federal Reserve), Henrique Meirelles (Governor of the Central Bank of Brazil), Dominique Strauss-Kahn (Managing Director of the International Monetary Fund) and President Trichet – and is also reflected in Ben Bernanke's keynote speech. Global imbalances endangering the current recovery are the common theme. Bernanke rejects the view that the United States can tackle its current account deficit on its own and links the imbalances with sustained foreign exchange interventions in some emerging market economies.

Finally, the focus of Session 5 is on monetary policy operations, although this topic arises frequently throughout the conference. The session is entitled "Monetary policy operations: experiences during the crisis and lessons learnt". Operational matters used to be viewed as a mere technicality. However, the credit turmoil placed them at the heart of central banking and exposed many controversies.

In their paper, Nuno Cassola, Alain Durré and Cornelia Holthausen (all from the ECB) model the central bank's trade-off between providing liquidity and sustaining private intermediation in the money market. The paper by Spence Hilton and James McAndrews (Federal Reserve Bank of New York) explains the institutional and balance sheet constraints on the Federal Reserve's response to the crisis. These papers reveal a contrast in policy frameworks before the crisis: while the ECB dealt with many counterparties and accepted a wide range of collateral, the opposite was true of the Federal Reserve. In the wake of the crisis a convergence in frameworks was observed, with both institutions dealing with many counterparties and collateral types.

In his contribution Marvin Goodfriend (Carnegie Mellon University) classifies central bank operations into two groups: "monetary policy" and "credit policy"; and he points out that the latter has fiscal implications that can impact on central bank independence. Rafael Repullo (CEMFI) distinguishes between three ways of managing liquidity and money market interest rates: through a structural liquidity

deficit (as with the ECB framework), where commercial banks constantly borrow from the central bank and the lending rate is the policy rate; with an approximate liquidity balance (as with the Federal Reserve prior to the crisis); and through a structural liquidity surplus, where the policy rate is the rate paid on commercial bank deposits with the central bank. He calls for a reconsideration of which is the best framework.

A prominent issue throughout the conference is whether the non-standard monetary policy measures are complements to, or substitutes for, the standard interest rate decisions. In the introductory speech President Trichet reiterates the ECB's view that non-standard measures are a complementary tool used to ensure the proper transmission of the standard measures. "We judged then – as we do now – that the level of our key rates was appropriate to serve the maintenance of price stability over the medium term. Rather, our view was that non-standard measures were required to ensure that the stance of monetary policy was effectively transmitted to the broader economy, notwithstanding the dysfunctional situation in some financial markets". Chairman Bernanke views the Federal Reserve's non-standard measures, consisting mainly of securities purchases, as a substitute for the interest rate cuts that are used when the zero lower bound is encountered: "Although securities purchases are a different tool for conducting monetary policy from the more familiar approach of managing the overnight interest rate, the goals and transmission mechanisms are very similar".

In his concluding remarks President Trichet reiterates that the ECB's medium-term inflation objective of "below, but close to, 2%" and its analysis of credit aggregates are increasingly recognised and adopted around the world. Yet, more research on nonlinearities and transitory dynamics is needed.

The President concludes: "I was fascinated by the wealth of discussion that we have had here".

We trust that the reader of this volume will share this view.

Jean-Claude Trichet

INTRODUCTORY SPEECH

REFLECTIONS ON THE NATURE OF MONETARY POLICY NON-STANDARD MEASURES AND FINANCE THEORY

BY JEAN-CLAUDE TRICHET, PRESIDENT OF THE ECB

1 INTRODUCTION

It is a great pleasure to open the ECB's 2010 Central Banking Conference.

As you know, we consider this event, which has been held every other year since 2000, as our institution's flagship conference. I am therefore particularly pleased to see that so many central bank governors from around the world have taken up our invitation, as well as representatives from European institutions and governments, leading academics, financial market participants and many other friends of the ECB. This year, we also have about 30 graduate students from all over Europe with us. I would like to extend a very warm welcome to all of you, on behalf of the Executive Board and the Governing Council of the ECB.

As ever, the goal of the conference is to bring together central bankers, policy-makers, academics, market participants and other observers to exchange views on topics of crucial relevance to central banks. I am sure you will all agree that the theme of the conference – "Approaches to monetary policy revisited: lessons from the crisis" – is both relevant and timely.

I think we have inspiring work ahead of us for these two days: the programme is packed with a combination of papers and panels, and I am very much looking forward to our discussions.

In these opening remarks, I would like to do two things. First, I will present a "bird's eye" view of the ECB's conduct of monetary policy during the crisis, focusing in particular on the distinction between standard and non-standard policy measures. And second, I will identify some of the main lessons to be learned from the crisis regarding economic analysis.

2 THE ROLE OF STANDARD AND NON-STANDARD MEASURES

Let me start with monetary policy. The widespread introduction of non-standard monetary policy measures has been a defining characteristic of the global financial crisis.

Across central banks, there has been no standardisation of non-standard measures: approaches are distinct, tailored to the respective economies and their structures. We have seen enhanced credit support, credit easing, quantitative easing,

interventions in foreign exchange and securities markets, and the provision of liquidity in foreign currency – to name but a few of the measures taken.[1]

These tools have been used to support the functioning of the financial sector, to protect the real economy from the fallout of the financial crisis, and, ultimately, to preserve price stability over the medium term.

There are two distinct views on non-standard measures.

Some view them as the continuation of standard policy by other means. Once nominal interest rates cannot be lowered further, central banks use other tools to determine the monetary policy stance – that is, to contribute in the desired way to economic, financial and monetary developments in pursuit of price stability.[2]

Figuratively speaking, this can be compared to – once the end of the road has been reached – engaging the four-wheel drive. Central banks expand their balance sheets and inject liquidity so as to influence the structure of yields and returns and thereby stimulate aggregate demand. This approach would be broadly in line with the theoretical analyses and prescriptions of Friedman, Tobin or Patinkin. The logic of this approach is essentially sequential: first the standard measures, then the non-standard measures. If this sequential logic were also to be applied to the exit, it would essentially mean unwinding non-standard measures first and subsequently raising interest rates.

At the ECB, we have a different view of our non-standard measures. We set our key interest rates at levels we consider appropriate to maintain price stability, drawing on our regular comprehensive assessment of economic and monetary conditions. In other words, we have followed our standard practice in this regard.

But on several occasions, the monetary policy stance established in this way faced obstacles in being transmitted to the euro area economy. During the financial crisis, market functioning was impaired. In response, we acted to overcome some severe malfunctioning that was hampering the channels of transmission of our policy. We introduced measures to help restore a more effective transmission of our monetary policy stance to the wider euro area economy.[3]

Staying with the image of the road, I would say that we sought to remove the major roadblocks in front of us, so that our policy stance could be transmitted to the economy in the intended way. The logic of this approach is therefore parallel and supportive: if the transmission of the standard measures is impeded in a very significant way, non-standard measures can offer support. This logic has potentially very clear implications for the exit: we consider that we can determine standard and non-standard measures largely independently. We consider that we are not bound to unwind non-standard measures before considering interest

1 For a summary, see Borio and Disyatat (2009).
2 For a discussion of this perspective, see Orphanides and Wieland (2000).
3 For a discussion, see Giannone, Lenza, Pill and Reichlin (2010).

rate increases; we could do one or the other or both. One set of measures depends on the outlook for price stability; the other depends on the degree of functioning of the monetary policy transmission through the financial system and financial markets.

With this overview of guiding principles in mind, I would like to discuss the three crucial elements of our monetary policy discussions during the financial crisis in more detail: the unwavering pursuit of price stability, our primary objective; the role of standard policy measures in pursuing that goal; and the support provided by the non-standard measures that we have introduced in recent years.

PRICE STABILITY

The Governing Council has defined the ECB's primary objective with a definition of inflation of "below, but close to, 2%" over the medium term.[4]

As some of you will remember, initially, this quantification of our definition was much criticised, but over time it has become fully accepted. Some doubts of the critics have proved unfounded. Our definition has not constrained growth: during the first ten years of Monetary Union, euro area per capita GDP growth was comparable to that seen in the United States, at about 1% per annum. Nor has it hindered employment creation: between 1999 and the second quarter of 2010 euro area employment grew by 14.2 million, which compares favourably with employment creation in the United States over the same period.[5]

What is more, I can say that I was also impressed by a recent speech of my colleague and friend, Chairman Ben Bernanke.[6] When describing the longer-run US inflation rate and outlook, he mentioned as being consistent with the Federal Reserve's mandate a longer-run inflation rate of "about 2% or a bit below". The world's two largest central banks in the advanced economies could hardly be more closely aligned with regard to the inflation rates they aim to establish in their respective economies over the medium term.

At the same time, it seems to me that our medium-term orientation has become more fully understood. We need to look beyond the impact of transient shocks to price developments and thus beyond the standard two to three-year horizon of conventional macroeconomic projections. Indeed, we condition our policy-relevant horizon on the nature and magnitude of the shocks hitting the economy. The nature and magnitude of the shocks faced during the financial crisis imply that the relevant notion of medium term might be somewhat longer than in more normal circumstances.

With these definitional issues largely resolved, there are two points that I would particularly like to highlight today.

4 See European Central Bank (2003).
5 Sources: Eurostat, ECB; BEA, BLS and current population survey (Q2 2010 figures for the United States).
6 See Bernanke (2010).

First, the precise quantitative nature of our definition of the price stability objective has proved crucial in anchoring longer-term inflation expectations. And, as a result, it has protected us against both upside and downside risks to price stability, even in these most turbulent of times. The anchoring of private inflation expectations induces a self-correcting mechanism in response to temporary disturbances in price developments, thereby easing the burden on monetary policy. In short, the quantitative definition has helped to protect us against the materialisation of the risks of deflation, even at the darkest moments of the crisis.

Second, the quantitative definition facilitates accountability. There should be no room for ambiguity in judging the ECB's track record. The average annual inflation rate in the euro area since January 1999 has been 1.97%. This represents an achievement that is worth taking note of. It is, moreover, the best result in the major euro area countries in over 50 years.

STANDARD MEASURES

How could these results be achieved in the face of financial crisis? Changes in the ECB's key short-term interest rates – in other words, standard policy measures – have remained the key instrument of monetary policy in the euro area. These rates have always been set at levels which the Governing Council has deemed appropriate for the delivery of price stability over the medium term.

In considering the implementation of standard monetary policy measures during the financial crisis, two issues are worth particular attention.

First, the close relationship normally observed between the key policy rate and short-term money market rates assumed a more complex form during the crisis.[7] It was important to recognise that, in times of crisis, a broader set of market interest rates, extending beyond the very short-term money market rates, was relevant in signalling the monetary policy stance, given the segmentation of financial markets, also taking into account that only a fraction of the banks had access to the unsecured EONIA.[8] Hence, the new positioning of the overnight money market rate was considered acceptable in these exceptional circumstances as a means of helping to offset the impaired functioning of the money market and, in particular, the abnormally high level of spreads on the term money market rates.

The second point I would like to highlight concerns the question of "forward guidance" or "pre-commitment" regarding the future path of key ECB interest rates. Let me emphasise that the Governing Council has never pre-committed to future interest rate decisions. And it did not do so during the financial crisis. The main reason, in our view, is the need for the central bank to retain the ability to react to unforeseeable contingencies without destabilising market expectations.

7 See European Central Bank (2010).
8 See Lenza, Pill and Reichlin (2010).

NON-STANDARD MEASURES

But, in the challenging context of a financial crisis, standard monetary policy proved insufficient. Standard measures have been complemented by a variety of non-standard measures, which have aimed to support the effectiveness and transmission of interest rate decisions.

As I mentioned at the outset, the ECB did not embark on non-standard measures because we thought the scope for further standard easing of the monetary policy stance had been exhausted. On the contrary, when the key rate was reduced to 1% in May 2009, I remarked: "we did not decide today that the new level of our policy rates was the lowest level that can never be crossed, whatever future circumstances may be".[9] We judged then – as we do now – that the level of our key rates was appropriate to serve the maintenance of price stability over the medium term.

Rather, our view was that non-standard measures were required to ensure that the stance of monetary policy was effectively transmitted to the broader economy, notwithstanding the dysfunctional situation in some financial markets.

Two episodes are of particular note.

First, the functioning of the euro interbank money market was impaired, to a greater or lesser extent, from the bankruptcy of Lehman Brothers in September 2008 through the whole of 2009. Given the crucial role of wholesale money markets for monetary policy transmission, dangers were immediately apparent. The flow of credit to the productive sectors of the economy – households and firms – was at risk, as banks faced massive uncertainty about their access to liquidity and funding, both in euro and foreign currencies.

Concerns about the impact of such tensions on bank credit supply were particularly acute in the euro area, given the preponderance of bank loans in corporate financing. About 70% of firms' external financing in the euro area comes via the banking system, compared with only 30% in the United States.

To contain these risks, prompt and decisive action needed to be taken: full allotment, the lengthening of maturities in liquidity provision, the expansion of collateral, the provision of liquidity in foreign currencies and a covered bond purchase programme to support this systemically important market in Europe. All these measures were aimed at supporting bank funding and maintaining the regular flow of bank credit to the private sector.

The second episode relates to the emergence of tensions in European sovereign debt markets earlier this year. Again, given the central role played by government bond markets in the financial system, dysfunctionality in these market segments threatened the effective transmission of monetary policy.

9 Trichet (2009).

We must remain mindful that the euro area consists of 16 sovereign states. It is not a fully-fledged political union or a fiscal federation, within a unified government bond market. The SMP programme has been designed to help restore a more normal functioning of the monetary policy transmission channels in countries where the sovereign debt markets were starting to be dysfunctional.

In light of these different episodes, what more general conclusions can be drawn regarding the ECB's non-standard measures? I would identify five principles that have shaped our thinking about these measures.

First, the design and implementation of such measures remains focused on the ECB's primary objective – the maintenance of price stability.

Second, non-standard measures are not intended to "fine-tune" the transmission mechanism. Instead, they aim to remove the major roadblocks. If you like, there is a "threshold effect": the measures must address a problem of significant magnitude to warrant exceptional action.

Third, the instruments employed in implementing such non-standard measures must lie within the usual realm of central banking. While rather exceptional (at least in the ECB's experience prior to the outbreak of the crisis), measures such as full allotment tenders at fixed rates, operations with one-year maturity and outright purchases or market operations in government bonds are all part of the traditional central bank armoury.

Fourth, the non-standard measures, by their nature, are temporary, to the extent that they have to be strictly commensurate to the degree of dysfunctionality of markets that is hampering the transmission mechanism. The central bank must guard against the danger of the necessary measures in a crisis period evolving into dependency once conditions normalise.

This naturally leads to the fifth principle: non-standard measures must be fully accompanied by an environment aiming at reactivating the private markets. In particular, the private sector, regulators and supervisors, and the fiscal authorities must face the right incentives to address the major underlying problems, such as distressed banks or fiscal weaknesses.

As we look to the future, these basic principles will continue to govern our approach to the conduct of monetary policy in the euro area, through both standard and non-standard means.

3 LESSONS FROM THE CRISIS FOR MACROECONOMICS AND FINANCE THEORY

Allow me now to turn to the broader issue of lessons from the crisis for macroeconomics and finance.

When the crisis came, the serious limitations of existing economic and financial models immediately became apparent. Arbitrage broke down in many market segments, as markets froze and market participants were gripped by panic. Macro models failed to predict the crisis and seemed incapable of explaining what was happening to the economy in a convincing manner.[10] As a policy-maker during the crisis, I found the available models of limited help. In fact, I would go further: in the face of the crisis, we felt abandoned by conventional tools.

In the absence of clear guidance from existing analytical frameworks, policy-makers had to place particular reliance on our experience. Judgement and experience inevitably played a key role.

In exercising judgement, we were helped by one area of the economic literature: historical analysis. Historical studies of specific crisis episodes highlighted potential problems which could be expected.[11] And they pointed to possible solutions.[12] Most importantly, the historical record told us what mistakes to avoid.[13] On this point, I look forward to this afternoon's discussion in our economic history panel.

But relying on judgement inevitably involves risks. We need macroeconomic and financial models to discipline and structure our judgemental analysis. How should such models evolve?

The key lesson I would draw from our experience is the danger of relying on a single tool, methodology or paradigm. Policy-makers need to have input from various theoretical perspectives and from a range of empirical approaches. Open debate and a diversity of views must be cultivated – admittedly not always an easy task in an institution such as a central bank. We do not need to throw out our DSGE and asset-pricing models; rather, we need to develop complementary tools to improve the robustness of our overall framework.

Which lines of extension are the most promising? Let me mention three avenues that I think may have been neglected by the existing literature.

First, we have to think about how to characterise the *homo economicus* at the heart of any model. The atomistic, optimising agents underlying existing models do not capture behaviour during a crisis period. We need to deal better with heterogeneity across agents and the interaction among those heterogeneous agents. We need to entertain alternative motivations for economic choices. Behavioural economics draws on psychology to explain decisions made in crisis circumstances.[14] Agent-based modelling dispenses with the optimisation assumption and allows for more complex interactions between agents.[15] Such approaches are worthy of our attention.

10 See, for example, Caballero (2010).
11 See, for example, Reinhart and Rogoff (2010).
12 See, for example, Jonung (2009).
13 For an example of the guidance offered by economic history, see Bernanke (2000).
14 See, for example, Diamond and Vartiainen (2007)
15 See, for example, LeBaron (2000).

Second, we may need to consider a richer characterisation of expectation formation. Rational expectations theory has brought macroeconomic analysis a long way over the past four decades. But there is a clear need to re-examine this assumption. Very encouraging work is under way on new concepts, such as learning[16] and rational inattention.[17]

Third, we need to better integrate the crucial role played by the financial system into our macroeconomic models. One approach appends a financial sector to the existing framework,[18] but more far-reaching amendments may be required. In particular, dealing with the non-linear behaviour of the financial system will be important, so as to account for the pro-cyclical build-up of leverage and vulnerabilities.[19]

These are certainly areas of rich potential, as I think we will hear tomorrow in our panel session on alternative approaches to economic analysis.

In this context, I would very much welcome inspiration from other disciplines: physics, engineering, psychology, biology. Bringing experts from these fields together with economists and central bankers is potentially very creative and valuable.[20] Scientists have developed sophisticated tools for analysing complex dynamic systems in a rigorous way.[21] These models have proved helpful in understanding many important but complex phenomena: epidemics, weather patterns, crowd psychology, magnetic fields. Such tools have been applied by market practitioners to portfolio management decisions, on occasion with some success. I am hopeful that central banks can also benefit from these insights in developing tools to analyse financial markets and monetary policy transmission.

An important perspective that researchers in other fields bring to economics is a focus on identifying the features that explain economic systems *as we know them*. Many aspects of the observed behaviour of financial markets are hard to reconcile with the "efficient markets" hypothesis,[22] at the heart of most conventional models.[23] Of course, establishing what the key features are remains an unresolved and difficult problem.[24] But a determinedly empirical approach –

16 See Evans and Honkapohja (2001).
17 See, for instance, Sims (2003); and Maćkowiak and Wiederholt (2009).
18 See Christiano, Motto and Rostagno (2003)
19 See Geanakoplos (2010).
20 One example of such interaction was the conference "New directions for understanding systemic risk" organised by the Federal Reserve Bank of New York and the US National Academy of Sciences in May 2006 (see the proceedings reported at http://www.newyorkfed.org/research/epr/2007n1.html).
21 Such techniques rely on models: built on the law of large numbers, exemplified by the statistical physics underlying modern thermodynamics; or that rely on advances in mathematical analysis, as embodied in hydrodynamics and turbulence theory. The main unifying theme is that a complex "macro" phenomenon is explained by postulating some simple behaviour of a "micro" element (an atom, particle or molecule) at the basis of the process under study and evaluating these postulates empirically using statistical and simulation methods.
22 Fama (1970).
23 See Farmer and Geanakoplos (2008).
24 See Bouchaud (2010).

which places a premium on inductive reasoning based on the data, rather than deductive reasoning grounded in abstract premises or assumptions – lies at the heart of these methods. In operationalising these insights, simulations will play a helpful role.[25] Using such approaches can help to deepen our understanding of market dynamics and the behaviour of the economy.

4 CONCLUSION

The lessons of the crisis for macroeconomic and financial analysis are profound. And the current situation remains very demanding.

Our economies and citizens rely deeply on decisions by policy-makers. These, in turn, rely very much on two foundations in the economic field: the credibility of central banks and the credibility of governments. The credibility of central banks relies on their capacity to deliver price stability over the medium term in line with their definition of price stability, and thereby solidly anchor inflation expectations. The credibility of governments means that they must preserve and consolidate their creditworthiness. In order to do so, they need, in particular, to consolidate public finances and thereby contribute to longer-run and sustainable growth.

In one sentence: in this still exceptionally demanding and uncertain environment for the financial sector and the real economy, it is essential to preserve and reinforce the authority of public authorities.

A final word on the European Union and euro area governance. As you know, the ECB's Governing Council has, since its inception, constantly called upon executive branches to apply strictly, preserve and reinforce the fiscal and economic governance of the euro area. In 2004 we defended fiercely the Stability and Growth Pact, which was under attack by the major countries of Europe. In 2005 we expressed solemnly our "grave concerns" as regards the amendments brought about to the corrective arm of the Pact. Also in 2005 we called for the governance of the euro area to be enlarged to include the surveillance of competitive indicators and imbalances. In recent days, taking into account the lessons of the global crisis, in particular as regards its impact on the European single market and the single currency area, we have called, and are still calling, for a quantum leap of governance. Every day I am even more convinced that this is absolutely essential. And I am sending this message, as solemnly today, as in 2005 when I expressed, on behalf of the Governing Council, those "grave concerns" that I just quoted.

25 See Bouchaud (2009).

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SESSION I

MONETARY POLICY STRATEGIES – EXPERIENCE DURING THE CRISIS AND LESSONS LEARNT

LESSONS FOR MONETARY POLICY STRATEGIES FROM THE RECENT PAST[1]

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ABSTRACT

We evaluate the ECB's monetary policy strategy against the underlying economic structure of the euro area economy, in normal times and in times of severe financial dislocations. We show that in the years preceding the financial crisis that started in 2007 the ECB's strategy was successful at ensuring macroeconomic stability and steady growth. Emphasis on monetary indicators in the policy process – the monetary pillar of the ECB's monetary policy strategy – was instrumental in avoiding more volatile and less predictable patterns of inflation and output growth. After the collapse of financial intermediation in late 2008, the strategy of the ECB was to preserve the integrity of the monetary policy transmission mechanism by adopting a comprehensive package of non-standard policy measures. The liquidity interventions decided in October 2008 and in May 2009 were critical to preserving price stability and forestalling a more disruptive collapse of the macroeconomy.

1 INTRODUCTION

The outbreak of the financial turmoil in 2007, the subsequent financial crisis and the collapse in trade and economic activity in 2008 following the default of Lehman Brothers have led to a rethinking of monetary policy frameworks. Recent contributions to this debate include Bean et al. (2010) and Mishkin (2010).

In this paper, we focus mainly on two aspects of this debate with reference to the euro area and US experience over the last 15 years. First, the financial boom and bust episode of the new millennium has brought into question the appropriateness of what is sometimes called the "Jackson Hole consensus". According to this

1 The views expressed in this paper are our own and not necessarily those of the European Central Bank or its Governing Council. We thank Gianni Amisano, Gergely Kiss, Huw Pill, Jean Pisani-Ferry, Guido Tabellini, Jens Ulbrich, Jean-Pierre Vidal and Bill White for their helpful comments on an earlier draft. We gratefully acknowledge Pavel Gertler's and Kerstin Holzheu's research assistance.

consensus, central banks should only respond to asset prices and financial imbalances to the extent that they affect the inflation forecast.[2] Other observers, including White (2006) and Rajan (2005), had warned that price stability may not be sufficient for financial stability and suggested that central banks should lean against the emergence of financial imbalances by tightening their monetary policy stances.

The ECB's monetary policy strategy with its medium-term orientation and emphasis on monetary and credit analysis explicitly involves looking beyond short-term price developments and taking into account the medium-term implications of booming asset prices and credit markets for price stability.[3] As argued by Trichet (2009), excessive money and credit growth in 2004 and 2005 was an important factor in the decision not to reduce the main refinancing rate below 2% in 2004 and underpinned the need to start a normalisation process from low interest rates in 2005. In Section 3 of this paper, we argue that, in line with the ECB's monetary policy strategy, responding to money and credit developments helps to stabilise both inflation and output. We, therefore, argue that one of the important lessons from the crisis is that money and credit should play an enhanced role in monetary policy strategies.[4]

Second, the great recession has led to an unprecedented use of non-standard monetary policy tools for two reasons. First, central banks had to intervene in financial markets to prevent liquidity problems turning into solvency problems with an eventual breakdown of the monetary transmission mechanism. Malfunctioning interbank and other financial markets called upon central banks to take on a more active financial intermediation role. They also highlighted the fact that there was no longer a single market rate owing to the collapse of normal arbitrage activities. Second, because monetary policy had to be eased beyond what can be achieved by reducing short-term interest rates close to their lower bound, a number of central banks had to pursue alternative policies of quantitative and credit easing. The notion that the policy-controlled, short-term interest rate is the sole tool of monetary policy has thus been questioned.

The ECB's broad and flexible operational framework with a large number of counterparties and a broad set of collateral allowed for a quick and pervasive expansion of its intermediation role in the interbank market, which was first demonstrated when tensions arose on 9 August 2007.[5] In Section 4, we discuss some of the non-standard policy measures the ECB took to address the malfunctioning in financial markets. We discuss these measures in the context of the academic literature and argue that the ECB intervention – which, notably, did not include entering into commitments regarding the future path of policy – was important to avoid disorderly deleveraging in the banking sector and instrumental in sustaining credit creation and averting downside risks to price stability.

2 See, for example, Bernanke and Gertler (1995) and the response by Cecchetti et al. (2000).
3 See, for example, Trichet (2004) and Issing (2002).
4 Another important lesson of the crisis which we do not examine here is the need for a new macro-prudential policy framework.
5 See Cassola, Durré and Holthausen (2010) for a thorough review.

Before addressing those two issues in the rest of this paper, we first review in Section 2 the euro area experience of the last 15 years in terms of nominal, real and financial stability. This provides the background and illustrates the developments we try to explain in the paper. For comparison, we contrast euro area evidence with that from the United States. We show that during the decade prior to the financial crisis, low and stable inflation and low volatility in economic activity coexisted with highly pro-cyclical asset prices. In the late 1990s this mostly took the form of rising stock prices, buoyant investment and rising credit, whereas in the middle of the last decade, rising house prices and mortgage debt with falling external finance premia were the main features. The secular rise in private debt associated with the low real and nominal volatility and the falling external finance premia contributed to the sharpness of the correction in the most recent recession. An important feature of the euro area experience is that medium and long-term inflation expectations have been strongly anchored throughout the last 15 years, including during the period of the financial crisis. This has contributed to limiting the consequences of adverse shocks.

2 A TALE OF THE LAST 15 YEARS

In this section, we briefly review the developments in inflation, economic activity and financial markets over the past 15 years in the euro area and the United States. In Section 2.1 we first document how, following a period of great moderation, the financial crisis has affected the level and the volatility of inflation and economic activity. Section 2.2 then describes the underlying behaviour of financial markets.[6]

2.1 THE GREAT MODERATION AND THE FINANCIAL CRISIS

The Treaty creating the monetary union establishes price stability as the primary objective of monetary policy in the euro area. To provide a clear yardstick against which the public can hold the ECB accountable and with a view to anchoring medium to long-term inflation expectations, the Governing Council of the ECB adopted a quantitative definition of price stability in 1998. This definition reads: "Price stability shall be defined as a year-on-year increase in the Harmonised Index of Consumer Prices (HICP) for the euro area of below 2%. Price stability is to be maintained over the medium term." Following a thorough evaluation of the monetary policy strategy in 2003, the Governing Council clarified that it aims to keep HICP inflation "below, but close to, 2%".[7]

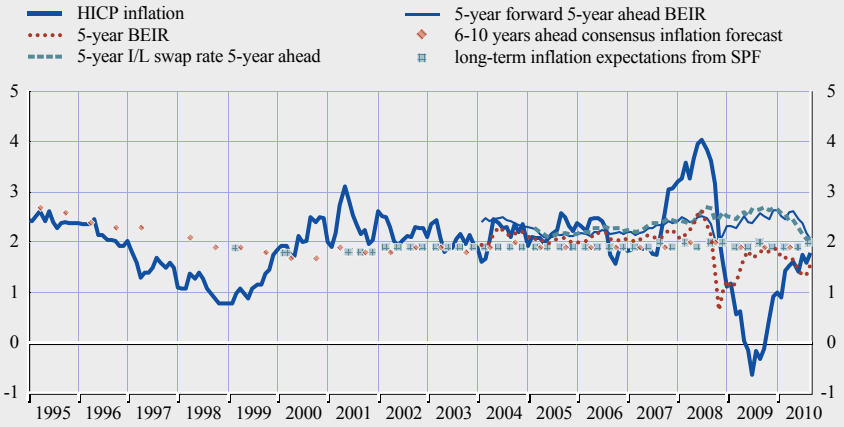
Chart 1 plots HICP inflation over the past 15 years, as well as various survey and market-based measures of medium-term inflation expectations. The average annual inflation rate in the euro area between January 1999 and September 2010 was 1.97%, about 0.65% lower than average inflation in the same 16 countries

6 The review in Section 2 is very selective. One of the important developments over this period that we do not focus on is the process of real and financial globalisation.

7 One of the reasons for keeping inflation close to 2% was to allow for a buffer in the presence of the lower bound on nominal interest rates. See Section 3 for a detailed analysis of the ECB's monetary policy strategy.

Chart 1 Stable inflation and inflation expectations

(stage three of EMU)

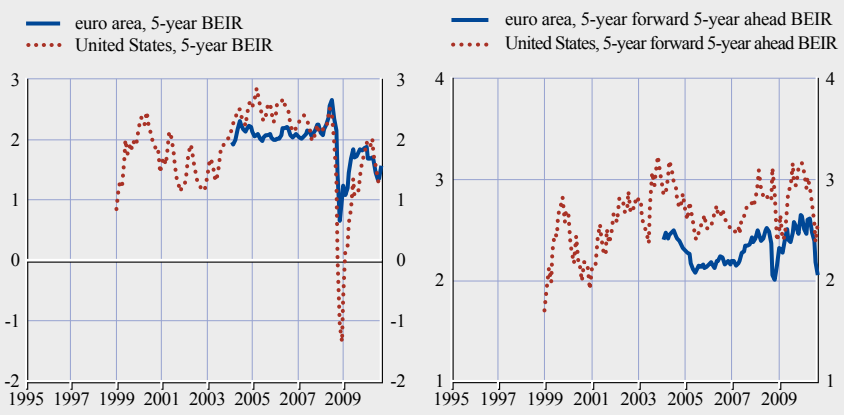


Sources: Consensus, ECB Survey of Professional Forecasters (SPF), Eurostat, Reuters and ECB calculations.
Notes: BEIR is the break-even inflation rate from the comparison of inflation indexed to conventional sovereign bonds. Last observation refers to September 2010.

of the current euro area in the decade prior to Economic and Monetary Union (EMU). More importantly, medium-term inflation expectations as measured by Consensus Economics or the ECB's Survey of Professional Forecasters have consistently been very close to 1.9%. Moreover, as shown in Smets (2010) and Orphanides (2010), differences across forecasters as, for example, captured by the standard deviation, systematically narrowed from the start of EMU up until the outbreak of the crisis.

This stability of inflation expectations can also be observed in other major economies. For example, Chart 2 compares the five-year ahead spot and

Chart 2 Inflation expectations in the euro area and the United States



Sources: Federal Reserve, Reuters and ECB calculations.
Note: BEIR is the break-even inflation rate from the comparison of inflation indexed to conventional bonds.

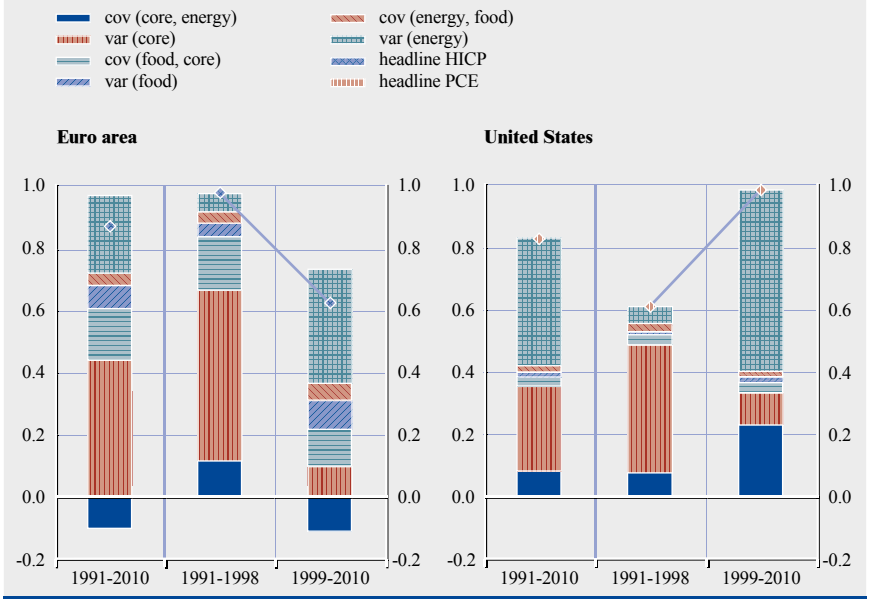
five-year forward, five-year ahead break-even inflation rates (BEIRs), as measured by the difference between nominal and indexed bond yields for the euro area and the United States. The euro area in this respect compares well with the experience in the United States.[8]

With the exception of the most recent period in which inflation briefly reached 4% in 2008 and subsequent negative rates in 2009 owing to highly volatile energy and commodity prices, annual inflation has fluctuated around 2% in a relatively narrow band. Chart 3 shows that the volatility of headline inflation since EMU has fallen significantly compared with the pre-EMU period. This has occurred because of a strong stabilisation of core inflation[9] and in spite of the surge in energy inflation volatility. An additional factor contributing to low inflation volatility is the negative correlation between core and energy inflation observed in the euro area. This negative correlation absorbed some of the increased volatility of energy inflation and is a special feature of the euro area data since EMU. The ECB's clear focus on headline inflation may have contributed to the negative correlation as potential cost-push factors are

8 The stability of inflation expectations has also been documented using more rigorous econometric techniques in Beechey et al. (2010) and Ehrmann et al. (2010). Galati et al. (2010) investigate whether the financial crisis has affected the stability of inflation expectations.

9 Core inflation is defined here for comparability reasons as headline inflation excluding processed and unprocessed food and energy prices.

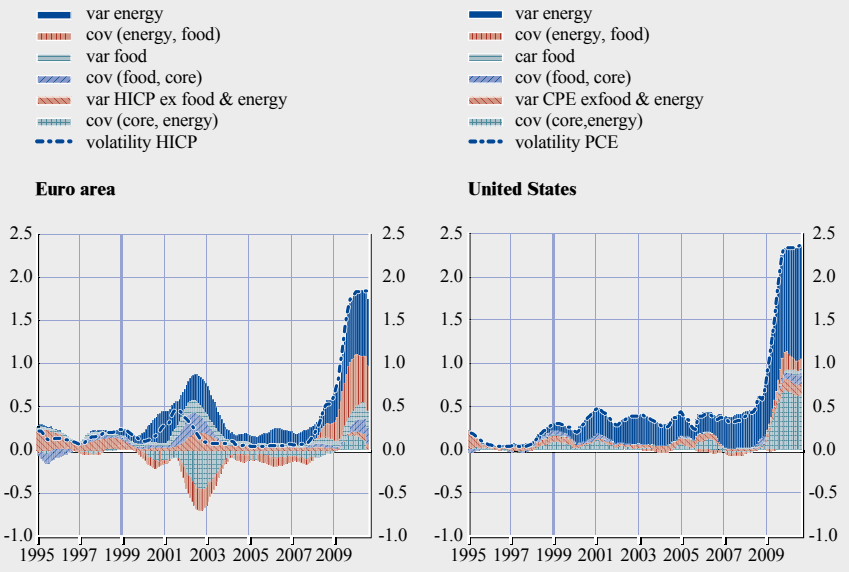
Chart 3 Variance decomposition of inflation



Sources: BEA, ECB, Eurostat, Federal Reserve and ECB calculations.

Notes: Inflation refers to HICP inflation for the euro area and personal consumption expenditure (PCE). Core refers to headline inflation excluding food and energy. "Var" is variance, "Cov" is twice the covariance between the respective measures in order to sum up to overall variance of the headline measure.

Chart 4 Variance decomposition of inflation over time Euro area



Sources: BEA, ECB, Eurostat, Federal Reserve and ECB calculations.

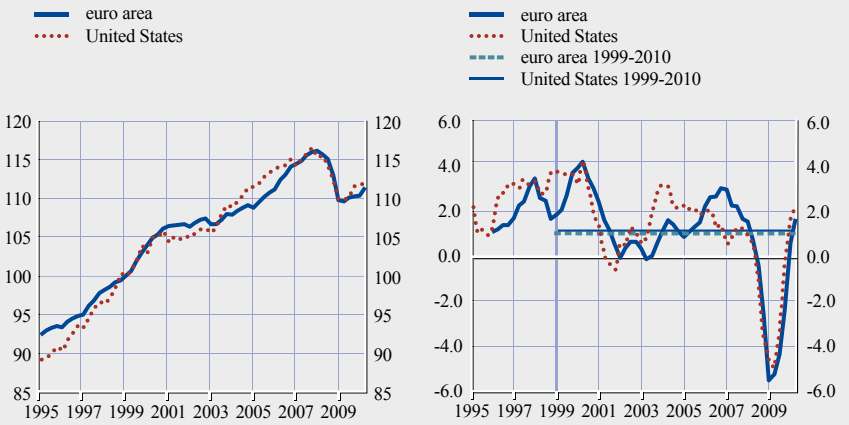
Notes: The variance is computed as 36-month moving windows. Inflation refers to HICP inflation for the euro area and the personal consumption expenditure (PCE) deflator for the United States. Core refers to headline inflation excluding food and energy. "var" is variance, "cov" is twice the covariance between the respective measures in order to sum up to overall variance of the headline measure.

offset through anchored inflation expectations. Chart 4 shows a decomposition of headline inflation volatility over time using a backward-looking 36-month moving window. It reveals that the negative correlation between food and energy as well as between core inflation and energy appeared relatively soon after the beginning of EMU and became strongest over the three years leading up to 2002, a period of declining energy prices and increasing core inflation. Chart 4 further shows the sharply increased volatility of inflation rates during the most recent crisis episode. This is, however, mainly due to the sharp rise in the volatility in energy and food price inflation, combined with stronger positive co-movement between all three considered sub-components of headline inflation.

The stabilisation of headline inflation at low levels in the euro area has not been at the expense of reduced growth performance.[10] As shown in Chart 5, average annual per capita growth since the start of EMU until the end of 2010

10 The Treaty on the Functioning of the European Union indicates price stability as the primary objective of the European System of Central Banks (ESCB), but in addition states that "[w]ithout prejudice to the objective of price stability, the ESCB shall support the general economic policies in the Union" (Article 127(1), as updated by the Lisbon Treaty). The purpose of these general economic policies is to "establish an internal market. It shall work for the sustainable development of Europe based on balanced economic growth and price stability, a highly competitive social market economy, aiming at full employment and social progress […]" (Article 3(3) European Union Treaty). The ECB is able to contribute to these objectives through its pursuit of price stability.

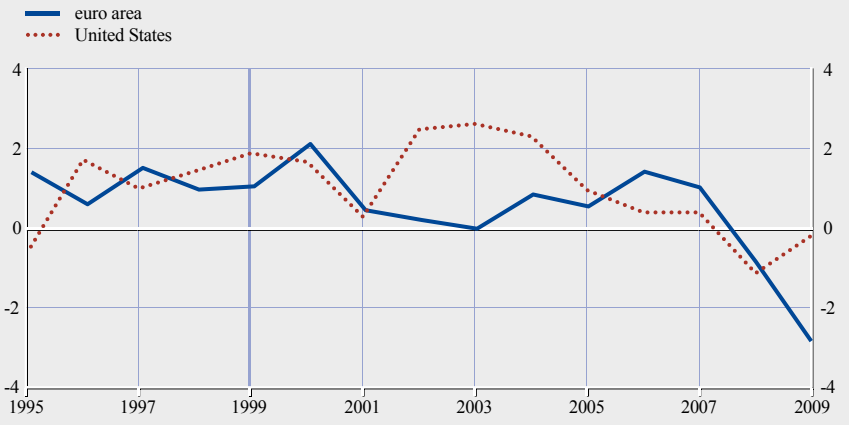
Chart 5 Output per capita performance



Sources: BEA, Eurostat and ECB calculations.
Notes: Output per capita is real GDP divided by total population. Left panel: Q1 1999 =100; right panel: annual percentage changes. Last observation refers to Q2 2010.

was 1.1%, compared with 1.2% for the United States. Output per capita for the euro area and the United States is about 11% higher than in the first quarter of 1999, although the growth dynamics between the two regions have differed over time. The United States took a stronger hit after the burst of the dot-com bubble, but performed especially well in 2004-05 when the euro area suffered from subdued growth performance. This strong growth performance compared with the euro area was mainly due to large differences in total factor productivity developments in the years 2002 to 2004, as documented in Chart 6. Section 3 further elaborates on the consequences of these supply shocks for the economy

Chart 6 Total factor productivity



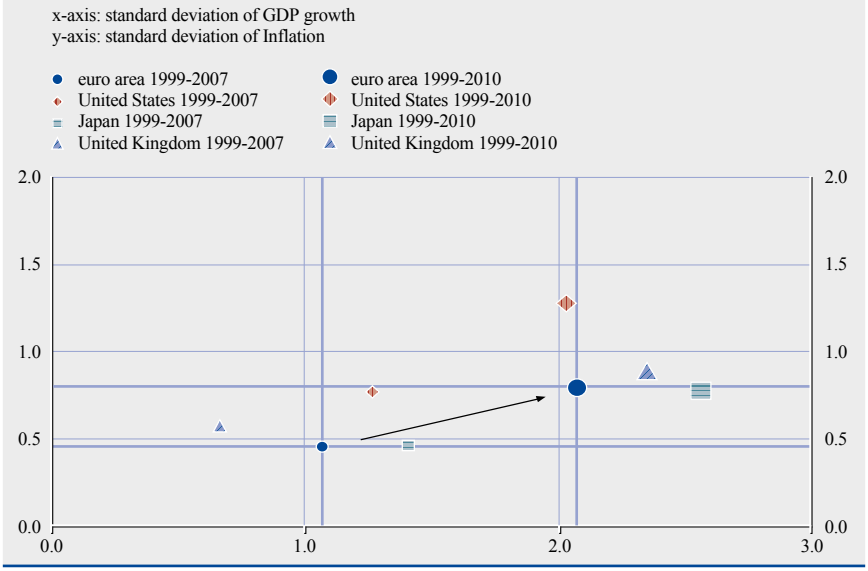
Sources: Basu and Fernald (2009) and ECB calculations.
Note: Total factor productivity is obtained from growth accounting taking into account labour and capital quality.

and particularly for inflation and monetary policy. Remarkably, both regions went through a similar contraction of about 5% on an annual basis during the acute period of the financial crisis, demonstrating in an impressive way the global implications of the crisis, which was evidenced in the trade collapse towards the end of 2008 and the beginning of 2009.

Chart 7, adapted from Benati and Goodhart (2010), shows how the financial crisis has put a (temporary) end to the long period of low nominal and real economic volatility in industrial countries. The period before the financial crisis, known as the "Great Moderation", was the result of a number of factors that can be grouped into: a) structural change, e.g. better inventory management (McConnel and Perez-Quiros (2000)) or financial innovation and better risk sharing (Blanchard and Simon (2001)); b) improved macroeconomic policies, such as the establishment of stability-oriented monetary policies; and c) good luck, i.e. the absence of large shocks such as the oil price crises of 1974 and 1979.[11] The relative importance of these factors has been hotly debated, but all three factors are likely to have contributed to a reduction in volatility.[12] The strong increase in volatility becomes apparent when extending the sample from the beginning of EMU to cover the recent crisis period. All four economies that we consider (the euro area, the United States, Japan and the United Kingdom) have experienced

11 See Bernanke (2004) for an overview of the factors behind the great moderation from a policy perspective. The break in volatility in real GDP was first documented by McConnell and Perez-Quiros (2000).
12 See, for example, Stock and Watson (2004).

Chart 7 Macroeconomic volatility over two periods for various economies

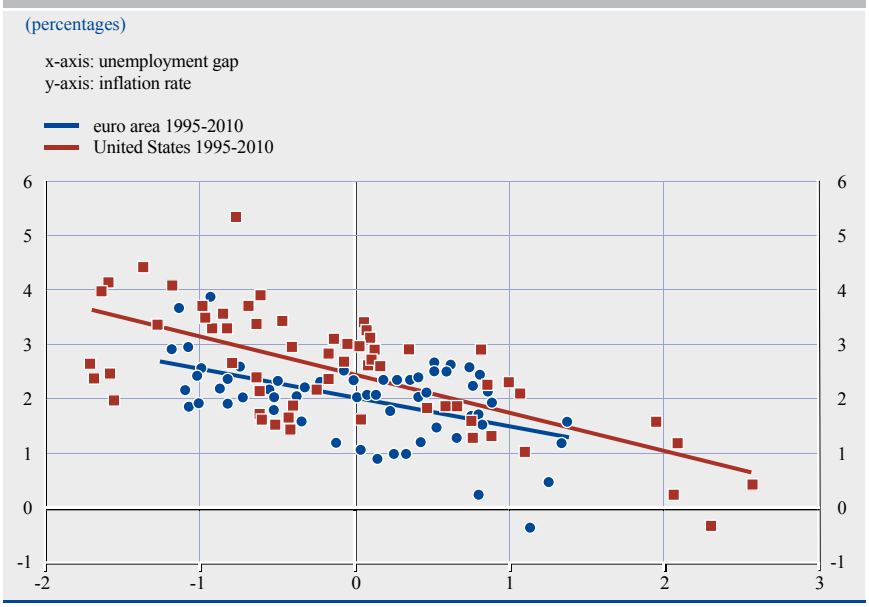


Source: OECD. Adapted from Benati and Goodhart (2010).
Note: Inflation is annual CPI inflation, GDP growth is annual real GDP growth.

a stronger increase in real output volatility than in price inflation, probably reflecting the strong anchoring of inflation expectations throughout the crisis.

A number of additional observations are worth making. First, there is no apparent trade-off between output and inflation volatility in the cross-section of industrial countries shown in Chart 7. This may be partly due to the fact that the shocks have varied across countries. Nevertheless, both output and inflation volatility have been relatively small in the euro area compared with other countries. However, to the extent that the stability-oriented monetary policy of the ECB has been successful in anchoring inflation expectations and avoiding inflation or deflation scares, it may also have supported an inward shift of the output/inflation volatility trade-off. Smets (2010) illustrates this mechanism by performing a counterfactual simulation of the recent recession using the ECB's New Area-Wide Model. This simulation shows that a higher sensitivity of long-term inflation expectations to actual headline inflation would have deepened the most recent recession significantly and led to a longer period of deflation, in particular in the light of the lower bound on interest rates. Notwithstanding the differences in policy objectives and the role played by inflation expectations as well as differences in labour market institutions, the trade-off between inflation and the unemployment gap – referred to as the Phillips curve – appears to be very similar over the past 15 years in the euro area and the United States (see Chart 8). It appears that different features of labour market and price-setting

Chart 8 Similar Phillips curves across the euro area and the United States



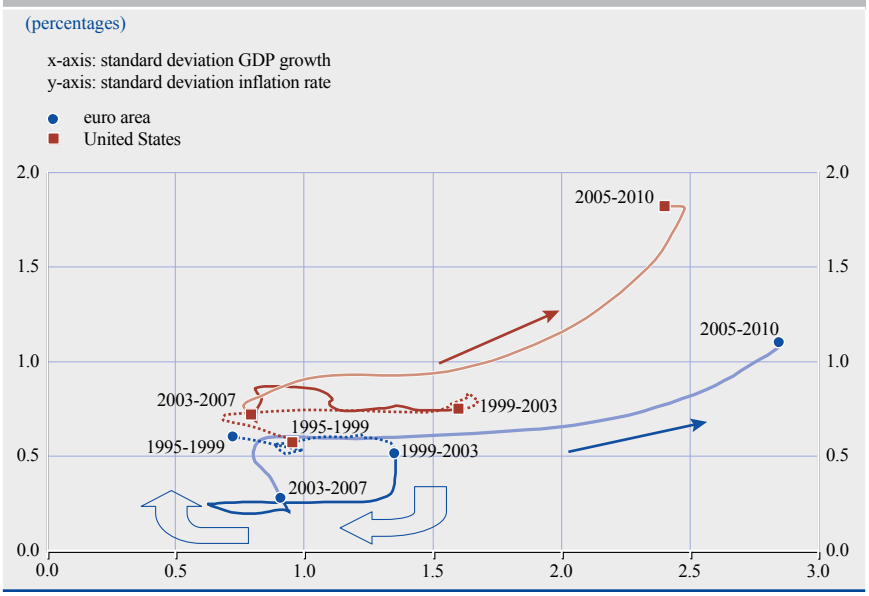
Sources: AWM database (see Fagan et al. (2001)), BLS, Eurostat and ECB calculations. Adapted from Anderton and Hiebert (2009).

Notes: Inflation is computed using HICP inflation for the euro area and CPI inflation for the United States. The unemployment gap is computed as the difference between the unemployment rate and trend unemployment using HP filter (20000).

institutions compensate each other to deliver a similar sacrifice ratio. However, the range of inflation and unemployment gap outcomes is smaller in the euro area than in the United States. The chart also reflects the fact that the flattening of the Phillips curve, which can be observed if considering data only up to 2007, may have been a temporary phenomenon of the last few years of the great moderation.

Second, there has been a uniform outward shift in the volatility of output and inflation following the financial crisis. A closer look at the dynamic evolution of inflation and output growth volatility is presented in Chart 9 by employing a five-year window for computing volatilities from 1995 until the present. The chart indicates that the turn of the century led to an increase in output growth volatility in the euro area and the United States associated with the burst of the dot-com bubble in 2001, but inflation volatility remained constant. If anything, inflation volatility slightly declined for the euro area, whereas it increased somewhat for the United States. The 1999-2003 window marks the first period entirely under the auspices of the ECB. Thereafter, and up until 2007, inflation volatility and output growth volatility declined. The traditional stabilisation trade-off became a "trade-in" for the euro area. In the United States, output volatility was reduced as well, but inflation volatility remained at its previous levels. Most recently, as energy prices began to rise significantly in 2007 and 2008, volatilities in both the euro area and the United States increased, first for inflation in the euro area, but later for output growth too, particularly following the financial crisis.

Chart 9 Macroeconomic volatility over time



Sources: BEA, BLS and Eurostat.
Note: Inflation is computed using HICP inflation for the euro area and CPI inflation for the United States.

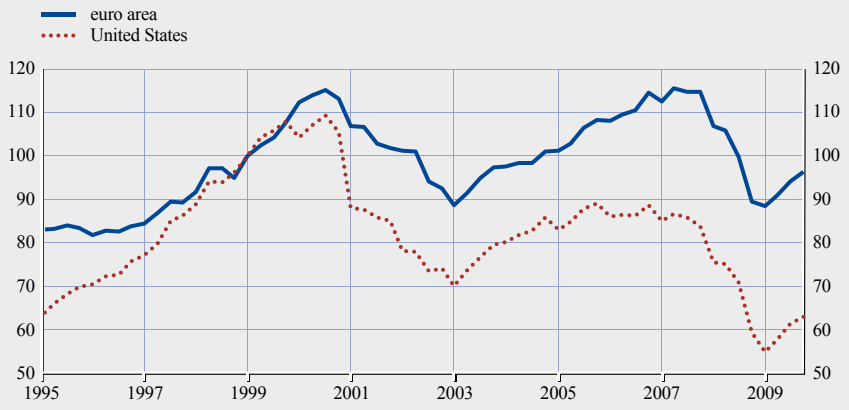
In conclusion, while the volatility of headline inflation and economic activity has increased quite dramatically over the past three years, average headline inflation and medium-term inflation expectations have remained closely anchored to the ECB's definition of price stability. This, in turn, has contributed to a stabilisation of both nominal and real volatility. The low macroeconomic volatility during most of the early part of the new millennium may have contributed to a reduction in the perception of risk and an increase in leverage and debt, which subsequently exacerbated the depth of the financial crisis. In the next section, we turn to some of the developments in financial markets.

2.2 BOOMS AND BUSTS IN ASSET AND CREDIT MARKETS

The previous section described how the last 15 years have been characterised by price stability. Over the same period, signs of instability existed within the financial sector which eventually led to the most recent crisis. Chart 10 shows the development of aggregate asset prices over nominal GDP in the euro area and the United States since 1995. This measure of aggregate asset prices includes stock market prices as well as residential and commercial property prices weighted by their relative sectoral size.[13] It captures nicely the two boom-bust episodes in this period, illustrating the equity-driven boom and the subsequent dot-com bust at the beginning of the millennium, as well as the cycle predominantly driven by property prices leading to the great recession. The developments of aggregate

13 For the link between asset price booms and money and credit growth, see Borio and Lowe (2002) and Detken and Smets (2004).

Chart 10 Aggregate asset prices over nominal GDP



Sources: BEA, BIS calculations based on national data, Eurostat and ECB calculations.
Notes: Q1 1999 = 100. The Quarterly Aggregate Asset Price Index encompasses prices for equity, residential real estate and commercial real estate. The euro area index is composed using the national series of the eight largest countries (DE, FR, IT, ES, NL, BE, FI, IE) and 30 weighted by their relative real GDP.

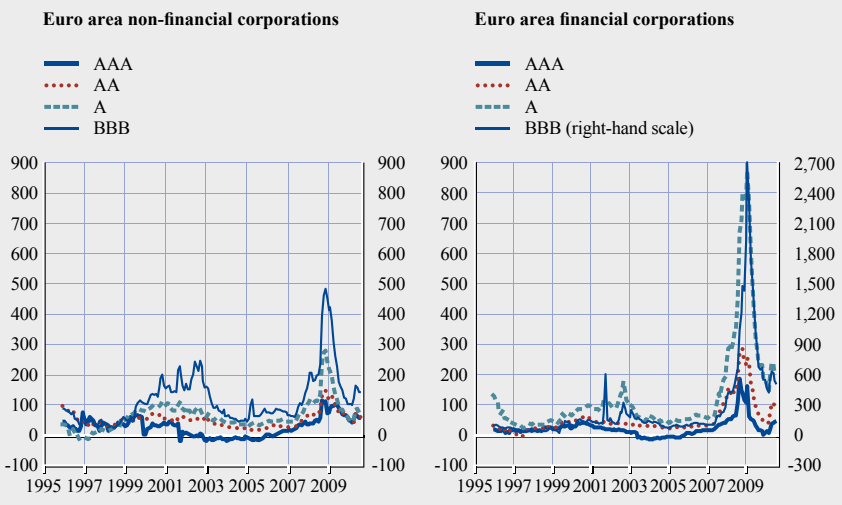
asset prices in the United States and the euro area are amazingly synchronised, with the euro area exhibiting a slightly lower amplitude owing to the relatively lower share of stock prices in the index.

The two boom and bust phases experienced by the United States and the euro area over the past 15 years were clearly different in nature with different implications for the rest of the economy. Chart 11 directly compares the two phases through the lens of corporate bond spreads, separated into financial and non-financial corporations. These spreads indicate the special nature of the recent crisis in comparison with the dot-com bubble in 2001. Spreads between BBB-rated securities of non-financial corporations and AAA-rated government bonds in the euro area increased persistently to above 200 basis points during the bursting of the dot-com bubble, whereas financial securities remained well contained.[14] During the financial crisis, however, BBB-rated financial spreads reached up to 2,700 basis points over AAA-rated government bond yields, while non-financial spreads have a pattern reflecting nothing more than a deeper but common recession.

There are, however, many similarities between the two boom periods. As shown in Chart 12 for the euro area, in both boom periods the rise in stock

14 Two short-lasting spikes can nevertheless be identified, which caused the spreads to rise by more than 200 basis points above the AAA-rated government bond yields.

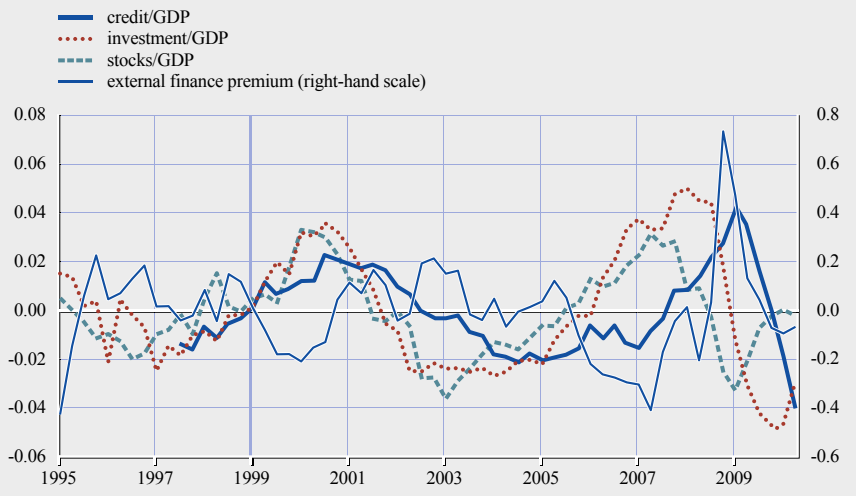
Chart 11 Spreads of corporate securities



Source: Thompson Financial Datastream.

Notes: In basis points. The spreads represent the difference from the EMU benchmark AAA government bond index by Merill Lynch.

Chart 12 Pro-cyclicality of the financial sector in the euro area



Sources: BSI, Dow Jones, Eurostat and ECB calculations.

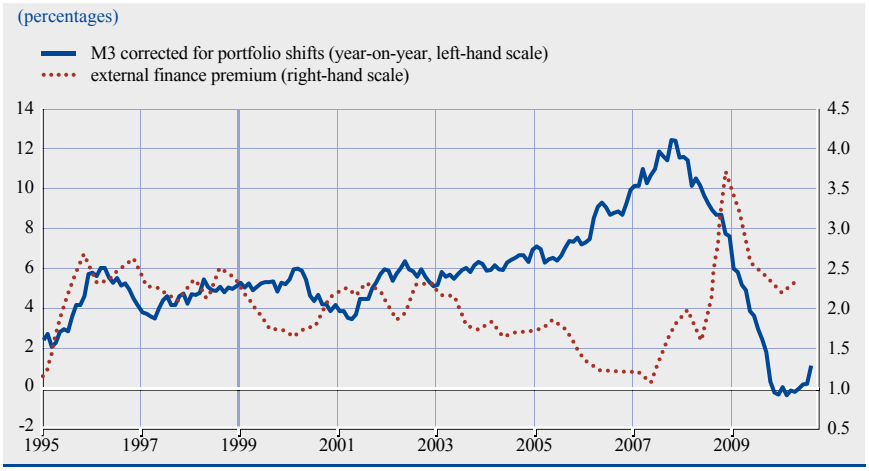
Notes: All series show the percentage deviation from HP (1600)-trend, stocks/GDP rescaled. Credit is defined as total MFI loans and securities to non-financial corporations, investment is total private investment, stocks are represented by the Dow Jones Euro Stoxx 600 index. The external finance premium is measured as an average of spreads between lending rates, including corporate bond yields, and measures of risk-free rates of corresponding maturities.

prices was associated with increasing shares of credit and investment in GDP in the corporate sector and supported by a fall in the external finance premium. The reverse pattern is visible when stock prices fall, illustrating the pro-cyclicality of the financial system. The latter effect is in line with models where collateral valuations are relevant for credit supply such as in the financial accelerator models of Bernanke, Gertler and Gilchrist (1999) or Christiano, Motto and Rostagno (2010). Higher stock prices increase the net worth of borrowers and thereby relax the external finance constraint.

Another complementary interpretation is that higher stock prices and a booming economy increase the risk-taking capacity of the financial sector and thereby lead to lower risk premia, in turn reinforcing the economic boom. This process then goes in reverse when the first signs of a slowing economy become apparent. Recent research has emphasised the importance of such a risk-taking channel as a driver of the business cycle. For example, Adrian and Shin (2010) argue that value-at-risk (VaR) constraints on the banking sector will lead to a pro-cyclical pricing of risk. Recent evidence on the impact of the monetary policy stance on the price of risk and credit standards in a number of financial markets provides support for such an interpretation.[15]

15 See, for example, Jiménez et al. (2009), Bekaert, Hoerova and Lo Duca (2010), Maddaloni et al. (2010), and Gambacorta and Marquez (2010).

Chart 13 Money and external finance premium



Sources: BIS, ECB, Dow Jones and ECB calculations.
Notes: M3 refers to annual growth rates of M3, corrected for portfolio shifts. The external finance premium is measured as an average of spreads between lending rates, including corporate bond yields, and measures of risk-free rates of corresponding maturities, in percentage points.

Chart 13 plots M3 corrected for portfolio shifts and the external finance premium. The chart further confirms the negative correlation between the external finance premium and monetary indicators. As discussed in Section 3, the ECB's monetary analysis can be used to identify signals of the monetary-financial side that affect the economy.[16] At the same time, it has to be acknowledged that monetary policy is not the most efficient instrument to deal with such financial imbalances.

Another feature of Chart 13 worth mentioning is the secular decline in the external finance premium from 1995 till 2007 and the sharp rise thereafter. The decline in the external finance premium up until 2007 also compares well with the widespread finding that the equity premium fell over the same period, as surveyed in the meta-analysis by van Ewijk, de Groot and Santing (2010). This coincides with a secular decline in long-term interest rates, which may partly be the result of the global savings glut observed since the Asian financial crisis in 1997. A complementary explanation for the fall in risk premia is the greater macroeconomic stability during that period. To the degree that greater stability has been achieved through better institutional set-ups and policies, it may provide sound reason for the fall in risk premia. But to the degree that smaller shocks are behind this stability, it may have led to mispricing and overly positive asset valuations.[17]

The fall in risk premia, long-term interest rates and macroeconomic uncertainty may also have played a role in the rise in leverage across sectors in the euro

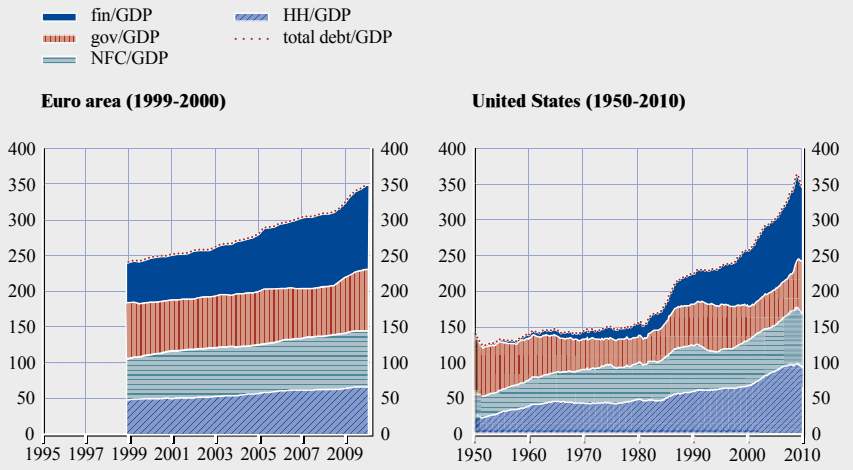
16 See Detken, Gerdesmeier and Roffia (2010) for an overview of methodological improvements in assessing asset price bubbles through monetary analysis.
17 See also Trichet (2008) in this respect.

area and the United States, including over longer periods. Chart 14 shows the evolution of private and government debt in the euro area since 1999 and the United States since 1950. Three observations are worth making. First, according to the national financial accounts, overall private and government debt in both the euro area and the United States exceeded 300% of GDP ahead of the financial crisis. Second, the share of government and corporate debt is relatively larger in the euro area than in the United States, but the rapid growth of debt in the first half of the 2000s in the United States was mainly due to the increase in household debt. Over the short and long run, it was net financial debt (excluding equity) that grew fastest, with strong increases since the mid 1980s. Finally, the most recent rise in overall debt since 2008 was mainly due to an increase in government debt in response to the deep recession, while the private sector has been deleveraging, particularly in the United States. As noted by Reinhart and Rogoff (2008), the increase in sovereign debt levels is typical following a financial crisis and is not primarily caused by the implicit or explicit bailout costs, including guarantees to the private sector, but instead is the consequence of a period of increased use of automatic stabilisers and government spending to offset the recession.

Overall, the period since 1995 has been characterised by booms and busts in asset prices and the build-up of financial imbalances against the background of stable prices and economic activity. The current financial crisis, which started in August 2007, was triggered by a European bank declaring it could not value the underlying assets in three of its funds that were invested in US sub-prime mortgages. Its ultimate source, however, derived from the excessive build-up of debt and leverage in the period of great moderation.

Chart 14 Debt by sector

(as a percentage of GDP)



Sources: Quarterly Euro Area Accounts Eurostat, Flow of Funds Federal Reserve, BEA.

Notes: Debt is defined as loans for euro area households (credit market instruments in the United States); for non-financial corporations and financial corporations debt is credit, securities excluding equity, and pension liabilities, net of inter-company loans (credit market instruments in the United States); debt by governments are loans and securities.

3 THE ECONOMY AND MONETARY POLICY STRATEGY

Macroeconomically speaking, and despite growing financial imbalances, the period between 1999 and 2007 was a successful one for the euro area. Monetary union built a solid constituency for low inflation in Europe. The ECB acceded to the people's demand for economic security by delivering stable prices in a context of steady income progression and moderate real fluctuations. The financial crisis that started in 2007 and deflagrated in 2008 sharply changed that economic landscape. This is where Section 2 leaves us.

In the jargon of Great Moderation analysts, the first nine years of monetary union pose an identification issue. What provided the underpinnings for the good macroeconomic performance? Did monetary policy have an active role in steering the economy along a steady path, which would not have been that steady otherwise? In other words, did the monetary policy strategy lead the economy? If it did, what was the role of monetary analysis in creating the conditions for success?

3.1 STRUCTURAL ANALYSIS

Answering our question of whether the strategy lead the economy requires structural inference and the use of counterfactual analysis, which simulates a change in the systematic pattern of monetary policy conduct. In the jargon of modern quantitative macroeconomics, a strategy is identified by the "policy rule". If the systematic behaviour – the coefficients and the reaction variables – of the central bank had been different, history would have looked different.

But which policy rule is our baseline? And in which directions do we twist its specification in counterfactuals in order to test the performance of the strategy? In synthesis: how can we stress-test a multifaceted strategy on the basis of a policy rule? Arguably, our ambition to assess selective elements of the ECB's monetary policy strategy is limited by the tool at our disposal. This limitation is measurable by considering the list below, which enumerates the main elements of the ECB's monetary policy strategy.

- First, the Treaty that lays down the institutional foundations of EMU instructs the ECB – and the whole European System of Central Banks – to pursue price stability as its *overriding objective*, to which any other policy consideration is to be subordinated. The ranking of priorities is clearly hierarchical.

- Second, as mentioned in Section 2, the Governing Council of the ECB has quantified its overriding objective with a range of values for inflation – positive inflation rates of below 2% – which, if realised over the horizon that is relevant for policy (see below), would be consistent with the attainment of price stability. Here, it is critical to note that a quantitative definition of price stability is not a point target for inflation.

- Third, the Governing Council has enunciated that, in pursuing its objective, it will aim to maintain inflation around values not too far below 2% in the

medium term. The notion of the medium-term horizon is critical. It is not preset or quantified, but it is meant to depend on the nature and source of the shocks that hit the economy from time to time. And, even more importantly, it is associated with a steady-handed response to the evolution of the economic state – realised or expected – and a rejection of day-to-day fine-tuning.[18]

- Fourth, in assessing the risks to price stability, the Governing Council gives great prominence to monetary factors, which – if left unattended – can pose threats to price stability over longer horizons. Analysis of monetary trends and imbalances – for example, money and credit growing consistently out of line with sustainable trajectories – is a cornerstone of the strategy. It provides a perspective from which the Governing Council cross-checks the robustness of the policy implications that emanate from standard conjunctural analysis and macroeconomic projections. It is an insurance against policy myopia.

The distance between these strategic principles and the measurement tool at our disposal is evident. Price stability is a pre-ordered policy priority in the ECB's statutes, but it is only a weighted objective among others in the policy rule that we estimate and simulate. Put differently, our rule is non-hierarchical. A quantification of price stability is not an inflation point target. Yet, specifying a policy rule requires postulating a reaction to inflation in deviation from a single numerical value. The medium-term horizon is not a fixed time window in the ECB's strategy, but it necessarily has a mechanical element in the policy feedback in our simulations. Finally, a two-pillar strategy where the Governing Council systematically cross-checks inferences and policy implications across different ways to describe the monetary transmission mechanism is, by construction, impossible to render if one – like us – is to use a single model. These are the terms of our heuristic compromise.

Our analysis in this section will fall short of the task in a further dimension, namely that it will be selective. We will mainly concentrate on one element of the strategy: the role of monetary analysis. The prominent role of monetary analysis is critical to the entire structure of the strategy, but has been contentious to a varying degree of intensity over time. We will try to demonstrate that it has inspired a policy attitude which could have been instrumental in avoiding major policy mistakes over the recent past. Those mistakes, if incurred, would have worsened the starting conditions in which the ECB would have found itself when the crisis hit its climax in the autumn of 2008.

In order to generate the structural inference that we need as a precondition of our counterfactual simulations, we need a structural model of the euro area economy. Because our counterfactual critically involves the central bank reacting to monetary phenomena – specifically, under the second pillar of the ECB's monetary policy strategy – we choose to conduct our exercise using the structural model documented in Christiano, Motto and Rostagno (2010; hereinafter "CMR"). This framework combines the standard features of a dynamic general

18 For a different view on the role that fine-tuning should receive in the monetary policy strategy, see Blinder and Reis (2005) who suggested that the Federal Reserve System under Chairman Greenspan brought "new life" to the idea that the central bank should pursue fine-tuning.

equilibrium model of the monetary business cycle, such as the one presented in Smets and Wouters (2003, 2007), with variables pertaining to the financial and monetary sector.

Our exercise is two-staged. In a first stage, we estimate the CMR model over a long sample which starts prior to monetary union. This exercise yields a sequence of structural shocks that the model identifies to have occurred in the historical sample. In a second stage, holding fixed the history of the economic non-policy shocks that the structural model identifies over the estimation sample period, the model is re-simulated using a different policy rule.

We estimate the CMR model over the sample period from the first quarter of 1985 to the third quarter of 2008. For this estimation, we use the following specification of the money market feedback relationship:

$$(1) \qquad R_t = (\rho R_{t-1} + (1-\rho)[\alpha(E_t \pi_{t+1} - \pi^*) + \beta \Delta y_t + \gamma \Delta M_t] + \varepsilon_t) + \theta \xi_t$$

In (1) the very short-term money market interest rate on the left side, which we identify with the euro overnight index average (EONIA), is determined by two components. The first component corresponds to the first term in round brackets on the right-hand side of (1) and reflects policy intentions: the "policy rule" proper. Conventionally, this includes the lagged interest rate, the expected gap between GDP inflation and a numerical value consistent with price stability, GDP growth in deviation from its trend, and a white noise policy error, ε_t. Unconventionally, and in order to capture monetary analysis considerations, we add an extra regressor to this term: excess growth of a monetary indicator, ΔM_t.[19] The second component of (1) is the last term on the right-hand side, $\theta \xi_t$. This includes a latent shock, ξ_t, which, in the model, calibrates banks' demand for central bank credit.[20] In estimation, this shock is identified with the total outstanding stock of Eurosystem refinancing operations, which is included in the set of observables. The coefficient, θ, attached to the shock thus measures the sensitivity of the overnight interbank rate on the left of (1) to money market liquidity conditions. Indeed, we find that this estimated elasticity is positive, large and highly significant in the pre-crisis period.

Regarding the shocks identified through estimation, we concentrate on two classes which seem to be particularly relevant for explaining – according to the CMR model – the euro area business cycle: monetary-financial shocks and supply-side shocks. Monetary and financial factors lead or coincide with the peaks and troughs of output and tend to dissipate quickly as a determinant of growth, except in crisis times, but introduce long-lasting trends in inflation. Supply shocks, instead, have usually been timely indicators and certainly extraordinarily persistent pro-cyclical determinants of growth and inflation, at least since the start of monetary union. While a typical demand shock and a typical financial shock that move aggregate demand pose little puzzle to a

19 Later on in this Section we shall discuss the reasons behind our choice of credit – rather than headline money – as a proxy for the monetary variable to be included in (1).
20 The Annex gives an intuition for this and other latent shocks.

stability-orientated central bank – given that they move output and inflation in the same direction – a supply shock poses a signal extraction problem for the central banker. What is policy relevant is the effect that the shock is expected to have on inflation expectations and on the self-sustaining momentum that expectations – once unsettled – can add to the inflation process going forward. If inflation expectations are sufficiently impervious to a supply shock, then monetary policy can afford to lengthen its policy horizon and look through the disturbance. Otherwise, it needs to intervene to stem the transmission of the shock via expectations. In a way, central banks need to be vigilant to the fact that a supply shock might morph into a demand shock, if and when it is allowed to influence inflation expectations. It is this mutation that is most relevant for policy. But, of course, judging whether the mutation will happen or is likely to happen is fraught with hazards in real time.

By bearing these findings on the shock decomposition in mind we now stress-test the ECB's monetary policy strategy along the dimension of monetary analysis.[21]

3.2 MONETARY ANALYSIS AND THE MEDIUM-TERM ORIENTATION

More recently, the controversy over the usefulness of monetary analysis has subsided somewhat. Many academic critics who had long advised the ECB to place less emphasis on the role of money in its strategy have qualified or recanted their earlier positions. At the same time, the related question of whether a central bank should concentrate on targeting inflation or should also "lean against the wind" blown by rising monetary and financial imbalances has been put back on the agenda for discussions relating to the theory and practice of central banking. Inflation targeting was the almost undisputed view of the majority of participants in that debate before the crisis. Since the crisis, the median view has arguably shifted.

It is this latter aspect of monetary analysis that we want to address.[22] As the ECB – like all other central banks – has presided over a period of heightened volatility in financial markets, it is interesting to ask whether macroeconomic history would have looked materially different in the euro area if the ECB had not relied on its monetary pillar. This requires a counterfactual. But, as we mentioned before, this counterfactual exercise is not an easy one, for essentially two reasons. First, using one *single* model, we obviously forfeit one critical side of the monetary pillar approach: that it can induce robust policy, namely a policy that has a better chance of delivering good results across different specifications of the inflation process. It is the cross-checking aspect of the two-pillar strategy that we are sure to miss. Quoting from ECB (2003):

21 As mentioned before, by focusing on a single aspect of the ECB's monetary policy strategy we are disregarding different facets of the same that may be complementary in delivering price stability. In particular, the medium-term orientation, which is not covered here, goes hand in hand with the analysis of money aggregates.

22 The fact that trends in money are highly coherent with trends in consumer prices provides the main foundation for the role of money in the ECB's strategy. This role is sufficiently well-established in theory and econometrics (for example, see Lucas (1995) and Benati (2009)). So, we concentrate on the leaning against the wind component of the monetary pillar.

"In order to assess the indications about the appropriate stance of monetary policy, the two-pillar approach provides a cross-check of the information that stems from the shorter-term economic analysis with that from the monetary analysis, which mainly provides information about the medium to long-term determinants of inflation." (p. 92)

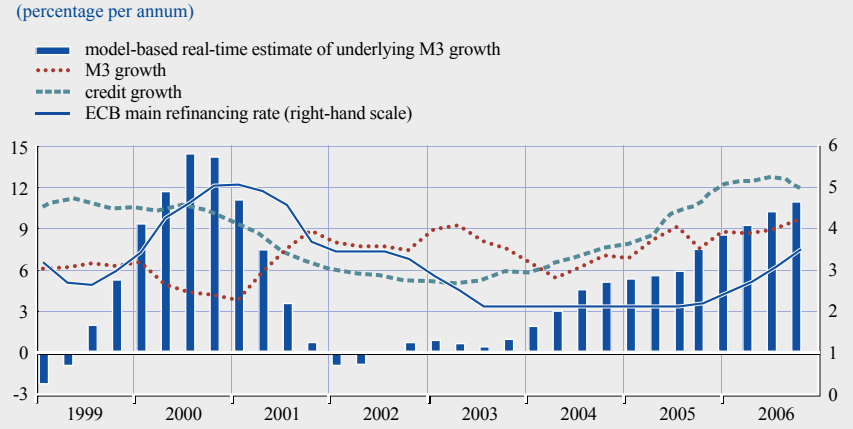
Second, the policy rule should include the *underlying* money trend as an indicator of the underlying trend in prices. Indeed, it is this connection that lies at the centre of the ECB's mandate (see Stark (2010)).[23] Avoiding excess volatility in asset markets is a by-product of the strategic role of money, and is justified only to the extent that it can contribute to price stability over a medium to long-term horizon. However, owing to the technical complications implicit in estimating and simulating a policy reaction function which feeds back on the underlying trend – as opposed to headline growth rates – of money, we employ a proxy in our quantitative exercises. Our proxy is the growth rate of bank credit to the non-financial sector in deviation from its long-run trend. This is the reaction variable ΔM_t which we include in the money market interest rate feedback equation (1).[24] Chart 15 gives some grounds to believe that such a proxy might indeed be acceptable. 1t shows that the correlation – at least since monetary union – between credit and underlying money growth based on the CMR model (the red bars) is large.[25]

23 Quoting from Stark (2010): "[Monetary analysis] compels policy-makers to consider trends in money and credit growth, which may exert an influence on price developments beyond that identified by a purely conjunctural or output-gap view of the world."

24 Owing to the prevalence of shifts in the demand for money over the relevant sample period, estimating (1) with feedback on headline – as opposed to trend – money growth does not yield a significant reaction coefficient.

25 In the CMR model, underlying M3 growth is derived by generating the M3 growth path in response to all shocks identified in sample by the model estimation, except those that pertain to the demand for money by households and firms. For a thorough discussion of the measures of underlying money computed by the ECB, see Papademos and Stark (2010).

Chart 15 Money, underlying money and credit growth



Note: The blue bars correspond to the annualised rates of money growth in the CMR model, after purging headline money growth of the impact of shocks shifting the demand for money.

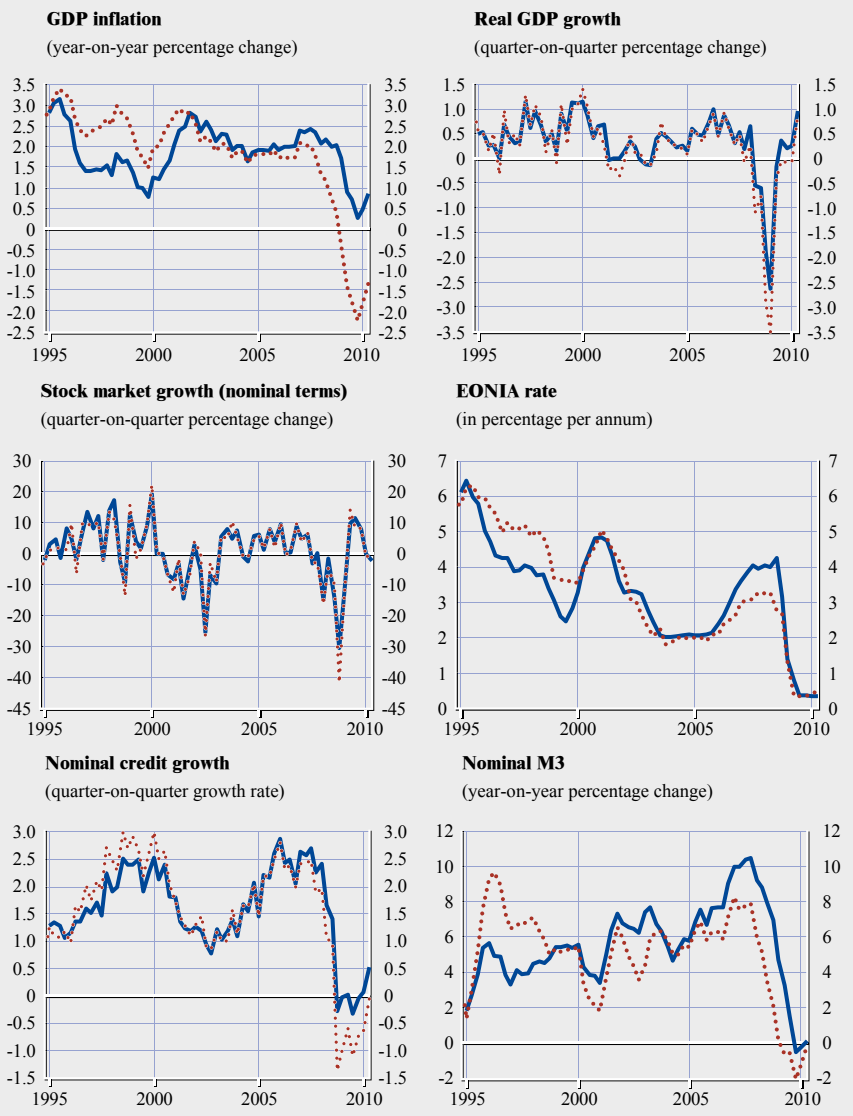
Subject to these limitations, we run the following counterfactual exercise. We set the reaction coefficient γ, which in (1) is attached to excess credit growth, equal to zero.[26] We then re-simulate the model in response to the estimated sequence of all non-policy shocks. The difference between history and the artificial path is a rough representation of the contribution of the monetary pillar. Chart 16 is consistent with the following two conclusions. First, inflation would have been distinctly higher at times of financial exuberance and would have fallen precipitously into negative territory in the wake of the financial market collapse, starting in the autumn of 2008. In other words, inflation would have been more reactive to the state of financial sentiment. Second, the economy as a whole would have been more volatile. Monetary policy would have added fuel to credit market euphoria – visibly in the early years of monetary union – which would have made the subsequent reversal even more spectacular and destabilising than it was in retrospect.

We generalise these results to test their robustness to all possible realisations of shocks. Chart 17 shows the inflation-output variability frontier – the Taylor frontier – that can be traced out in our model given the profile of the whole spectrum of shocks that hit the euro area economy on average. The black line with diamonds on the right-hand scale of the chart shows the frontier that is attainable if the feedback rule does not feature a reaction to excess credit growth (the γ coefficient in (1) is zero). Diamonds of a bigger size correspond to higher coefficients – with a step size of 0.2 – of reaction to inflation (the α coefficient). It is apparent that starting from very low values of α and shifting along the upper portion of the black line, which is positively bent, a central bank would be able to improve on both dimensions of policy by just making its response to inflation more aggressive. Note, however, that adding a response to excess credit growth would be even more effective: it would systematically curtail output volatility at no cost in terms of inflation volatility. This is shown by the blue lines that depart from the black Taylor frontier on the right-hand scale of the chart and point left. The blue diamonds along these lines indicate different degrees of response (step size of 0.05) to excess credit growth. Among them, the red diamonds mark the maximum response to credit – in association with the corresponding inflation coefficient on the black frontier – that would be possible without incurring a trade-off. Connecting the red diamonds with a line, one could trace out a curve. This curve would represent a shift of the black curve towards the origin. In other words, reaction to credit brings with it a Pareto improvement in policy design which would be unattainable otherwise.

Notice the difference between a monetary pillar and a genuine "leaning against the wind" approach. The ECB has long recognised that it is not asset prices per se that a central bank should incorporate in its policy framework. After all, the equilibrium value of assets – particularly real assets, such as claims on companies and houses – is difficult to compute and is certainly state contingent. So, there is little merit in an unconditional monetary policy response to asset price changes, as was advocated by the early proponents of a "leaning against

26 The mode of the estimated posterior distribution for γ is 0.54.

Chart 16 Counterfactual: history without the monetary pillar

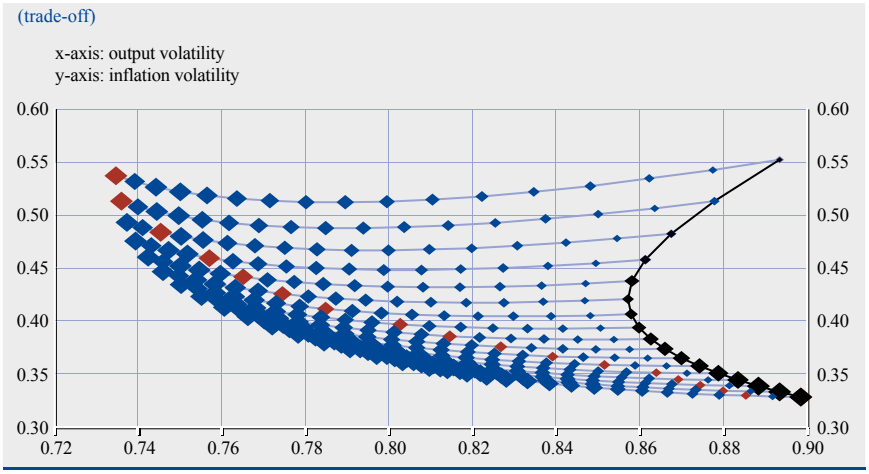


Notes: In each panel, the blue line indicates history. The red dotted line indicates the counterfactual associated with a money market feedback relationship (1) in which the monetary policy reaction coefficient, γ, is set equal to zero.

the wind" strategy.[27] The policy response should be *conditional*. And the critical condition that a central bank should ascertain before judging if an asset price trend is policy-relevant is whether the market trend is causing – and/or is being fed by – a concomitant monetary imbalance. Quoting from ECB (2005):

27 An early manifesto of "leaning against the wind" is Cecchetti, Genberg, Lipsky and Wadhwani (2000). Bernanke and Gertler (2001) provide a critique of that approach.

Chart 17 The Taylor frontier with and without the monetary pillar



Source:

Notes: Taylor frontiers with a reaction to credit (blue lines) and without a reaction to credit (black lines). Black (blue) diamonds of increasing size indicate reaction to inflation (credit) of increasing intensity. Reddish brown diamonds represent the maximum reaction to credit consistent with a trade-in.

"Monetary analysis can contribute to assessing the extent to which generously valued assets can be traced to – and at the same time become a source of – excess creation of liquidity and over-extension of credit. Detecting and understanding this link helps the ECB form an opinion on whether an observed movement in asset prices might already reflect the inflating of an unsustainable bubble." (p. 59)

A market bubble that progresses in symbiosis with a credit bubble, and which then spills over into excess money creation, is certainly a policy-relevant event. Being vigilant to the monetary imbalance means for a central bank being better able to discriminate between benign and less-benign phenomena in financial markets.

In conclusion, the mechanism by which a monetary pillar can improve on policy outcomes achievable under different policy strategies is simple. The monetary pillar draws attention to rising imbalances in the monetary sector. Monetary imbalances are well-correlated with financial imbalances. In turn, financial imbalances are typically a distinct feature of the macroeconomy at those critical time junctures when the central bank is called upon to find a balance between short-term risks and its long-term stability objective. In attempting to strike this difficult balance, monetary analysis can promote a longer-term perspective. It can act as the commitment mechanism which a central bank needs to have in place to overcome policy myopia.

4 THE FINANCIAL CRISIS

The initial turmoil and the subsequent crisis that swept through financial markets over the past three years have posed unprecedented challenges for central banks.

Their policy responses have been equally unprecedented and have involved non-standard measures, i.e. actions that go beyond the usual changes in a "policy" interest rate.

Inevitably, the exceptional nature of the financial crisis which led to the deep recession of 2008-09 – often referred to as the "Great Recession" in the academic literature – implies that a full assessment of the effectiveness of non-standard policies deployed by monetary and fiscal authorities will have to wait until the world's major economies have completely recovered. The exceptional nature of these policies also implies that their effectiveness cannot be entirely understood using traditional frameworks and models. From this perspective, new benchmarks for "appropriate policy" and new interpretative tools have to be developed before alternative policy responses can be studied – with the considerable benefit of hindsight.

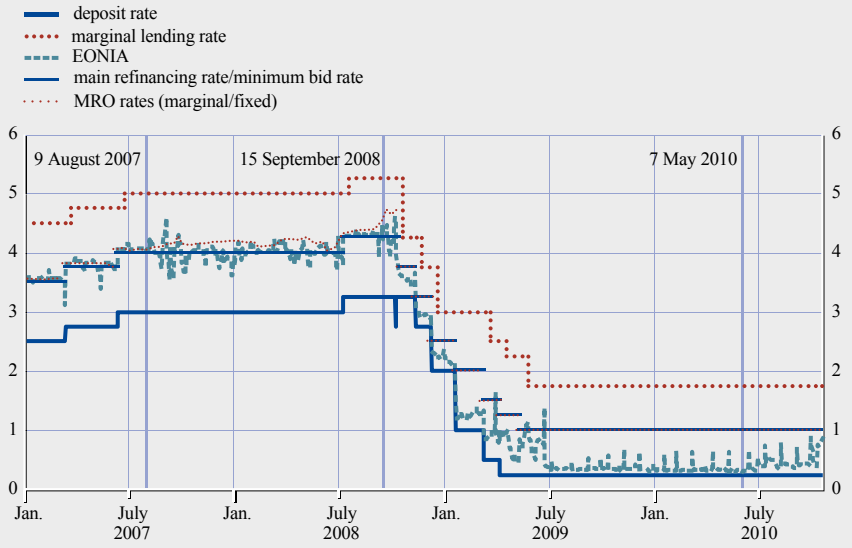
In this section, we provide a summary description of economic and financial developments in the euro area starting from August 2007, until mid-2010. The main objective of this review is to highlight the main standard and non-standard measures enacted by the ECB, clarify their stated intent, and provide preliminary evidence on their economic impact.[28] In so doing, we attempt to relate non-standard measures to the academic literature, including papers which were already available at the time of the crisis and thus provided a possible framework to help interpret unfolding events, and papers which were written after the crisis and are thus tools to understand the policy decisions that were taken ex post.

4.1 FROM THE FINANCIAL TURMOIL TO THE GREAT RECESSION

Before the inception of the financial turmoil, euro area developments in 2007 were characterised by an environment of sound economic growth and vigorous money and credit expansion. Throughout the year, medium-term risks to price stability remained clearly on the upside. Average annual HICP inflation stood at 2.1% in 2007, rising sharply towards the end of the year, mainly owing to substantial increases in international oil and food prices. Economic activity expanded at solid rates throughout the year, with contributions from all GDP components, thanks to favourable financing conditions (especially in the first half of the year), and positive developments in real disposable income as labour market conditions improved. Monetary analysis confirmed the existence of upside risks to price stability at medium to longer horizons, owing to the strength of the underlying rate of money and credit expansion, as underlined, in particular, by the sustained growth of loans to the private sector. To contain these risks, the Governing Council adjusted the monetary policy stance, raising the key ECB rates twice in the first half of the year. As a result, the minimum bid rate in the main refinancing operations of the Eurosystem stood at 4.00% in June 2007 (see Chart 18).

28 See also Baumeister and Benati (2010) and Lenza et al. (2010) for a description and analysis of non-standard monetary policy measures in the euro area and other countries.

Chart 18 ECB interest rates and money market rates



Source: ECB.
Note: Last observation refers to 21 October 2010.

At the same time, longer term risks for economic growth remained on the downside, mainly on account of external factors, such as the possibility of further increases in oil and other commodity prices. Following the onset of the turmoil and increased volatility in financial markets in early August 2007, the outlook for economic activity in the euro area was characterised by unusually high uncertainty. ECB interest rates remained unchanged in the second half of the year.

4.1.1 THE PERIOD BEFORE SEPTEMBER 2008

When the first signs of turmoil manifested themselves on 9 August 2007, the ECB was among the first central banks to react to the shock and to inject abundant liquidity into the money market. Owing to the adverse developments in the US sub-prime mortgage market, euro area banks became increasingly concerned with the risk of having to provide funding to structure investment vehicles that had invested in mortgage-backed securities. At the same time, banks became increasingly unwilling to provide funds to counterparties in the interbank market owing to concerns about their creditworthiness. These two phenomena led to a hoarding of liquidity and weak activity in the interbank market. An indicator of these difficulties was the spread between the interbank rate, which is unsecured, and the overnight swap rate, which is only subject to a minimum amount of counterparty risk. After remaining very close to zero for years, these spreads rose to around 60 basis points for 12-month rates in the euro area, the United States and the United Kingdom (see Chart 19).

The first consequence of the turmoil was that banks that had lost access to liquidity from the interbank market started to increasingly rely on liquidity

from the Eurosystem and notably to frontload the fulfilment of the reserve requirement at the beginning of the maintenance period. The Eurosystem's reaction over the rest of the year and until the collapse of Lehman Brothers was to satisfy the increase in demand for liquidity, while keeping the overall policy stance unchanged. Significant changes were therefore decided in the timing and maturity of open market operations, so as to continue steering aggregate liquidity conditions in a way which supported banks' liquidity management process.

The distinction between monetary policy decisions and liquidity operations has been characterised by the ECB as a "separation principle" (see, for example, ECB (2008)). The separation principle can be understood in the context of the traditional analysis of Poole (1970), according to which stabilising the short-term interest rate in the face of purely financial shocks is the best way to insulate the real economy from the effects of those shocks. Poole's analysis is obviously merely illustrative, since it is based on a backward-looking model and also abstracts from the inflationary consequences of any shock. At the same time, the intuition for why the central bank should stabilise the short-term interest rate, rather than the supply of liquidity, in the face of high-frequency financial shocks appears relevant also in relation to the late 2007/early 2008 period of financial turmoil. If the ECB had not accommodated banks' desire to frontload their reserve requirements, excess demand for central bank money would have driven the EONIA rate upwards at the beginning of the maintenance period, and downwards at the end. These fluctuations could have led to a de facto change in the policy stance – in spite of the Governing Council's decision not to move the ECB interest rates – and thus induced undesired consequences on the economy.

The separation principle could also be understood under the more recent conceptual framework provided by Woodford (2003) and, with specific reference to the financial crisis, Cúrdia and Woodford (2010). These analyses suggest that the central bank should operate a corridor system and remunerate reserves at market interest rates – like the ECB does for required reserves – or at least at a constant spread below market rates – which is again consistent with the ECB's approach for excess reserves. The remuneration of reserves has the advantage of eliminating (if the remuneration is at market rates), or making constant (if the remuneration is a constant spread below market rates) banks' opportunity cost of holding reserves. Fluctuations owing to exogenous factors in banks' needs for reserves can then be accommodated through corresponding changes in the demand for central bank liquidity without placing an additional burden on banks. Hence, liquidity policy can be implemented independently of monetary policy proper, i.e. without involving changes in the monetary policy stance.

From the perspective of both Poole's and Cúrdia and Woodford's analyses, the changes in the ECB's liquidity policy in the second half of 2007 can be understood as shock absorbers, rather than as the desire to stimulate the economy in the face of an adverse shock. While clearly increasing the uncertainty of the economic outlook, the financial turmoil of the late 2007 and early 2008 period did not pose direct threats to the economy, provided that the risk of a "bank run"-type collapse of the banking sector resulting from a drying up of interbank liquidity could be avoided.

In this paper, we do not venture into a detailed discussion of money market developments (see Cassola et al. (2010) for an in-depth analysis of the latter). Nevertheless, recent analyses have supported the view that spreads in the interbank markets were initial signals of a type of bank run (see Gorton (2009)). At the ECB, Heider et al. (2009) provide a model of how varying levels of counterparty risk, together with asymmetric information, can lead to the evaporation of liquidity in the unsecured interbank market. At high levels of risk, safer banks leave the unsecured market and trading occurs at a higher interest rate among higher risk-taking banks. When the dispersion of risk is particularly high, the interbank market may break down altogether, leading to multiple equilibria driven by self-fulfilling expectations. In these circumstances, the central bank can be thought of as acting as a "market maker of last resort". It can offer to take on the excess liquidity and act as a counterparty for all liquidity transactions. In an extreme case, the central bank could entirely replace the interbank market.

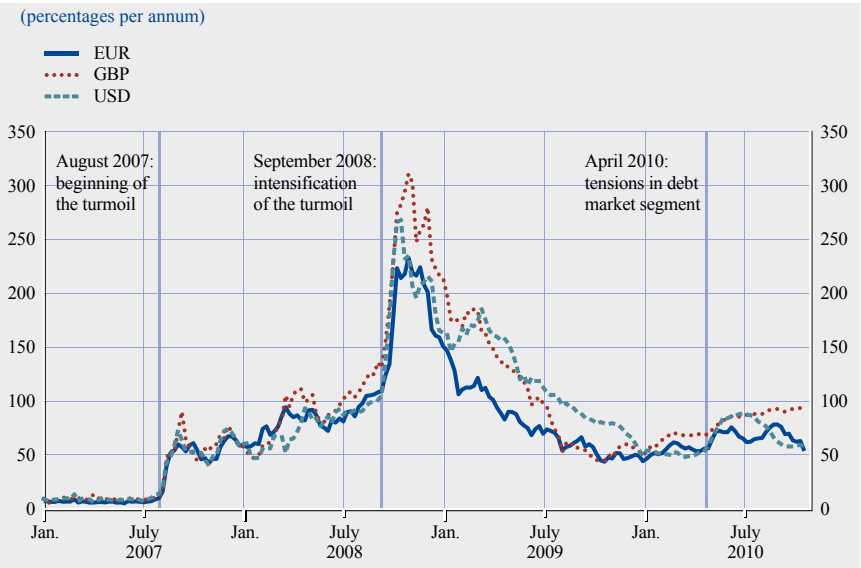
4.1.2 DEVELOPMENTS AFTER SEPTEMBER 2008

With the financial turmoil still ongoing, inflationary pressures in the euro area increased in the first half of 2008 leading to a climb in annual HICP inflation from 3.2% in January to 4% in June and July. While the US slowdown and the financial market turbulence kept the outlook particularly uncertain, there were clear risks that levels of inflation well above the ECB definition of price stability could begin affecting expectations of future wage and price levels. To ensure that long-term inflation expectations remained anchored, the Governing Council raised the ECB rates by 25 basis points in July.

As of 15 September, however, the financial turbulence intensified following the bankruptcy of Lehman Brothers, leading to a renewed and unprecedented increase in interbank spreads (see Chart 19). The high levels, around 60 basis points, reached by the EURIBOR-OIS spreads at the end of 2007 were dwarfed by the new values of over 200 basis points, touched by the same spreads in September 2008. The overall level of macroeconomic uncertainty – as measured, for example, by stochastic volatility in the stock market – also increased to unprecedented levels. In a few weeks, the outlook changed dramatically. Euro area GDP contracted by 0.2% in the third quarter of 2008 (quarter on quarter) and by a further 1.5% in the fourth quarter. Annual HICP inflation fell to 1.6% in December. By the turn of the year, a clear decline was also observed in the growth rate of loans to non-financial corporations. Overall, monetary trends supported the view that inflationary pressures were weakening further.

Against the background of this worsening outlook, the Governing Council decided on a fast sequence of reductions in ECB interest rates, starting with a coordinated move with the Bank of Canada, the Bank of England, the Federal Reserve System, Sveriges Riksbank and the Swiss National Bank on 8 October. In eight months, ECB rates fell by 325 basis points, so that the main refinancing operation (MRO) rate stood at 1% in May 2009.

Chart 19 Turmoil in the money market



Sources: Bloomberg and ECB calculations.

Note: Spreads are the difference between 12-month Euribor/Libor and Overnight Index Swap rates, in basis points. Last observation refers to 22 October 2010.

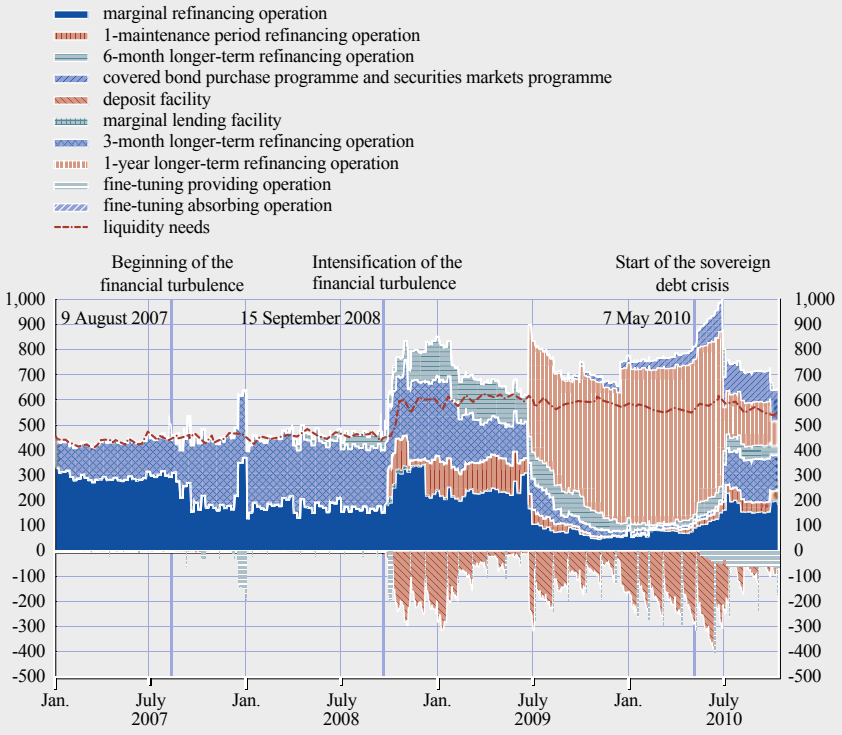
4.1.3 THE EXPANSION OF THE ECB BALANCE SHEET

At the same time, the worsening of the macroeconomic situation was accompanied by signals of increasing impairments in credit markets. Evidence from the ECB's Bank Lending Survey suggested that part of the reduction of credit to the non-financial sector may have been due to supply constraints (see, for example, Ciccarelli et al. (2010)). While reducing interest rates, the Governing Council adopted non-standard measures to deal with the dysfunctional money market, relax banks' balance sheet constraints and facilitate the transmission of key ECB interest rates to bank lending rates. First, it decided on a temporary narrowing of the corridor formed by the rates on the standing facilities, thereby increasing the ECB's role of market maker in the interbank market. Second, the Governing Council introduced additional open-market operations at one, three and six-month horizons to cover a longer maturity spectrum for liquidity provision. Third, it announced full allotment at fixed rates in its tender operations. This led to a surge in demand from banks for central bank liquidity and, as a result, to a large increase in the ECB balance sheet (see Chart 20).

Additional non-standard measures were adopted in May 2009 – when the MRO rate reached the 1% level – to support the flow of credit to households and corporations. These included: the lengthening of the maximum maturity of refinancing operations to one year; the extension of the list of assets accepted as collateral; the provision of liquidity in foreign currency; and outright purchases in the covered bond market. These decisions, together with those adopted in October 2008, configured the ECB's policy of "enhanced credit support" in response to the financial crisis.

Chart 20 ECB balance sheet during the financial crisis

(EUR billions)



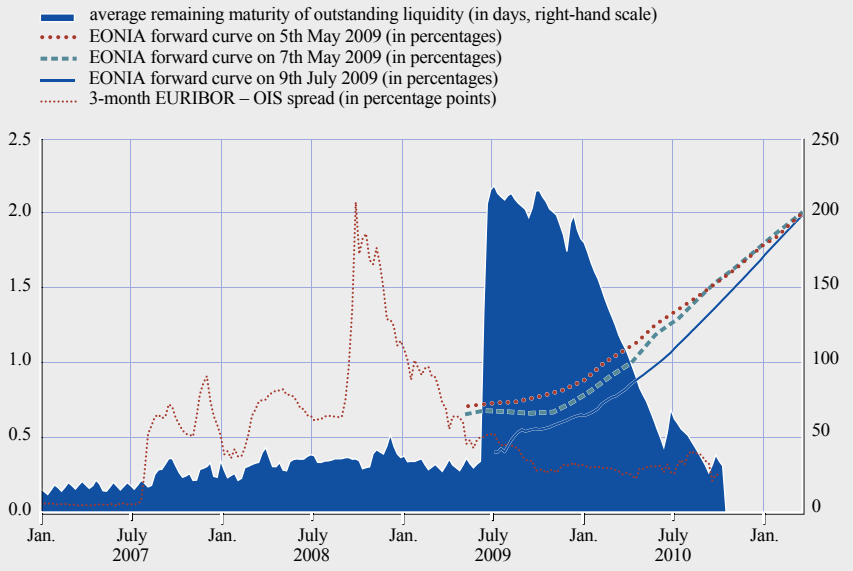
Source: ECB.

Note: Last observation refers to 15 October 2010.

The measures taken under the enhanced credit support umbrella aimed to overcome the financial market impairments which were constraining the process of credit creation in spite of the reduction in policy interest rates. As a result, the ECB succeeded in lowering the cost of financing in specific financial market segments. Over time, conditions in the money market stabilised and funding uncertainty for banks abated. Chart 21 depicts the average remaining maturity of outstanding liquidity granted through the main and longer-term refinancing operations, which was lengthened from around 30 days before the first one-year long-term refinancing operation (LTRO) to 200 days during the second half of 2009. This decision was instrumental in stabilising the three-month EURIBOR-OIS spread at levels below those observed before the collapse of Lehman Brothers. In addition, the announcement of the one-year LTRO at the Governing Council meeting of 7 May 2009 shifted the EONIA forward curve downwards and flattened it out up until the end of 2009 (see the EONIA curves of 5 May and 7 May 2009 in Chart 21). The implementation of the one-year operation at the end of June 2009 led to further decreases in EONIA forward rates (see the EONIA curve of 9 July 2009). While the main aim of the one-year LTROs was to stabilise the banking system by providing a stable funding environment, these operations also contributed

Chart 21 Maturity of outstanding liquidity and money market conditions

(percentages per annum)



Source: ECB.

Notes: Last observation refers to 15 October 2010, weekly data. Average remaining maturityis calculated by averaging the remaining maturity on main and long-term refinancing operations up until their respective maturity date and weighting by the corresponding outstanding amount of each operation. The EONIA forward curves are based on EONIA swaps, and the chosen dates are before (5 May 2009) and after (7 May 2009) the announcement of one-year LTROs and two weeks after settlement of the first one-year LTRO (25 June 2009).

to lower expected future short-term rates up to one and a half years ahead. Their effects therefore share similarities with policies of forward guidance and commitment recommended in the presence of the zero lower bound, even though the ECB did not explicitly commit to a path for its future policy rate. In contrast to forward guidance, though, the result of the longer-term liquidity operations affected only the short end of the yield curve.

In addition to the money market conditions, the covered bond programme led to a fall in yields in this market, which is important for banks' financing needs. A more direct impact of the vast expansion of ECB liquidity which went along with the full allotment policy, especially after the lengthening of the maturity of LTROs to one year, was the persistent fall in the EONIA below the levels of the MRO rate. This fall was also facilitated by the decision in January 2009 to widen the corridor formed by the rates on the standing facilities back to 2%: the corresponding 0.5% reduction in the rate on the deposit facility allowed for a further decrease in the EONIA rate.

Allowing for a persistent spread to open between the EONIA and the MRO rate – something unprecedented in the ECB's history – was the approach followed by the ECB to deal with the segmentation which had, in the meantime, materialised in the banking sector. Only some of the banks with liquidity needs could

borrow funds from their counterparties at the EONIA rate; other banks were considered too risky and therefore forced to obtain refinancing directly from the ECB at the higher MRO rate. The spread between the EONIA and the MRO rate had two effects. On the one hand, the lower refinancing rate (the EONIA) available to banks with access to the overnight market could be expected to influence other money market segments and, ultimately, the rates on loans to the non-financial sector. On the other hand, the MRO refinancing rate available for banks with larger perceived exposures to illiquid assets – together with the extension of the list of assets accepted as collateral – could be interpreted as a standard application of the Bagehot principle. according to which, at times of crisis, the central bank should provide unlimited liquidity at a penalty rate. The unlimited provision of liquidity allowed solvent banks to overcome their liquidity problems, while the penalty at which they obtained central bank funds maintained their incentives to restructure their balance sheets. This policy also aimed to keep the risk of "zombie banks" (see Caballero et al. (2005)) operating in the euro area at a low level.

Overall, the ECB's enhanced credit support policy has a distinct character from the "quantitative easing" policy introduced in Japan between 2001 and 2006. One key feature of the latter approach was the aim to increase the amount of excess reserves of commercial banks, primarily by buying government securities. By contrast, the ECB's objective was to improve liquidity in market segments that were especially impaired. The increase in excess reserves was thus only a by-product, rather than the primary target, of the ECB's enhanced credit support. This also explains why government bonds purchases were not part of the programme.

A second key feature of quantitative easing was that it was only introduced after policy rates had reached levels very close to zero. Quantitative easing can thus be seen as a substitute for conventional policy easing, to be exploited only once there is no more room for manoeuvre in policy interest rates. By contrast, the ECB programme was rather a complement to standard policy easing. Standard and non-standard measures were in fact adopted in parallel, as of October 2008. Non-standard measures aimed to reinforce, rather than replace, the impact of the reductions of policy interest rates, whose effectiveness had been reduced by impairments in the financial market.

The enhanced credit support programme was therefore independent of the level of the MRO rate: it could have been adopted, thus generating a large expansion of the ECB's balance sheet, at any interest rate level. The possibility of creating large amounts of excess reserves at any level of the policy rates, and not only when they are zero, is a result of the ECB's corridor system. This system makes the opportunity cost of excess reserves independent of the level of the MRO rate and only a function of the spread between the MRO rate and the rate on the deposit facility. As a result, lowering policy interest rates to zero is not a prerequisite for an expansion of the ECB's balance sheet.

Some elements of the ECB's enhanced credit support make it akin to the credit easing of the Federal Reserve System. Both policies, for example, share the

objective of targeting specific segments of the financial market. At the same time, there are differences in the specific implementation of this objective. While the Federal Reserve intervened through direct lending to the non-financial sector, the ECB approach was, by and large, limited to improving liquidity in the banking sector. These differences simply reflect the differing financial structures of the euro area and the United States. The ECB focused on banks because, in the euro area, banks are the primary source of financing for the real economy. The bulk of external financing of non-financial corporations comes from the banking sector, which is especially important for small and medium-sized enterprises.

Another distinguishing feature of the enhanced credit support programme, compared with the Federal Reserve's credit easing, is that most operations carried out in the context of the ECB programme have been conducted as repurchase transactions. These operations facilitate the "phasing out" of non-standard measures because they can easily be terminated if they are not renewed upon maturity.

Since the crisis, new frameworks have been put forward to understand developments during 2008 and 2009 and to help devise the best policy response (see Gertler and Kiyotaki (2010) and Curdia and Woodford (2010)). By and large, these analyses conclude that non-standard monetary policy measures were warranted, since they addressed the inefficient intensification of credit market frictions.

For example, in the Gertler and Kiyotaki (2010) framework, the ECB's expansion of liquidity can be understood as a means to support the provision of credit to the economy through the relaxation of a liquidity constraint for some banks. In that framework, banks willing to lend may be unable to do so owing both to the deterioration of their own balance sheet and to the segmentation of the interbank market. Central bank intervention through the provision of liquidity is then warranted, provided that the central bank has an advantage, with respect to other commercial banks, in ensuring that the funds will be used for productive purposes. Then banks that have good investment opportunities, but are otherwise constrained, can benefit from the provision of central bank liquidity, even at a penalty rate. Gertler and Kiyotaki (2010) report that, in their simple model, this policy has equivalent effects as the central bank lending directly to the private sector.

4.1.4 THE SECURITIES MARKETS PROGRAMME

Over the course of 2009 spreads in the money market began to gradually decline and overall financial market conditions started showing signs of stabilisation. The ECB therefore announced in December 2009 that non-standard measures would begin to be gradually phased out, alongside the normalisation of financial markets. The phasing-out began with the discontinuation of one-year longer-term operations. In March 2010 the return to a variable rate tender procedure in the three-month operations was also decided.

In early 2010, however, new tensions emerged in euro area government bond markets. Market concerns about the sustainability of public finances in some euro area countries led to the increase in spreads between ten-year government bonds of those countries relative to German bonds. Once again, some secondary markets dried up. The tensions increased in April and early May 2010 and, on 9 and 10 May, euro area governments announced a comprehensive package of measures, including the set-up of a European Financial Stability Facility, to react to the new financial market tensions.

On 10 May the ECB announced the launch of the Securities Markets Programme. Under the programme, targeted to overcome the new market impairments, the Eurosystem can intervene in the euro area public and private debt securities markets to ensure depth and liquidity in dysfunctional market segments and to restore the proper functioning of the monetary policy transmission mechanism. All purchases are fully sterilised by conducting liquidity-absorbing operations. In addition, in order to avoid spillovers from domestic sovereign bond markets to other financial markets, the ECB reintroduced the fixed rate tender procedure with full allotment for the three-month operations and conducted a new six-month refinancing operation with full allotment. The temporary liquidity swap lines with the Federal Reserve System were also resumed.

The Securities Markets Programme appears to have been temporarily effective in reducing the risks of contagion across euro area government bond markets.

5 CONCLUSION

The financial crisis has led to a rethinking of monetary policy frameworks. In this paper, we investigate some features of the ECB's monetary policy strategy and the ECB's monetary policy response to the financial crisis against the background of economic and financial developments in the euro area over the last 15 years. While the volatility of headline inflation and economic activity has increased quite dramatically over the past three crisis years, underlying inflation and medium-term inflation expectations have remained closely anchored to the ECB's definition of price stability, even during the financial crisis. During the decade prior to the financial crisis, low and stable inflation and low volatility in economic activity co-existed with highly pro-cyclical asset prices and money and credit developments. The low real and nominal volatility and the falling external finance premia led to a secular rise in private debt, which itself contributed to the sharpness of the correction in the most recent recession. The strong anchoring of medium-term inflation expectations, on the other hand, helped to limit the consequences of the adverse financial shocks.

The boom-bust nature of the financial system over the past 15 years and the high cost of the recent financial crisis have challenged the so-called Jackson Hole consensus that central banks should only react to asset prices and financial imbalances to the extent that they affect the short-term inflation forecast. Using the fully-specified structural model of Christiano, Motto and Rostagno (2010), we investigate this proposition. As argued by Christiano et al. (2010b), supply

developments complicate the appropriate setting of monetary policy because they typically require a pro-cyclical rise in the equilibrium real interest rate at a time when price developments point in the opposite direction. A second lesson is that monetary policy strategies should allow for an enhanced role of the analysis of money and credit developments. One important remaining issue is how a monetary policy that leans against financial imbalances interacts with macro-prudential policies.

The great recession led to an unprecedented use of non-standard monetary policy tools. In this paper, we discuss some of the non-standard policy measures the ECB took to address the malfunctioning in financial markets. The measures taken under the "enhanced credit support" umbrella aimed to overcome the financial market impairments which were constraining the process of credit creation in spite of the reduction in policy interest rates. We put these measures in the context of the academic literature and conduct a preliminary assessment of their effectiveness. We argue that the ECB intervention – which, notably, did not include entering into commitments regarding the future path of the policy rate – was important to avoid disorderly deleveraging in the banking sector and instrumental in sustaining credit creation and averting downside risks to price stability. An important lesson from the financial crisis experience is therefore that, by taking on a financial intermediation role in markets that are impaired, central banks can complement their more traditional interest rate policy and ensure its proper transmission. These non-standard policies are quite different from policies of quantitative easing which typically aim to act as a substitute for the traditional interest rate policy in an environment where the latter is constrained by the lower bound.

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ANNEX

THE DSGE MODEL AND METHODOLOGY

The DSGE model used in the paper to interpret the data and carry out counterfactual simulations is taken from CMR (2010). The CMR model builds on the DSGE model developed by Christiano, Eichenbaum and Evans (2005) and Smets and Wouters (2003) and is extended by including the credit market, bankruptcies, money holding decisions and a liquidity-creating banking sector. The presence of a profit-maximising banking sector extending credit, operating a fractional reserve system for the transformation of base money into deposits and issuing short-term securities to finance capital formation makes it possible to include a broad array of monetary aggregates and financial prices in the empirical analysis. The model is estimated using Bayesian methods on data spanning the 1985-2008 period for the euro area. In the estimation, 16 variables are treated as observables, spanning from standard macroeconomic variables to monetary and financial variables such as the stock market, a measure of the external finance premium, credit, M1 and M3, the outstanding stock of refinancing operations with the Eurosystem,[29] and the spread between the ten-year bond rate and the short-term interest rate. CMR (2010) shows that the model is capable of reproducing the dynamic correlations of macroeconomic, monetary and financial variables existing in the data, and to be competitive in terms of out-of-sample performance.

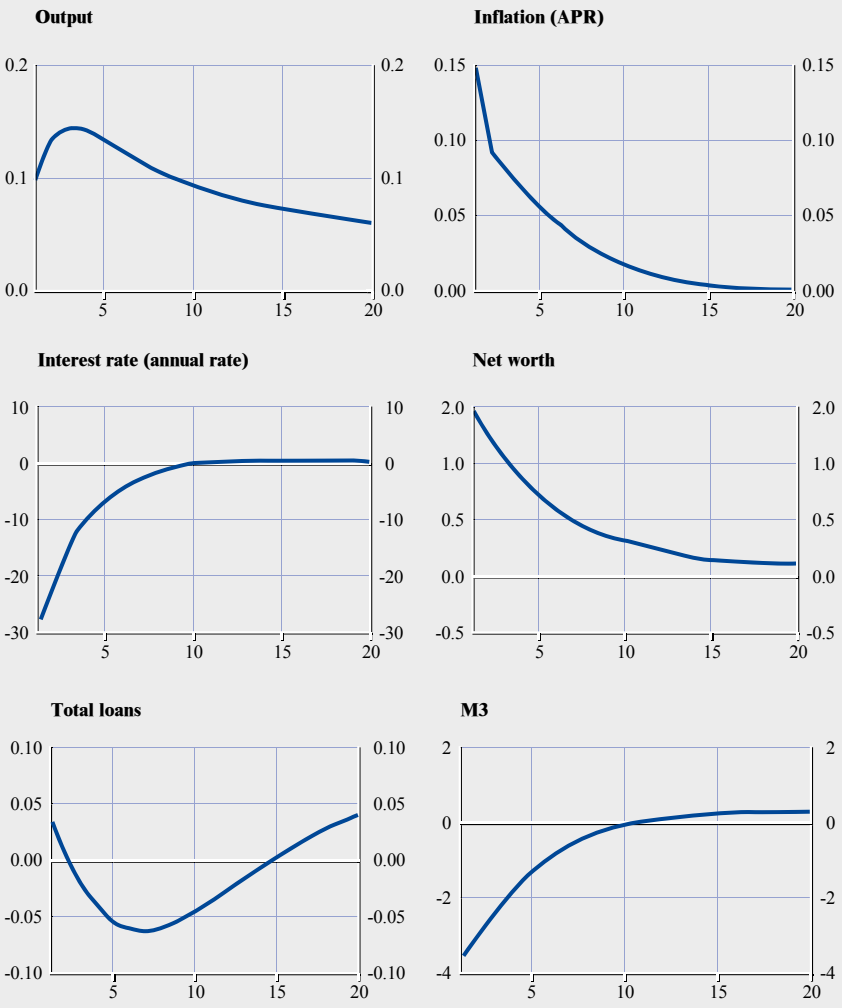
The size and composition of a bank's balance sheet, which is in itself the result of business decisions by banks interacting with households' and firms' demand for banks' assets and liabilities, can amplify or dampen macroeconomic fluctuations depending on the nature of shocks buffeting the economy. Another key finding is that shocks originating in the financial system and money-creating activities by banks can become an independent source of macroeconomic fluctuations. In particular, three shocks that alter conditions in credit and liquidity markets are found to be important. The first shock represents exogenous changes to the cross-sectional dispersion of borrowers' returns. By making the uncertainty about the borrowers' worthiness vary over time, this shock plays an important role in generating positive correlation between economic activity, credit and other financial variables. The second shock alters directly the amount of net worth at the disposal of borrowers. Both shocks have a realised and an anticipated "signal" component. In each period, economic agents observe the present realisation and receive signals that update their perceptions of the future evolution of these shocks. The realised and anticipated components have different macroeconomic implications. Anticipated shocks can generate expected excess returns that rise (or decline) in a sustained manner over time. The process of updating expectations also means that new signals reinforce or counteract (depending on their sign) previously received signals. This sets in motion waves of accumulation and decumulation of capital, credit and money

29 For the years 1985 to 1999, it uses an aggregation of bank reserves held with the central banks of Germany, France, Portugal, Spain, Italy, the Netherlands and Finland, appropriately rescaled.

that resemble typical economic fluctuations. The third type of shock originating within the financial and liquidity side of the economy is related to banks' access to complementary forms of funding in the model: the issuance of checkable deposits included in M1, the issuance of other short-term deposits and marketable securities (M3-M1), and central bank refinancing. In particular, it is found that a shock changing banks' desire for safe assets in the form of central bank liquidity exerted a significant downward impact on economic activity during the recent financial crisis. In the model, safe assets are held on banks' balance sheets to withstand unexpected withdrawals of funds, thereby ensuring continuity in banking activity and productivity within the banking sector. Chart 22 provides

Chart 22 Impulse response function to a bank's liquidity demand shock

(percentages)



Note: Reproduced from Christiano, Motto and Rostagno (2010), "Financial Factors in Economic Fluctuations", ECB WP No 1192.

an illustration of the transmission mechanism of such a shock. A lower demand for liquidity buffers by banks generates increased balance sheet capacity and a greater scope for expanding loan supply. This exerts expansionary effects on real economic activity and upward pressure on inflation. This impulse is not triggered by central bank decisions to change the policy rate, but finds its source within banks' funding activity itself.

COUNTERFACTUAL SIMULATIONS

Structural models can be used to construct policy scenarios and counterfactuals that try to assess the impact of alternative hypothetical policy actions. Counterfactuals centred around the financial crisis require models that can trace out the transmission mechanism of shocks originating in the financial sphere and that propagate to the rest of the economy. This is a further motivation for the use of the specific DSGE model described above.

The counterfactuals are constructed by using a two-stage approach. In the first stage, the model is used as a filter (two-sided) to recover the underlying shocks in the sample. In case the sample period relevant for the analysis extends beyond the available historical data and includes a projection horizon, the historical data can be augmented by model-based conditional or unconditional forecasts, or simply by treating forecasts produced outside the model as if they were "data" in sample. Having obtained an estimate of the underlying shocks, in a second stage it is imposed that a given variable, e.g. the policy rate, follows a different path from the historical one. This amounts to carrying out a conditional forecast where the conditioning assumption is met by manipulating the relevant shock. The relevant shock is chosen according to the source of uncertainty that the counterfactual is trying to understand. Then, the time series of all shocks that have been recovered in the first stage is kept unchanged, with the exception of the one for the relevant shock that is adjusted in order to meet the conditioning assumption. Finally, the model is used to trace out the implications of such an altered shock path for the other endogenous variables. Counterfactuals are generally carried out by assuming that the altered path of the shock materialises in an unexpected manner. This practice is followed in some of the counterfactuals presented in the paper. However, the paper also presents some simulations based on the assumption that agents know in advance about the new path for the shock.

MONETARY POLICY STRATEGY: LESSONS FROM THE CRISIS[1]

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ABSTRACT

This paper examines what we have learned about monetary policy strategy and considers how we should change our thinking in this regard in the aftermath of the 2007-09 financial crisis. It starts with a discussion of where the science of monetary policy stood before the crisis and how central banks viewed monetary policy strategy. It then examines how the crisis has changed the thinking of both macro/monetary economists and central bankers. Finally, it looks at the extent to which the science of monetary policy needs to be altered and draws implications for monetary policy strategy.

1 INTRODUCTION

Until August 2007, advances in monetary economics theory and in empirical work in the field had led both academic economists and policy-makers to argue that there was now a well-defined "science of monetary policy". There was a general consensus among central banks about most elements of monetary policy strategy, and monetary policy was perceived as being highly successful in OECD countries, with not only low inflation but also low variability of inflation. In addition, output volatility had declined in these countries, and the period from the early 1980s onwards was dubbed the "Great Moderation". Monetary economists and central bankers were feeling pretty good about themselves.

Then, in August 2007, the world was hit by what Alan Greenspan, former Chairman of the Federal Reserve System, described in Congressional testimony as a "once-in-a-century credit tsunami". The tsunami resulting from the 2007-09 financial crisis not only flattened economic activity, producing the most severe worldwide economic contraction since the Great Depression, but also seemed to sweep away confidence in the ability of central bankers to successfully manage the economy.

1 This paper was commissioned by the European Central Bank for its 6th ECB Central Banking Conference, Frankfurt, November 18-19, 2010. The views expressed here are my own and are not necessarily those of Columbia University, the National Bureau of Economic Research or the European Central Bank. I would like to thank Jean Boivin, Christopher Sims, Michael Woodford, Jean Pisani-Ferry and William White, as well as the participants of the brown bag lunch workshop held at the Federal Reserve Bank of San Francisco, the New York Area Workshop on Monetary Policy held at the Federal Reserve Bank of New York, and the 6th ECB Central Banking Conference for their helpful comments. Disclosure of my outside compensated activities can be found on my website at http://www0.gsb.columbia.edu/faculty/fmishkin/.

This paper examines what we have learned about monetary policy strategy and considers how we should change our thinking in this regard in the aftermath of the 2007-09 crisis. It starts with a discussion of where the science of monetary policy stood before the crisis and how central banks viewed monetary policy strategy. It then examines how the crisis has changed the thinking of both macro/monetary economists and central bankers. Finally, it looks at what implications this change in thinking has had for monetary policy science and strategy.

2 THE SCIENCE OF MONETARY POLICY BEFORE THE CRISIS

To examine the state of monetary policy analysis before the crisis I will draw heavily on a paper that I wrote just before the crisis began, which was presented at a conference at the Bundesbank in September 2007 (Mishkin (2009a)). In that paper I outlined nine basic scientific principles, derived from theory and empirical evidence, which guided thinking within almost all central banks. They are as follows: 1) inflation is always and everywhere a monetary phenomenon; 2) price stability has important benefits; 3) there is no long-run tradeoff between unemployment and inflation; 4) expectations play a crucial role in the determination of inflation and in the transmission of monetary policy to the macroeconomy; 5) real interest rates need to rise with higher inflation, i.e. the Taylor Principle; 6) monetary policy is subject to the time-inconsistency problem; 7) central bank independence helps improve the efficiency of monetary policy; 8) commitment to a strong nominal anchor is central to producing good monetary policy outcomes; and 9) financial frictions play an important role in business cycles.

The first eight of these principles are elements of what has been dubbed the "new neoclassical synthesis" (Goodfriend and King (1997)), and before the crisis almost all academic economists and central bankers agreed with them. The last principle – that financial frictions play an important role in business cycles – was not explicitly a feature of models used for policy analysis in central banks, but it was well understood by many, although not all, central bankers. Because a key issue for this paper will be whether or not recent events overturn these principles, it is worth spending a fair amount of time understanding the theoretical and empirical basis for each of them.

NINE BASIC PRINCIPLES

1. Inflation is always and everywhere a monetary phenomenon

By the 1950s and 1960s, the majority of macroeconomists had reached a consensus with regard to macroeconomic fluctuations that downplayed the role of monetary factors. Much of this consensus reflected the aftermath of the Great Depression and Keynes' seminal work *The General Theory of Employment, Interest, and Prices*, which identified shortfalls in aggregate demand as the source of the Great Depression and emphasised the role of fiscal policy as a possible remedy. In contrast, in their research Milton Friedman and others, in what became known as the "monetarist" tradition (Friedman and Meiselman (1963); Friedman and Schwartz (1963a, 1963b)), attributed much of the economic malaise of the

Depression to poor monetary policy decisions, and more generally argued that the growth in the money supply was a key determinant of aggregate economic activity and, particularly, inflation. Over time, this research, together with Friedman's predictions that expansionary monetary policy in the 1960s would lead to high inflation and high interest rates (Friedman (1968)), had a major impact on the economics profession, with almost all economists eventually coming to agree with Friedman's famous adage that "inflation is always and everywhere a monetary phenomenon" (Friedman (1963)), provided that by inflation we mean a sustained increase in the price level (e.g. Mishkin (2010a)).[2]

This general agreement with Friedman's adage did not mean that all economists subscribed to the view that money growth was the most informative piece of information about inflation, but rather that the ultimate source of inflation was overly expansionary monetary policy. In particular, an important manifestation of this line of thought was that central bankers came to recognise that keeping inflation under control was their responsibility.

2. Price stability has important benefits

With the rise of inflation in the 1960s and 1970s, economists, and also the public and politicians, began to discuss the high costs of inflation (for example, see the surveys in Fischer (1993) and in Anderson and Gruen (1995)). High inflation undermines the role of money as a medium of exchange by acting as a tax on cash holdings. On top of this, a high-inflation environment leads to overinvestment in the financial sector, which expands to help individuals and businesses escape some of the costs of inflation (English (1996)). Inflation leads to uncertainty about relative prices and the future price level, making it harder for firms and individuals to make appropriate decisions, thereby decreasing economic efficiency (Lucas (1972); Briault (1995)). The interaction between the tax system and inflation also increases distortions that adversely affect economic activity (Feldstein (1997)). Unanticipated inflation causes redistributions of wealth, and, to the extent that high inflation tends to be associated with volatile inflation, these distortions can raise the costs of borrowing. Finally, some households undoubtedly do not fully understand the implications of a general trend in prices – that is, they may suffer from nominal illusion – making financial

2 Although inflation can be characterised as a monetary phenomenon, it is crucial to recognise that fiscal policy can drive monetary policy if there is fiscal dominance, that is, if government budget deficits get so large that they force monetary authorities to expand the money supply to pay for government spending. Monetary authorities are only able to keep inflation under control if governments pursue responsible fiscal policy so that fiscal dominance does not occur. The usual view is that fiscal dominance is rarely a feature of advanced countries and instead is limited to developing countries. However, the recent massive government budget deficits in advanced countries and the reluctance of politicians in these countries to rein in future entitlements may indicate that fiscal dominance is now a danger even for advanced economies.

planning more difficult.[3] The total effect of these distortions came to be more fully appreciated over the course of the 1970s, and the recognition of the high costs of inflation led to the view that low and stable inflation can increase the level of resources productively employed in the economy.[4, 5]

3. There is no long-run tradeoff between unemployment and inflation

A paper published in 1960 by Samuelson and Solow (1960) argued that research by Phillips (1958), which resulted in what became known as the Phillips curve, pointed towards a long-run tradeoff between unemployment and inflation and that this tradeoff should be exploited. Acting in accordance with this view, the policymaker would have to choose between two competing goals – inflation and unemployment – and decide how high an inflation rate he or she would be willing to accept to attain a lower unemployment rate. Indeed, Samuelson and Solow even mentioned that a non-perfectionist's goal of a 3% unemployment rate could be achieved alongside what they considered to be a not-too-high inflation rate of 4% to 5% per year. This thinking was influential, and probably contributed to monetary and fiscal policy activism aimed at bringing the economy to levels of employment that, with hindsight, were not sustainable. In fact, the economic record for the late 1960s and the 1970s was not a happy one: inflation accelerated, with the inflation rate in the United States and other industrialised countries eventually climbing above 10% in the 1970s, leading to what has been dubbed "The Great Inflation."

The tradeoff suggested by Samuelson and Solow was hotly contested by Friedman (1968) and Phelps (1968), who independently argued that there was no long-run tradeoff between unemployment and the inflation rate: rather, the economy would gravitate to a natural rate of unemployment in the long run, no matter what the rate of inflation was. In other words, the long-run Phillips curve would be vertical, and attempts to lower unemployment below the natural rate would result only in higher inflation. The Friedman-Phelps natural rate hypothesis was immediately influential and fairly quickly began to be incorporated into formal econometric models.

3 Of course, economic theory implies that inflation can be either too high or too low. The discussion has emphasised costs associated with high inflation. But there are also potentially important costs associated with rates of inflation that are very low. For example, Akerlof, Dickens, and Perry (1996) suggest that downward nominal wage rigidity could result in severe difficulties for economic performance at times when inflation is too low. Other research has shown that the zero lower bound on nominal interest rates can lower economic efficiency if inflation is too low (e.g. Reifschneider and Williams (2000)). Eggertsson and Woodford (2003) discuss strategies to address the zero lower bound problem.

4 A further possibility is that low inflation may even help increase the rate of economic growth. While time-series studies of individual countries and cross-national comparisons of growth rates were not in total agreement (Anderson and Gruen (1995)), the consensus grew that inflation is detrimental to economic growth, particularly when inflation rates are high.

5 The deleterious effects of inflation on economic efficiency imply that the level of sustainable employment is probably lower at higher rates of inflation. Thus, the goals of price stability and a high employment rate are likely to be complementary, rather than competing, and so there is no policy tradeoff between the goals of price stability and maximum sustainable employment, the so-called dual mandate that the Federal Reserve has been given by Congress (Mishkin (2007a)).

Given the probable role that the attempt to exploit a long-run Phillips curve tradeoff had in the "Great Inflation", central bankers now adopted the natural rate, or no-long-run-tradeoff, view. Of course, my earlier discussion of the benefits of price stability suggests a long-run tradeoff, but not of the Phillips curve type. Rather, low inflation is likely to contribute to improved efficiency and hence higher employment in the long run.

4. Expectations play a crucial role in the macroeconomy

A key assertion of the Friedman-Phelps natural rate hypothesis was that while sustained inflation may initially confuse firms and households, in the long run it does not boost employment because *expectations* of inflation adjust to any sustained rate of increase in prices. From the early 1970s onwards, the rational expectations revolution, which began with a series of papers by Lucas (1972, 1973, and 1976), took this reasoning a step further and demonstrated that the expectations of the public and the markets with regard to policy actions have important effects on almost every sector of the economy.[6] The theory of rational expectations assumed that economic agents are driven by optimising behaviour, and therefore their expectations of future variables are optimal forecasts (the best guess of the future), using all available information. The optimising behaviour posited by the theory of rational expectations indicates that expectations should respond immediately to new information, and the theory therefore suggests that the long run might be quite short, so that attempting to lower unemployment below the natural rate could lead to higher inflation very quickly.

A fundamental insight of the rational expectations revolution is that expectations about future monetary policy have an important impact on the evolution of economic activity. As a result, the systematic component of policy-makers' actions – i.e., the component that can be anticipated – plays a crucial role in the conduct of monetary policy. Indeed, the management of expectations about future policy has become a central element of monetary theory, as emphasised in the recent synthesis by Woodford (2003).[7] And this insight has far-reaching implications, for example with regard to which types of systematic behaviour on the part of policy-makers are likely to be conducive to macroeconomic stability and growth.[8]

6 The 1976 Lucas paper was already very influential in 1973, when it was first presented at the Carnegie-Rochester Conference. Note that although Muth (1961) introduced the idea of rational expectations more than ten years earlier, his work went largely unnoticed until resurrected by Lucas.

7 Indeed, one implication of rational expectations in a world of flexible wages and prices was the policy ineffectiveness proposition, which indicated that if monetary policy was anticipated, it would have no real effect on output; only unanticipated monetary policy could have a significant impact. Although evidence for the policy ineffectiveness proposition turned out to be weak (Barro (1977); Mishkin (1982a, 1982b, 1983)), the theory arising from the rational expectations revolution that monetary policy's impact on the economy is substantially influenced by whether it is anticipated or not has become widely accepted.

8 Of course, the recognition that management of expectations is a central element in monetary policy-making brings to the forefront the credibility of monetary policy authorities as regards doing what they say they will do. It does not diminish, however, the importance of actions by the monetary authorities, because "actions speak louder than words": monetary authorities will be believed only if they take actions consistent with how they want expectations to be managed.

5. The Taylor Principle is necessary for price stability

The recognition that economic outcomes depend on expectations of monetary policy suggests that policy evaluation requires a comparison of how the economy performs under different monetary policy rules.[9] One type of rule that has received enormous attention in economic literature is the Taylor rule (Taylor (1993)), which describes monetary policy as setting an overnight bank rate (federal funds rate in the United States) in response to the deviation of inflation from its desired level or target (the inflation gap) and the deviation of output from its natural rate level (the output gap).[10] Taylor emphasised that a rule of this type had desirable properties and that it would stabilise inflation only if the coefficient on the inflation gap exceeded unity. This conclusion came to be known as the "Taylor principle" (Woodford (2001)) and can be described most simply by saying that a stabilising monetary policy must raise the nominal interest rate by more than the rise in inflation. In other words, inflation will remain under control only if real interest rates rise in response to a rise in inflation. Although the Taylor principle now seems pretty obvious, estimates of Taylor rules, such as those by Clarida, Gali and Gertler (1998), indicate that during the late 1960s and 1970s many central banks, including the Federal Reserve, violated the Taylor principle, resulting in the "Great Inflation" that so many countries experienced during this period.[11] Indeed, as inflation rose in the United States, real interest rates fell.[12]

6. The time-inconsistency problem is relevant to monetary policy

Another important development in the science of monetary policy that emanated from the rational expectations revolution was the discovery of the importance of the time-inconsistency problem in papers by Kydland and Prescott (1977), Calvo (1978), and Barro and Gordon (1983). The time-inconsistency problem can arise if monetary policy conducted on a discretionary, day-by-day basis leads to worse long-run outcomes than could be achieved by committing to a policy rule. In particular, policy-makers may find it tempting to exploit a short-run Phillips curve tradeoff between inflation and employment; but private agents, cognisant of this temptation, will adjust their expectations to anticipate the expansionary policy, so that it will result only in higher inflation with no short-run increase in employment. In other words, without a commitment mechanism, monetary policy-makers may find themselves unable to *consistently* follow an optimal plan *over time*; an optimal plan can be *time-inconsistent* and therefore could be soon abandoned. The notion of time-inconsistency has led to a number of important insights regarding central bank behaviour, such as the importance of reputation (formalised in the concept of *reputational equilibria*) and of institutional design.

9 Although Lucas' paper (1976) was a critique of the then-current practice of using econometric models to evaluate specific policy actions, it leads to the conclusion that monetary policy analysis should involve a comparison of how the economy performs under different rules.

10 Variants of the Taylor rule also allow for interest rate smoothing, as in Taylor (1999).

11 In contrast, Orphanides (2003) argues that the Federal Reserve did abide by the Taylor principle, but pursued overly expansionary policies during this period as a result of large and persistent misperceptions of the potential output level and the natural unemployment rate.

12 E.g. the estimates in Mishkin (1981, 1992).

7. Central bank independence improves macroeconomic performance

The potential problem of time-inconsistency has led to a great deal of research into the importance of institutional features that can give central bankers the commitment mechanisms they need to pursue low inflation. Perhaps the most significant findings are those showing that central bank independence, at least in some respects, is likely to be very important in maintaining low inflation. Allowing central banks to be instrument-independent, i.e. allowing them to control the setting of monetary policy instruments, can help insulate them from short-run pressures to exploit the Phillips curve tradeoff between employment and inflation, and thus avoid the time-inconsistency problem.[13]

Evidence supports the conjecture that macroeconomic performance improves when central banks are more independent. When central banks in industrialised countries are ranked from least legally independent to most legally independent, the inflation performance is found to be the best for countries with the most independent central banks (Alesina and Summers (1993); Cukierman (1993); Fischer (1994); and the surveys in Forder (2000) and Cukierman (2006)).[14]

Although there is a strong case for instrument independence, the same is not true for goal independence, i.e. the ability of the central bank to set its own goals for monetary policy.[15] In a democracy, the public exercises control over government ctions, and policy-makers are accountable – a situation that requires the goals of monetary policy to be set by the elected government. Although basic democratic principles dictate that the government should set the goals of monetary policy, the question of whether it should set goals for the short-run or intermediate-run is more controversial. For example, an arrangement in which the government sets a short-run inflation or exchange rate target that is changed every month or every quarter could easily lead to a serious time-inconsistency problem in which short-run objectives would dominate. In practice, however, this problem does not appear to be severe, because, for example, in many countries in which the government sets the annual inflation target, the target is rarely changed once

13 For an example of how the time-inconsistency problem can be modelled as arising resulting from political pressure, see Mishkin and Westelius (2008). Instrument independence also insulates the central bank from the myopia that can be a feature of the political process. Instrument independence thus makes it more likely for the central bank to be forward-looking and to adequately allow for the long lags between monetary policy actions and inflation in setting their policy instruments.

14 A case study constituting a striking example of the benefits of instrument independence is provided by the granting of instrument independence to the Bank of England in May 1997 (Mishkin and Posen (1997); Bernanke, Laubach, Mishkin and Posen (1999)); before that date, the Chancellor of the Exchequer (the finance minister) set the monetary policy instrument, not the Bank of England. During 1995 and 1996 the UK retail inflation rate (RPIX) was fairly close to 3%, but the spread between nominal and indexed bond yields – referred to as 10-year breakeven inflation – was substantially higher, in the range of 4% to 5%, reflecting investors' inflation expectations as well as compensation for perceived inflation risk at a 10-year horizon. Notably, breakeven inflation declined markedly on the day that the government announced the Bank of England's independence and has remained substantially lower ever since.

15 The distinction between goal and instrument independence was first made by Debelle and Fischer (1994) and Fischer (1994).

price stability is achieved. Even though, in theory, governments could manipulate monetary policy goals to pursue short-run objectives, they usually do not if the goal-setting process is highly transparent.

However, the length of the lags between monetary policy and inflation is a technical issue that the central bank is well-placed to determine. Thus, for example, deciding how long it should take for inflation to return to a long-run goal necessarily requires judgement and expertise regarding the nature of the inflation process and its interaction with real activity. That need for judgement and expertise constitutes support for having the central bank set medium-term goals, because the speed with which it can achieve them depends on the lags of monetary policy. Whether the central bank or the government should set medium-term inflation targets is therefore an open question.

8. Credible commitment to a nominal anchor promotes price and output stability

The inability of monetary policy to boost employment in the long run, the importance of expectations, the benefits of price stability, and the time-inconsistency problem are the reasons why a credible commitment to a nominal anchor – i.e. the stabilisation of a nominal variable such as the inflation rate, the money supply, or an exchange rate – is crucial to successful monetary policy outcomes.

An institutional commitment to price stability via the establishing of a nominal anchor provides a counterbalance to the time-inconsistency problem because it makes it clear that the central bank must focus on the long-run and thus resist the temptation to pursue short-run expansionary policies that are inconsistent with the nominal anchor. Commitment to a nominal anchor can also encourage governments to be more fiscally responsible, which also supports price stability. For example, persistent fiscal imbalances have, in the absence of a strong nominal anchor, led some governments, particularly in less-developed economies, to resort to the so-called inflation tax, i.e. the issuing/printing of money to pay for goods and services, which leads to more inflation and is thus inconsistent with price stability.

Commitment to a nominal anchor also leads to policy actions that promote price stability, which helps promote economic efficiency and growth. A credible commitment to a nominal anchor helps stabilise inflation expectations, which reduces the likelihood of "inflation scares", in which expected inflation and interest rates shoot up (Goodfriend (1993)). Inflation scares lead to bad economic outcomes because the rise in inflation expectations leads not only to higher actual inflation but also to monetary policy tightening to get inflation back under control, which often results in large declines in economic activity. A credible commitment to a nominal anchor is therefore a crucial element in the successful management of expectations; and it is a key feature of the new neoclassical synthesis (Goodfriend and King (1997); Clarida, Gali and Gertler (1999); Woodford (2003)). A successful commitment to a nominal anchor has been found to produce not only more-stable inflation, but also lower volatility of output fluctuations (Fatás, Mihov and Rose (2007); Mishkin and Schmidt-Hebbel (2002, 2007)).

Commitment to a nominal anchor can also help stabilise output and employment. Specifically, to counter a contractionary demand shock, the monetary authorities' response may be to reduce the short-run nominal interest rate; however, the effectiveness of such a policy action may be hindered if long-run inflation expectations are not firmly anchored. For example, should the private sector become less certain about the longer-run inflation outlook, then an increase in the inflation risk premium could boost longer-term interest rates by more than the increase in expected inflation. A higher inflation risk premium would place upward pressure on the real costs of long-term financing for households and businesses (whose debt contracts are almost always expressed in nominal terms) and hence could partially offset the direct monetary stimulus. Thus, a central bank commitment that firmly anchors long-run inflation expectations can make an important contribution to the effectiveness of the central bank's actions aimed at stabilising economic activity in the face of adverse demand shocks.

9. Financial frictions play an important role in the business cycle

Research outlining how asymmetric information could impede the efficient functioning of the financial system (Akerlof (1970); Myers and Majluf (1984); Greenwald, Stiglitz and Weiss (1984)) suggests an important link between business cycle fluctuations and financial frictions. When shocks to the financial system increase information asymmetry and thereby dramatically increase financial frictions, it gives rise to financial instability, and to the financial system no longer being able to channel funds to those with productive investment opportunities. This can result in the economy experiencing a severe economic downturn (Mishkin (1997)). The rediscovery years later of Fisher's paper on the Great Depression (1933) led to the recognition that financial instability played a central role in the collapse of economic activity during that period (Mishkin (1978); Bernanke (1983); and the survey in Calomiris (1993)), and it spawned a large amount of literature on the role of financial frictions in business cycle fluctuations (e.g. Bernanke and Gertler (1999, 2001); Bernanke, Gertler and Gilchrist (1999); Kashyap and Stein (1994)). Empirical evidence also strongly supported the proposition that the most severe business cycle downturns are always associated with financial instability, not only in advanced countries but also in emerging market countries (Mishkin (1991, 1996)).

Even before the crisis, most central bankers understood that financial disruptions could be very damaging to the economy, and this explains the extraordinary actions that central banks took during the crisis to shore up financial markets (Mishkin (2011)). However, the macroeconomic models used for forecasting and policy analysis, whether they were dynamic stochastic general equilibrium (DSGE) models or more traditional macroeconometric models such as FRBUS, which is used at the Federal Reserve, did not allow for the impact of financial frictions and disruptions on economic activity.

2.1 THEORY OF OPTIMAL MONETARY POLICY

The theory of optimal monetary policy starts by specifying an objective function that represents economic welfare, that is, the well-being of households in the economy, and then maximises this objective function, subject to constraints

provided by a model of the economy. Before the crisis, both the objective function and the model of the economy were based on the principles of the new neoclassical synthesis.

2.1.1 OBJECTIVE FUNCTION

Standard descriptions of the central bank's objective function have been expressed in terms of two components (e.g. Svensson (1997); Clarida, Gali and Gertler (1999); Woodford (2003)). The benefits of price stability (principle 2) are reflected in the first component, which involves minimising the deviations of inflation from its optimal rate, which most central bankers take to be around the 2% level. The second component reflects the costs of underutilised resources in the economy and involves minimising the deviations of real economic activity from its natural rate level, which is the efficient level determined by the productive potential of the economy. Because expectations about the future play a central role in the determination of inflation and in the transmission mechanism of monetary policy (principle 4), in order to achieve an optimal monetary policy the intertemporal nature of economic welfare must be taken into account, and the objectives both for the present state of the economy and for the expected path in future periods maximised. Given that inflation is a monetary phenomenon and is thus viewed as controllable by monetary policy (principle 1), the central bank sets its policy instruments (under normal circumstances, a short-term interest rate) to maximise the objective function, subject to the constraints.

2.1.2 CONSTRAINTS: THE MODEL

The constraints, as embodied in macroeconometric models in use at central banks before the crisis, also reflect the principles of the new neoclassical synthesis. These models display no long-run tradeoff between unemployment and inflation (principle 3). Expectations play a central role in household and business behaviour (principle 4) and lead to the existence of the time-inconsistency problem (principle 5). The models also display the importance of a credible commitment to a strong nominal anchor in order to produce good monetary policy outcomes (principle 8), and this requires an independent central bank (principle 7). Because the transmission of monetary policy to the economy operates through the real interest rate, real interest rates have to rise in order to stabilise inflation (Taylor principle 5).

2.1.3 LINEAR-QUADRATIC FRAMEWORK

As we have seen, the objective function and the model (constraints) used by central banks before the crisis reflected all eight principles of the new neoclassical synthesis. However, the approach to analysing optimal monetary policy used by central banks had an additional important feature: it made use of a linear-quadratic (LQ) framework, in which the equations describing the dynamic behaviour of the economy are *linear* – a basic feature of DSGE models – and the objective function specifying the goals of policy is *quadratic*. For example, the objective function was characterised as a loss function comprising the squared value of the inflation gap (that is, actual inflation minus desired inflation) and the squared value of the output gap (that is, actual output minus potential output).

2.1.4 REPRESENTATIVE-AGENT FRAMEWORK

The models also contained another additional feature: a representative-agent framework in which all agents are alike, thereby precluding the presence of financial frictions as the latter require agents to differ, particularly in the amount of information they have. With asymmetric information ruled out, the financial sector has no special role to play in economic fluctuations. Thus, although central bankers were aware of principle 9, i.e. that financial frictions could have an important effect on economic activity, financial frictions were not a key feature in the macroeconometric models used in central banks and were not an element of the pre-crisis theory of optimal monetary policy.

3 MONETARY POLICY STRATEGY BEFORE THE CRISIS

The science of monetary policy described above had several implications for monetary policy strategy, some of which were generally agreed to by almost all central bankers and others of which were accepted by most, but not all, central bankers, but on which there was not a complete consensus.

3.1 FLEXIBLE INFLATION TARGETING

The monetary policy strategy that follows from the eight principles of the new neoclassical synthesis is referred to in the academic literature as "flexible inflation targeting" (Svensson (1997)). It involves a strong, credible commitment by the central bank to stabilising inflation in the long run, often at an explicit numerical level, but also allows for the central bank to pursue policies aimed at stabilising output around its natural rate level in the short run.

The phrase "inflation targeting" to describe this monetary policy strategy is somewhat unfortunate. Although I would argue that almost all central banks in advanced economies that have an independent monetary policy follow the general principles of flexible inflation targeting, they do have very different approaches to the communication strategy surrounding it. Some of these central banks announce an explicit numerical inflation objective and treat it as a target – these are classified as fully fledged inflation targeters – while others are reluctant to be so explicit.

For example, the Federal Reserve has espoused a strong commitment to stabilising inflation, but has not been willing to announce an explicit inflation objective. Instead, the Federal Reserve reports on the individual Federal Open Market Committee (FOMC) participants' projections of inflation in the long run under "an appropriate monetary policy". In effect, the Federal Reserve provides the long-run inflation objective for each FOMC participant, but has not required that the participants agree on a common objective for inflation. The Federal Reserve has therefore not yet adopted an agreed-upon inflation objective and so it is not classified as being in the inflation-targeting camp. On the other hand, the FOMC participants' long-run inflation projections have all fallen within a pretty tight range – between 1 ½ and 2% – and so they are not far from committing to a specific inflation objective: it would not require a vast degree of modification to their communication strategy to move them to the inflation targeting camp (Mishkin (2008)).

In other cases, such as those of the European Central Bank and the Swiss National Bank, central banks have been willing to announce an explicit numerical inflation objective, but are reluctant to treat it as a target because they believe that this would not give them sufficient flexibility. They are unwilling to be classified as inflation targeters because they believe that the use of the word "target" might lead the public to expect them to hit the inflation targets too precisely or over too specific a horizon.

Despite these apparent differences in communication strategy, the basic approach of central banks with an independent monetary policy before the crisis was very similar. They adhered to the eight principles of the new neoclassical synthesis and were willing to conduct monetary policy under a strong commitment to stabilising inflation in the long run. Indeed, Svensson (2002) argues that any central bank that indicates that it will pursue the standard objective function, involving minimising both inflation and output gap in an intertemporal setting, is effectively a flexible inflation targeter. Before the crisis, almost all central banks with an independent monetary policy fell into this classification.

3.2 CERTAINTY EQUIVALENCE, GRADUALISM AND RISK MANAGEMENT

Under the assumptions of the linear-quadratic framework, the optimal policy is certainty equivalent: it can be characterised by a linear time-invariant response to each shock, and the magnitude of these responses does not depend on the variances or on any other aspect of the probability distribution of the shocks. In such an environment, optimal monetary policy does not focus on tail risk, which might require risk management. Furthermore, when financial market participants and wage and price setters are relatively forward-looking, the optimal policy under commitment is characterised by considerable inertia, which is commonly referred to as gradualism.[16]

Indeed, in the United States, as well as in many other industrial economies, the actual course of monetary policy before the crisis was typically very smooth. For example, the Federal Reserve usually adjusted the federal funds rate in increments of 25 or 50 basis points (that is, ¼ or ½ percentage point) and sharp reversals in the funds rate path were rare. Numerous empirical studies have characterised monetary policy before the crisis using Taylor-style rules, in which the policy rate responds to the inflation gap and the output gap; these studies have generally found that the fit of the regression equation is improved by including a lagged interest rate that reflects the smoothness of the typical adjustment pattern.[17]

Although in many ways central banks have conducted monetary policy under a certainty equivalence strategy, central bankers have not been completely

16 The now-classic reference on this approach is Woodford (2003). Also see Goodfriend and King (1997); Rotemberg and Woodford (1997); Clarida, Gali and Gertler (1999); King and Wolman (1999); Erceg, Henderson and Levin (2000); Benigno and Woodford (2003); Giannoni and Woodford (2005); Levin, Onatski and Williams (2005); and Schmitt-Grohé and Uribe (2005).

17 See Clarida, Gali and Gertler (1998, 2000); Sack (2000); English, Nelson and Sack (2003); Smets and Wouters (2003); Levin, Onatski and Williams (2005). Further discussion can be found in Bernanke (2004).

comfortable with this approach to monetary policy. While a linear-quadratic framework may provide a reasonable approximation of how optimal monetary policy operates under fairly normal circumstances, this approach is less likely to be adequate for the consideration of monetary policy when there is a risk, however small, of particularly poor economic performance. First, the dynamic behaviour of the economy may well exhibit nonlinearities, at least in response to some shocks (Hamilton (1989); Kim and Nelson (1999); Kim, Morley and Piger (2005)). Furthermore, the use of a quadratic objective function does not reflect the extent to which most individuals have a strong preference for minimising the incidence of worst-case scenarios. Therefore, given the central bank's ultimate goal of maximising public welfare, there is a case to be made for monetary policy to reflect the public's preference of avoiding particularly adverse economic outcomes.

Their discomfort with a certainty equivalence approach to monetary policy led central bankers to exposit a "risk management" approach to the conduct of monetary policy, even before the crisis. Alan Greenspan indeed described his thinking about monetary policy as exactly such an approach (Greenspan (2003)), although he was not very explicit about what this meant. However, it is clear that even before the crisis, central bankers were aware that they had to worry about risks of very bad economic outcomes. Specifically, they were aware that in some circumstances the shocks hitting the economy might exhibit excess kurtosis, commonly referred to as "tail risk", in which the probability of relatively large disturbances is higher than would be implied by a Gaussian distribution.

3.3 DICHOTOMY BETWEEN MONETARY POLICY AND FINANCIAL STABILITY POLICY

Even before the crisis, central bankers were aware that financial disruptions could have a serious negative impact on the economy. This is why many central banks not only issued reports on monetary policy, but also published *Financial Stability Reports* to discuss potential threats to the financial system. Nonetheless, the general equilibrium modelling frameworks at central banks did not incorporate financial frictions as a major source of business cycle fluctuations. This naturally led to a dichotomy between monetary policy and financial stability policy in which these two types of policies were conducted separately. Monetary policy instruments would focus on minimising inflation and output gaps. It would then be up to prudential regulation and supervision to prevent excessive risk-taking that could promote financial instability.

Although I would say that most central bankers supported the dichotomy between monetary policy and financial stability policy, there were views that monetary policy should address financial stability issues, particularly as regards responding to potential asset price bubbles, as discussed below.

3.4 RESPONSE OF MONETARY POLICY TO ASSET PRICE BUBBLES: THE "LEAN" VERSUS "CLEAN" DEBATE

One active debate in central banks before the crisis focused on how central banks should respond to potential asset price bubbles. Because asset prices are a central

element in the transmission mechanisms of monetary policy, the theory of optimal monetary policy requires that monetary policy responds to asset prices in order to obtain good outcomes in terms of inflation and output. Hence, the issue of how monetary policy might respond to asset price movements is not whether it should respond at all, but whether it should respond at a level over and above that called for in terms of the objectives of stabilising inflation and employment. Another way of defining the issue is whether monetary policy should try to pop, or slow, the growth of possibly-developing asset price bubbles in order to minimise damage to the economy when these bubbles burst. Alternatively, rather than responding directly to possible asset price bubbles, should the monetary authorities respond to asset price declines only after a bubble bursts, to stabilise both output and inflation? These opposing positions have been characterised as *leaning* against asset price bubbles versus *cleaning up* after the bubble bursts, and so the debate over what to do about asset price bubbles has been labelled the "lean versus clean" debate.

Even before the crisis, there was no question that asset price bubbles have negative effects on the economy. As Dupor (2005) emphasised, the departure of asset prices from fundamentals can lead to inappropriate investments that decrease the efficiency of the economy. Furthermore, throughout history the bursting of bubbles has been followed by sharp declines in economic activity, as Kindleberger's (1978) famous book demonstrated.

Before the crisis, the clear-cut dangers of asset price bubbles led some economists, both inside and outside central banks, to argue that central banks should at times "lean against the wind" by raising interest rates to stop bubbles from getting out of hand.[18] They argued that raising interest rates to slow a bubble's growth would produce better outcomes because it would either prevent the bubble or would result in a less severe bursting of the bubble, with far less damage to the economy.

The opposing view to the "leaning against the wind" view that asset prices should have a special role in the conduct of monetary policy, over and above that implied by their foreseeable effect on inflation and employment, is often referred to as the "Greenspan doctrine", because, when Chairman of the Federal Reserve Board, he strenuously argued that monetary policy should not try to lean against asset price bubbles, but rather should just clean up after they burst (Greenspan (2002)).[19] There were several elements to this argument.

First, bubbles are hard to detect. In order to justify leaning against a bubble, a central bank must assume that it can identify a bubble in progress.

18 See Cecchetti and others (2000). The Bank for International Settlements (BIS) view, as represented by Borio and Lowe (2002), Borio, English and Filardo (2004), and White (2004), has been viewed as advocating leaning against asset-price bubbles, but the BIS view is far more nuanced. Instead it advocates leaning against financial imbalances, only one element of which was an asset-price boom. As we will see the case for leaning against financial market imbalances is far stronger than the case for leaning against asset-price bubbles and so characterizing the BIS position as advocating leaning against potential asset-price bubbles is misleading.

19 I was also a proponent of this view (Mishkin (2001a, 2007b)).

That assumption was viewed as highly dubious because it is hard to believe that the central bank has such an informational advantage over private markets. If the central bank has no informational advantage, and if it knows that a bubble has developed, the market will almost surely know this too, and the bubble will burst. Thus, any bubble that can be identified by the central bank would be unlikely ever to develop much further.

A second objection to leaning against bubbles was that raising interest rates may be very ineffective in restraining the bubble, given that market participants expect such high rates of return from buying bubble-driven assets.[20]

A third objection was that there are many asset prices, and at any one time a bubble may be present in only a fraction of assets. Monetary policy actions are a very blunt instrument in such a case, as such actions are likely to affect asset prices in general, rather than solely those in a bubble.

Fourth, although some theoretical models suggested that raising interest rates could diminish the acceleration of asset prices, others suggested that raising interest rates could cause a bubble to burst more severely, thus doing even more damage to the economy (Bernanke, Gertler and Gilchrist (1999); Greenspan (2002); Gruen, Plumb and Stone (2005); Kohn (2006)). This view was supported by historical examples, such as the monetary tightening that occurred in 1928 and 1929 in the United States and in 1989 in Japan, where the subsequent bursting of the bubble was followed by severe economic contractions.[21] Another way of saying this is that bubbles are departures from normal behaviour, and it is unrealistic to expect that the usual tools of monetary policy will be effective in abnormal conditions. Attempts to prick bubbles were thus viewed as possibly violating the Hippocratic oath of "do no harm".

Finally, there was a view that the monetary authorities have the tools to keep the harmful effects of a bursting bubble at a manageable level, as long as they respond in a timely fashion. This was held to be true even in the event of interest rates falling and approaching the zero lower bound, and so the conventional tool of lowering the policy interest rate would no longer be an option. The economy could be stimulated by either: 1) managing expectations in order that the policy rate be viewed as staying low for an extended period, thereby lowering long-term interest rates; 2) lowering risk and term premiums by purchasing securities, and thereby changing their relative supply; or 3) by exchange rate interventions aimed at lowering the value of the domestic currency, which would increase foreign demand for domestic production.[22]

One counterargument to this view was the disastrous experience of Japan after the bursting of the stock market and real estate bubbles. However, as Posen (2003) pointed out, the problem in Japan was not so much the bursting of the bubble as the subsequent policies. The imbalances in Japan's banking sector were

20 For example, see the discussion in Greenspan (2002).
21 For example, see Gruen, Plumb and Stone (2005), Hamilton (1987), Cargill, Hutchison and Ito (1995), Jinushi, Kuroki and Miyao (2000) and Posen (2003).
22 E.g. see Svensson (2001), and Bernanke (2004).

not resolved, so they continued to get worse well after the bubble had burst. In addition, as pointed out in Ahearne and others (2002), the Bank of Japan did not ease monetary policy sufficiently or rapidly enough in the aftermath of the crisis.

The bottom line of the analysis behind the Greenspan doctrine was that the cost of leaning against asset price bubbles was likely to be high, while the cost of bursting bubbles could be kept low. Rather than advocating leaning against bubbles, the view supported an approach in which central banks just clean up after the bubble. This approach was fully consistent with monetary policy focusing on stabilising inflation and employment without a special focus on asset price bubbles.

Another argument against focusing on asset prices is that it could lead to public confusion regarding the objectives of such a policy. As reported in Giavazzi and Mishkin (2006), interviews with participants from different sectors of Swedish society suggested that statements on house prices by Sveriges Riksbank confused the public and led to a general weakening of confidence in the Swedish central bank.

I would argue that the Greenspan doctrine, which was strongly supported by Federal Reserve officials, held great sway in the central banking world before the crisis. However, there were dissenting voices. For example, over the course of several meetings in 2004, a minority of members of the Monetary Policy Committee (MPC) of the Bank of England argued in favour of raising interest rates more than could be justified in terms of the Bank's objectives for inflation over its normal policy horizon.[23] According to the minutes of those meetings, the advocates believed that such a move would reduce the risk of high house-price appreciation and the rapid accumulation of household debt leading to an abrupt adjustment process, with serious negative consequences for the economy.[24] Mervyn King, the Governor of the Bank of England, did not advocate leaning against the wind, but did suggest that to prevent a build-up of financial imbalances a central bank might extend the horizon over which inflation is brought back to target (King (2004a, 2004b)). Statements from officials at the European Central Bank and other central banks also suggested that in the event of an asset boom or bust, a longer period than the usual one to two years might be required to assess whether the price stability goal was being met (Issing (2003a, 2003b); Stevens (2004); Selody and Wilkins (2004); Bank of Canada (2006); Rosenberg (2006)).

4 HOW HAS THE CRISIS CHANGED OUR THINKING?

The global financial crisis of 2007-09 was not only a tsunami that flattened the economy: in the eyes of some commentators it flattened the science of monetary policy, necessitating a total rethink. Armed with an understanding of where the science of monetary policy stood before the crisis, we can now consider which aspects of the events that unfolded during the crisis require us to modify our earlier

23 Bank of England (2004), MPC Minutes: January, p. 8; March, p. 9; April, p. 9; and August, p. 9.
24 Bank of England (2004), MPC Minutes, March, p. 8.

analysis. From my reading of the crisis, there are five lessons that should change how we think about the science of monetary policy and monetary policy strategy.

1. Developments in the financial sector have a far greater impact on economic activity than we previously realised

Although central bankers generally recognised that financial frictions could play an important role in business cycle fluctuations, the 2007-09 financial crisis made it clear that the adverse effects of financial disruptions on economic activity could be far worse than originally anticipated for advanced economies. When the financial crisis started in August 2007, central bank actions to contain it seemed to be working. Many central bank officials, although still concerned about the disruption to the financial markets, hoped that the worst was over and that the financial system would begin to recover (see Mishkin (2011)). The subprime mortgage sector was after all only a small part of the overall capital market, and the losses in the subprime mortgage market, although substantial, still seemed manageable. By the summer of 2008, central banks were even turning their attention to the very high inflation rates at the time: for example, there were discussions within the Federal Reserve as to whether the easing phase of monetary policy might have to be reversed in order to contain inflation (e.g. see Wessel (2009)).

But then came a set of shocks that sent the financial system and the economy over the cliff: the Lehman Brothers bankruptcy on 15 September 2008, the AIG collapse on 16 September, the run on the Reserve Primary Fund on the same day, and the US Treasury's struggle to get the TARP plan approved by US Congress over the following couple of weeks (Mishkin (2011)). The financial crisis now morphed into a global crisis, causing a sharp drop in economic activity in the United States – real GDP declined at an annual rate of -1.3% in the fourth quarter of 2008, -5.4% in the first quarter of 2009 and -6.4% in the second quarter of 2009 – but also in the rest of the world, with real GDP falling by -6.4% in the fourth quarter of 2008 and by -7.3% in the first quarter of 2009. The unemployment rate shot up to over 10% in the United States and in many other advanced economies, and it remained stubbornly high even after the world economy started to recover. The worldwide recession that resulted from the financial crisis turned out to be the most severe economic contraction since the worldwide depression of the 1930s.

The global financial crisis of 2007-09 therefore demonstrated that financial frictions should be front and centre in macroeconomic analysis: they could no longer be ignored in the macroeconometric models that central banks used for forecasting and policy analysis, as we saw was the case before the crisis. As a result of this, there has been a resurgence of interest in the interaction of finance and macroeconomics. Economists, both in academia and in central banks, are now actively trying to build financial frictions into their general equilibrium models, and there is a new body of literature, currently in its infancy, based on the exploration of how financial frictions would modify the prescriptions provided by the science of monetary policy.[25]

25 For example, see Gertler and Karadi (2009) and Curdia and Woodford (2009).

2. The macroeconomy is highly nonlinear

Because economic downturns typically result in even greater uncertainty about asset values, such episodes may involve an adverse feedback loop whereby financial disruptions cause investment and consumer spending to decline, which, in turn, causes economic activity to contract. Such contraction then increases uncertainty about the value of assets, and, as a result, the financial disruption worsens. In turn, this development causes economic activity to contract further, in a perverse cycle.

The deterioration of balance sheets during a recession can also intensify problems of adverse selection and moral hazard because it removes an important channel through which information asymmetries can be mitigated: the use of collateral. If a borrower defaults on a loan backed by collateral, the effects of the adverse selection problem are less severe because the lender can take title to the collateral and thus make up for the loss. In addition, the threat of losing the collateral gives the borrower more of an incentive not to take unmanageable risks that might ultimately lead to a default, and it thus reduces the moral hazard problem. These mechanisms work only as long as the collateral is of sufficient quality: during macroeconomic downturns, the value of collateral may fall, problems of adverse selection and moral hazard again become central, and lenders become much less willing to lend. Again, these events can result in an adverse feedback loop.

The events following the Lehman Brothers bankruptcy showed how nonlinear both the financial system and the macroeconomy could be. In the aftermath, the financial system seized up and both credit spreads (such as the Baa-Treasury or junk bond Treasury spreads) and liquidity spreads (such as the TED or the LIBOR-OIS spreads) shot up dramatically. The subsequent economic downturn, which saw the collapse of real GDP and world trade during the fourth quarter of 2008 and the first half of 2009, as mentioned above, also indicated that the macroeconomy can at times be highly nonlinear.

The role of nonlinearities in the macroeconomy when there is a financial disruption implies an important flaw in the theory of optimal monetary policy that was in general use prior to the crisis: the theory of optimal monetary policy was based on the assumption that the macroeconomy can be described by linear dynamic equations. The financial crisis of 2007-09 demonstrated that although the linear-quadratic framework may provide a reasonable approximation of how optimal monetary policy operates under fairly normal circumstances, this approach is not adequate for the consideration of monetary policy when financial disruptions hit the economy.[26] Furthermore, the use of a quadratic objective function does not reflect the extent to which most individuals have a strong preference for minimising the incidence of worst-case scenarios, such as the one we have just experienced. Therefore, given that the central bank's ultimate goal is the maximisation of public

26 Even before the crisis there was some research which recognised that the dynamic behaviour of the economy could exhibit nonlinearities, at least in response to some shocks (Hamilton (1989); Kim and Nelson (1999); Kim, Morley and Piger (2005)).

welfare, the design of monetary policy should reflect the public's preferences, especially with respect to avoiding particularly adverse economic outcomes.

Most of the quantitative studies of optimal monetary policy have also assumed that shocks hitting the economy have a time-invariant Gaussian distribution, that is, a classical bell curve with symmetric and well-behaved tails. In reality, however, the distribution of shocks hitting the economy is more complex. In some instances, the uncertainty facing the economy is clearly skewed in one direction or another; again, this is likely when there are significant financial disruptions. In addition, as we have seen with the recent crisis, shocks hitting the economy may exhibit excess kurtosis, that is, tail risk, because the probability of relatively large negative disturbances is higher than would be implied by a Gaussian distribution.

3. The zero lower bound is more problematic than we realised

As discussed earlier, before the crisis, central bankers recognised that the zero lower bound for nominal interest rates would require the use of non-conventional monetary policy in the event of a contractionary shock causing interest rates to fall toward zero. One view is that the zero lower bound problem is more serious than originally contemplated because non-conventional monetary policy was not that effective during the crisis. I disagree strongly with this view.

The shock to the financial system resulting from the global financial crisis was in many ways more complicated than the shock that produced the Great Depression of the 1930s, and yet the economic contraction turned out to be far less severe. One key factor that appreciably lessened the severity of the recent economic downturn was that monetary policy was very aggressive, and that it was effective.[27]

Non-conventional monetary policy took four forms: 1) liquidity provision in which central banks expanded lending to both banks and other financial institutions; 2) asset purchases of both government securities and private assets to lower borrowing costs for households; 3) quantitative easing, in which central banks greatly expanded their balance sheets; and 4) management of expectations, which involved central banks committing to keeping their policy rate at very low levels for a long period of time.

In evaluating liquidity provision, some research argues that these types of programmes had little effect. Taylor and Williams (2009), for example, do not find that the actual lending from the Term Auction Facility (TAF) had any impact on easing credit markets. Other research challenges this conclusion by arguing that financial markets would react to the announcements of programmes rather than the actual lending, and that the dependent variable in the analysis should use changes in spreads and not levels. McAndrews, Sarkar and Wang (2008) find that announcements about TAF did significantly lower credit spreads, and other research supports the conclusion that the TAF and other credit facilities helped lower interest rates (Wu (2008), Christensen, Lopez and Rudebusch (2009),

27 Not all economists would agree with this view, notably John Taylor (2009).

and Sarkar and Shrader (2010)). Baba and Packer (2009), McAndrews (2009) and Goldberg, Kennedy and Miu (2010) find that the US dollar swap facilities did help improve the performance of the dollar swap markets. Using a similar event-study methodology, Ait-Sahalia et al. (2010) find that liquidity provision, not only in the United States but also in the United Kingdom and Japan, did help lower interbank risk premiums. This research suggests that liquidity provision did help stabilise financial markets during this crisis.

Research on the impact of the Federal Reserve's large-scale asset purchases during the global financial crisis by Gagnon, Raskin, Remache and Sack (2010) finds that these programmes lowered long-term bond rates relative to short rates by around 50 basis points, and lowered mortgage-backed securities (MBS) interest rates even further by improving liquidity in this market, thereby having a substantial impact on residential mortgage rates.

I am more sceptical of quantitative easing, by itself, making much difference to stimulating the economy. Why should an expansion of the monetary base lead to higher aggregate demand when it was unable to lower interest rates further or stimulate bank lending? (For example, see Curdia and Woodford (2009)). In addition, evidence from the Japanese episode does not provide much support for the theory that a pure expansion of a central bank's balance sheet can be effective in stimulating aggregate demand (Kuttner (2004)).

There is strong theoretical support for the idea that the management of expectations stimulates spending when the policy rate hits the zero lower bound, because a commitment to keep short-term interest rates low for a substantial period of time helps lower long-term interest rates and also raises inflation expectations, thereby reducing the real interest rate (Eggertsson and Woodford (2003, 2004) and Woodford (2003)). However, empirical evidence on how effective management of expectations was during this episode is not yet available.

What I take from all this evidence is that non-conventional monetary policy was effective during the recent financial crisis. I would also argue that conventional monetary policy was effective as well – even more so during this financial crisis than is normally the case (Mishkin (2009b)). To see this, we can think about the counterfactual: what would have happened to the interest rates relevant to spending decisions by households and businesses if the Federal Reserve had *not* lowered the federal funds rate by over 500 basis points starting in September 2007? Clearly interest rates on default-free Treasury securities would have been higher, but also credit spreads would have widened by even more than they did during the crisis, because the weaker economy would have made conditions in financial markets even more stressed. Another way of saying this is that macroeconomic risk would have been higher, and so credit spreads would have been higher, along with higher default-free interest rates. The outcome would then surely have been that households and firms would have faced much higher interest rates, with the result that household and firm spending would have declined even more precipitously, leading to a far deeper recession and possibly even a depression. The problem with regard to conventional monetary policy during the financial crisis is not that it was ineffective, but that the contractionary

shock from the financial crisis was so severe that it overwhelmed the ability of conventional monetary policy to counteract it.

My view that monetary policy, both conventional and non-conventional, was effective during the crisis does not imply that the zero lower bound problem is less serious. Indeed, the lesson that I take from the crisis is that it is a more serious problem than central bankers anticipated. Research before the crisis took the view that as long as the inflation objective was around 2%, then the zero lower bound problem would not be very serious because it would be infrequent and short-lived (Reifschneider and Williams (2000) and Coenen, Orphanides and Wieland (2004)). The fact that the Federal Reserve has had to resort to non-conventional monetary policy twice during the first decade of the 21st century – once in 2003-04 when it made a commitment to keep interest rates low for a considerable period, and once during the 2009-10 period – suggests that the zero lower bound problem may be far more prevalent than earlier research suggested, and not short-lived at all. The flaw with this research is that it was conducted with models that were essentially linear, and, as pointed out above, we now recognise that the macroeconomy is likely to be very nonlinear.

The second reason why it is now clear that the zero lower bound problem is more serious than previously thought is that we now see that contractionary shocks to the economy can be far greater than previously anticipated. Again, this results from the presence of nonlinearities and large tail risks. Sufficiently large contractionary shocks can make the costs of the zero lower bound constraint very significant. Large contractionary shocks can thus overwhelm the ability of conventional policy to counteract them, and may necessitate massive interventions in credit markets and the expansion of central bank balance sheets. As I will discuss below, these massive interventions may have a very high cost for central banks later on.

4. The cost of cleaning up after financial crises is very high

Besides the obvious cost of a huge loss of aggregate output as a result of the worldwide recession, the global financial crisis suggests that there are likely to be three additional costs that will raise the total cost far higher: 1) financial crises are typically followed by very slow growth; 2) the budgetary position of governments may sharply deteriorate; and 3) the exit strategy for central banks from non-conventional monetary policy may both be complicated and hinder the ability of the central bank to successfully manage the economy in the future.

When economies experience deep recessions, typically they subsequently experience very strong recoveries, often referred to as V-shaped recoveries. However, as Reinhart and Reinhart (2010) document, this V-shaped pattern is not characteristic of recessions that follow financial crises because the deleveraging process takes a long time, resulting in strong headwinds for the economy. When analysing 15 severe post-World War II financial crises, as well as the Great Depression, the 1973 oil shock period and the recent crisis, they find that real GDP growth rates were significantly lower during the decade following each of these episodes, with the median decline in GDP growth being about 1%. Furthermore, unemployment rates stay persistently higher for a decade after

crisis episodes, with the median unemployment rate 5 percentage points higher in advanced economies. Although we have many years to go until a decade has passed following the most recent crisis, it actually looks like it might have worse outcomes than the average crisis episode studied by Reinhart and Reinhart. They find that 82% of the observations of per capita GDP during the period 2008 to 2010 remain below or equal to the 2007 level, while the comparable number for the fifteen earlier crisis episodes is 60%. We now recognise that the cumulative output losses from financial crises are massive, and the current crisis looks like it will be no exception.

As pointed out by Reinhart and Rogoff (2009), in the aftermath of financial crises there is almost always a sharp increase in government indebtedness. We have seen this exact situation in the aftermath of the current crisis. The massive bailouts of financial institutions, fiscal stimulus packages, and the sharp economic contractions leading to reductions in tax revenue that occurred throughout the world have adversely affected the fiscal situation in many countries. Budget deficits of over 10% of GDP in advanced countries like the United States have become common. Furthermore, this rise in indebtedness has the potential to lead to sovereign debt defaults, which has become a serious concern in Europe following the Greek sovereign debt crisis and the problems that the Irish government is facing as a result of the spiralling cost of bailing out their banking system. The fiscal retrenchments required to put fiscal balances on a sustainable path are likely to not only be contractionary, but also to increase societal stress. Indeed, there is even a possibility that the fiscal problems brought on by the crisis could lead to countries exiting from the euro.

Actions by central banks aimed at containing the global financial crisis resulted in huge expansions of their balance sheets. The expansion of balance sheets arising from liquidity provision is typically easy to reverse because most liquidity facilities provide loans at interest rates that are higher than market rates during normal times. Hence these liquidity facilities are self-liquidating because as financial markets return to normal, market participants are no longer willing to borrow at above-market rates, so the use of these facilities shrinks. Hence this source of balance sheet expansion naturally reverses itself as the financial system recovers, and this is exactly what has happened.

A far more serious concern is the expansion of the balance sheet that stems from asset market purchases. This expansion of the balance sheet is not self-liquidating and there are concerns that the resulting expansion of the monetary base will lead to high inflation in the future. This would be of greater concern if the expansion in the monetary base was closely linked to inflation, but this is unlikely to be the case in the current environment. The huge increase in the monetary base of 144.6% in the United States from August 2007 to the end of 2009 has resulted in only a 16.0% increase in M2, because banks are perfectly happy to hold onto to huge amounts of excess reserves as long as they are paid interest on them, as is the case currently. Indeed, as argued earlier, because quantitative easing was unlikely to have had a large expansionary effect during the financial crisis, the large increase in the monetary base is unlikely to be inflationary.

More problematic is the fact that asset market purchases were often for long-term securities, and this exposes the central bank to interest risk (and credit risk if it buys private securities such as mortgage-backed securities) because these securities can have substantial price fluctuations. Possible losses on these securities thus mean that there could be an erosion of capital in the central bank's balance sheet, and this could subject it to Congressional or parliamentary criticism and actions that could weaken its ability to conduct an independent monetary policy. In addition, if a central bank has bought private securities, their presence on the balance sheet means that the central bank has encroached on the politicians' turf, because the central bank has engaged in a form of fiscal policy, which makes its political position more precarious, again possibly leading to a loss of independence.[28]

Even the purchase of long-term government securities poses a danger for central banks because it may create the perception that the central bank is willing to accommodate irresponsible fiscal policy by monetising the debt. This is a particular concern right now in the euro area, where the ECB has purchased securities issued not only by governments that have large fiscal imbalances, but also even by a government – in the case of Greece – that lied about its fiscal position. This problem is also a serious concern in the United States, where both political parties have been unwilling so far to address long-run trends in entitlements that could cause US government debt to explode. Not only can the purchase of long-term government assets encourage fiscal profligacy, but it can also lead to an unhinging of inflation expectations, which could make it difficult for the central bank to control inflation in the future.[29]

5. Price and output stability do not ensure financial stability

Before the recent financial crisis, the common view, both in academia and in central banks, was that achieving price and output stability would promote financial stability. This was supported by research (Bernanke, Gertler and Gilchrist (1999) and Bernanke and Gertler (2001)) indicating that monetary policy which optimally stabilises inflation and output is likely to stabilise asset prices, making asset price bubbles less likely. Indeed, central banks' success in stabilising inflation and the decreased volatility of business cycle fluctuations, which became known as the Great Moderation, made policy-makers complacent about the risks from financial disruptions.

The benign economic environment leading up to 2007, however, surely did not protect the economy from financial instability. Indeed, it may have promoted it. The low volatility of both inflation and output fluctuations may have lulled market participants into thinking there was less risk in the economic system than was really the case. Credit risk premiums fell to very low levels and underwriting

28 A particular problem for the Federal Reserve is that its holdings of MBSs on its balance sheet directly involve it in the most politicised financial market in the United States. As discussed in Mishkin (2011), this could lead to politicians viewing the Federal Reserve as personally responsible for developments in the housing markets, which could expose it to increased political criticism and pressure on its policy decisions, thereby further weakening its independence.

29 See Cochrane (2010) for a discussion of how recent fiscal events could lead to a rise in inflation expectations.

standards for loans dropped considerably. Some recent theoretical research even suggests that benign economic environments may promote excessive risk-taking and may actually make the financial system more fragile (Gambacorta (2009)). Although price and output stability are surely beneficial, the recent crisis indicates that a policy focused solely on these objectives may not be enough to produce good economic outcomes.

5 HOW MUCH OF THE SCIENCE OF MONETARY POLICY NEEDS TO BE ALTERED?

Pundits, such as Paul Krugman (2009) and the Economist Magazine (2009), have argued that the financial crisis has revealed deep flaws in the modern field of macro/monetary economics developed over the last forty or so years and that this field needs to be completely overhauled.[30] Indeed, Krugman titled his 2009 New York Times Magazine article "How Did Economists Get It So Wrong?". Does this mean that the science of monetary policy as we knew it before the crisis should be abandoned, and that policy-makers and monetary economists should start all over, as Krugman seems to imply?

To answer this question, let's examine which elements of the science of monetary policy are repudiated by the lessons from the financial crisis that we discussed in the previous section. First, let's look at the basic principles of the science of monetary policy, and then the theory of optimal monetary policy.

5.1 BASIC PRINCIPLES OF THE SCIENCE OF MONETARY POLICY

The lessons from the crisis are as follows: that the financial sector can have a very large impact on economic activity and can make the economy highly nonlinear; that the zero lower bound problem can be very serious, which is just one of the reasons why cleaning up after financial crises can have very high costs; and that price and output stability do not ensure financial stability. One reason why I devoted so much time earlier in the paper to the theory and empirical work that supports the nine principles of the science of monetary policy is that we can now ask whether any of the lessons from the crisis refute the justification for those principles. Upon examination of the reasoning behind each of the nine principles discussed earlier, the answer is very clear-cut: ***none of the lessons from the financial crisis in any way undermine or invalidate the nine basic principles of the science of monetary policy developed before the crisis***.

Each of the five lessons from the crisis is completely orthogonal to the theory or empirical work that supports the eight principles of the new neoclassical synthesis. The lessons in no way weaken the case for any of these principles. The above conclusion is an extremely important one (and this is why I boldfaced and italicised it to make it stand out). It tells us that we should not throw out all that we have learned in the field of macro/monetary economics over the last forty years, as some

30 See Lucas (2009) and Cochrane (2009) for spirited replies to both the Economist (2009) and Krugman (2009) articles.

pundits seem to suggest. Rather, much of the edifice of the science of monetary policy is clearly still as valid today as it was before the crisis. As we shall see, this has important implications for how we view monetary policy strategy.

The lesson that developments in the financial sector can have a large impact on economic activity indicates not only that the ninth principle about financial frictions is of course valid, but also that it is now even more important than central bankers previously realised.

5.2 THEORY OF OPTIMAL MONETARY POLICY

On the other hand, the lessons from the crisis do undermine two key elements of the pre-crisis theory of optimal monetary policy. The lesson that the macroeconomy is inherently nonlinear undermines the linear-quadratic framework that is a key element of that policy. The lesson that the developments in the financial sector can have a major impact on economic activity undermines the representative-agent framework, another key element of the pre-crisis theory of optimal monetary policy. Doubts about the linear-quadratic and representative-agent frameworks that have arisen because of the financial crisis also have important implications for the strategy of monetary policy.

6 IMPLICATIONS FOR MONETARY POLICY STRATEGY

Armed with an understanding of which areas of the science of monetary policy need rethinking, we can examine how monetary policy strategy might be modified in each of the four areas of monetary policy strategy we discussed earlier.

6.1 FLEXIBLE INFLATION TARGETING

I have referred to the monetary policy strategy that follows from the eight principles of the new neoclassical synthesis as flexible inflation targeting, for want of a better name. Since, as I have argued here, none of the principles are invalidated by the events of the recent financial crisis, this approach to monetary policy strategy is still equally valid. The arguments supporting central bank adherence to the principles of the new neoclassical synthesis are still every bit as strong as they were before the crisis. Therefore, there is still strong support for central banks having a strong, credible commitment to stabilising inflation in the long run by announcing an explicit, numerical inflation objective, but also having the flexibility to pursue policies aimed at stabilising output around its natural rate level in the short run.

Although the support for the flexible inflation targeting framework is not weakened by the lessons from the financial crisis, the lessons do suggest that the details of how flexible inflation targeting is conducted, and of what is meant by flexibility, need to be rethought. Let us first look at two possible basic modifications to the flexible inflation targeting framework: the choice of the level of the inflation target, and whether some form of price level targeting would produce better economic outcomes.

6.1.1 LEVEL OF THE INFLATION TARGET

Because the financial crisis has shown that the zero lower bound problem could be more serious than previously thought, there is the question of whether the optimal inflation rate level for a central bank target should be higher than the typical value of around 2%. With a higher inflation target, the real interest rate can be driven down to lower levels in the face of adverse aggregate demand shocks. For example, Blanchard, Dell'Ariccia and Mauro (2010) have suggested that the inflation target might be raised from the 2% to the 4% level. With expectations of inflation anchored to this target, by lowering the nominal interest rate to zero the real interest rate could be lowered to as low as -4%, rather than -2% with the 2% inflation target. Conventional monetary policy, which involves manipulating the nominal policy rate, would then be able to ease monetary policy to a greater extent than it could with the lower inflation target. Another way of stating this is to say that the zero lower bound on the policy rate would be less binding with a higher inflation target.

This argument suggests that inflation targets of less than 2% might be undesirable. While some FOMC participants have declared their desired long-run inflation rate level to be below 2% in the FOMC projections that come out four times a year, the lessons of the financial crisis provide support for the higher 2% long-run inflation goal of many of the other FOMC participants. However, does this support the raising of the inflation target to 4%, as Blanchard, Dell'Ariccia and Mauro (2010) seem to suggest?

The answer, to my mind, is no. The logic behind the view that a higher inflation target makes the zero lower bound on the policy rate less binding is of course correct. But we have to look not only at the benefits of a higher inflation target, but also at the costs. If it were no more difficult to stabilise the inflation rate at a 4% level than at a 2% level, then I think the case for raising the inflation target to 4% would be much stronger. However, the history of the inflation process suggests that this is not the case. Inflation rates that accord with the Greenspan definition of price stability, i.e. "the state in which expected changes in the price level do not effectively alter business or household decisions",[31] seem to be below the 3% level. Once inflation starts to rise above this level, the public is likely to believe that price stability is no longer a credible goal of the central bank and then the question arises, "if a 4% level of inflation is OK, then why not 6%, or 8%, and so on."

As was discussed earlier, economists such as Paul Samuelson and Robert Solow argued that policy-makers should be willing to tolerate higher inflation rates in the 4 to 5% range. But we have seen that when inflation rises above the 3% level, it tends to keep on rising. This was the experience in the United States in the 1960s that eventually led to the Great Inflation period from the 1970s to the early 1980s. Getting inflation back down again during the Volcker era was very costly. No central banker wants to go through that cycle again.

31 Greenspan apparently first expressed this definition in the July 1996 FOMC meeting (page 51 of the transcript, which can be found at http://www.federalreserve.gov/monetarypolicy/files/FOMC19960703meeting.pdf). This definition was later made public in numerous speeches.

A second consideration is that the benefits of a higher inflation target only accrue when the zero lower bound becomes a binding constraint. Although this has surely been a major problem during the recent episode, it must be remembered that episodes like this are not very frequent. Indeed, we have not experienced a negative shock to the economy of this magnitude for over seventy years. If shocks of this magnitude are rare, then the benefits of a higher inflation target are not very large because they are only available infrequently. On the other hand, the costs of higher inflation in terms of the distortions it produces in the economy are continuous. Thus, although they may not be that large in any given year, these costs add up, and in present value terms far outweigh the intermittent benefits obtained from the zero lower bound not being binding in periods like the current one.

6.1.2 PRICE LEVEL TARGETING

Although the commitment to a strong nominal anchor for countries that have an independent monetary policy has taken the form of a target for inflation, an alternative is to target a price level path instead. Theoretical research starting in the late 1990s (e.g. Svensson (1999), Woodford (2002), Ditmar, Gavin and Prescott (1999, 2000) and Vestin (2000, 2006)) demonstrated that a price-level target produces less output variance than an inflation target. Indeed, as expressed by Woodford (2003), a price-level target makes policy history-dependent and this produces improved economic outcomes. The reasoning is straightforward. A negative demand shock that results in a lower price level requires monetary policy to try to raise the price level back to its target path, and this means that inflation is expected to rise in the short run to a level above the long-run inflation target embedded in the price-level target path. The rise in expected inflation then lowers the real interest rate, thereby stimulating aggregate demand and economic activity. Hence, a price-level target is an automatic stabiliser: a negative demand shock leads to stabilising expectations, which stabilise the economy. This mechanism is even more effective when the negative demand shock is so large that the zero lower bound on nominal interest rates becomes binding, as Eggertsson and Woodford (2003) point out.

There are, however, some potential costs to price-level targets. A traditional objection, forcefully articulated by Fischer (1994), is that a price-level target can produce more output variability than an inflation target because unanticipated shocks to the price level are not treated as bygones and must be offset.[32] A price-level target requires that any overshooting or undershooting of the target must be reversed, and this can impart significantly more volatility to monetary policy, and, with sticky prices, to the real economy in the short run. An additional problem with a price-level target is that it is harder to communicate, particularly if it has an upward trend, which is required if the optimal long-run inflation rate is positive in order to make deflations a less frequent occurrence and the zero lower bound constraint less likely to bind. In this case, a price-level target would be a moving target and so harder to explain than an inflation target, which is always kept at a constant level.

32 This view is supported by simulations of econometric macro models with backward-looking expectations, which typically find that a price-level target leads to greater variability of output and inflation than an inflation target. E.g. see Haldane and Salmon (1995).

The lesson from the financial crisis that the zero lower bound problem is more serious than was previously contemplated suggests larger benefits of a price-level target, which may outweigh the costs. Although the communication challenges are serious,[33] the potential benefits of price-level targeting may prompt central banks to look into ways of effectively communicating a price-level target to the public. For example, a central bank could indicate that in the event that it undershoots its inflation target for a period of time, as is occurring currently in many countries, it would be willing to tolerate a higher inflation rate in the short run in order for the average inflation rate over a longer horizon to meet the target objective. For this strategy to work, however, it would be crucial for the central bank to make it clear, and convince the public, that in so doing it would not be raising its long-run inflation objective, and that its commitment to stabilising inflation would therefore remain as strong as ever.

6.2 RISK MANAGEMENT AND GRADUALISM

As discussed earlier, a key element of the analysis of optimal monetary policy is the linear-quadratic framework in which financial frictions do not play a prominent role. Although the linear-quadratic framework might be reasonable under normal circumstances, we have learned that financial disruptions can produce large deviations from these assumptions, indicating that the linear-quadratic framework may provide misleading answers for monetary policy strategy when financial crises occur.

The important role of nonlinearities in the economy arising from financial disruption suggests that policy-makers should not only focus on the modal outcomes, as they would in a certainty equivalent world which is a feature of the linear-quadratic framework, but should also tailor their policies to cope with uncertainty and with the possible existence of tail risks in which there is a low probability of extremely adverse outcomes. I have argued elsewhere (Mishkin (2010b)) that the importance of financial frictions and nonlinearities in the economy provides a rationale for a particular form of risk management approach to monetary policy.

What would this risk management approach look like? The first element of this approach is that monetary policy would act pre-emptively when financial disruptions occur. Specifically, monetary policy would focus on what I have referred to as *macroeconomic risk* (Mishkin (2010b)) – that is, an increase in the probability that a financial disruption will cause significant deterioration in the real economy through the adverse feedback loop described earlier, in which the financial disruption causes a worsening of conditions in the credit markets, which causes the economy to deteriorate further, causing a further worsening of conditions in the credit markets, and so on. Monetary policy would aim at reducing macroeconomic risk by cutting interest rates to offset the negative effects of financial turmoil on aggregate economic activity. In so doing, monetary policy could reduce the likelihood of a financial disruption setting off an adverse

33 This is why I argued in favour of inflation targeting over price-level targeting in the past (Mishkin (2001b)).

feedback loop. The resulting reduction in uncertainty could then make it easier for the markets to collect the information that facilitates price discovery, thus hastening the return of normal market functioning.

To achieve normal market functioning most effectively, monetary policy would be timely, decisive, and flexible. First, *timely action*, which is pre-emptive, is particularly valuable when an episode of financial instability becomes sufficiently severe to threaten the core macroeconomic objectives of the central bank. In such circumstances, waiting too long to ease policy could result in further deterioration of the macroeconomy and might well increase the overall amount of easing that would eventually be required to restore the economy to health. When financial markets are working well, monetary policy can respond primarily to the incoming flow of economic data about production, employment, and inflation. In the event of a financial disruption, however, pre-emptive policy would focus on indicators of market liquidity, credit spreads, and other financial market measures that can provide information about sharp changes in the magnitude of tail risk to the macroeconomy. Indeed, even if economic indicators were strong, monetary policy would act to offset the negative impact of the financial disruption.

Second, policy-makers would be prepared for *decisive action* in response to financial disruptions. In such circumstances, the most likely outcome (the modal forecast) for the economy may be fairly benign, but there may also be a significant risk of more severe adverse outcomes. In this situation the central bank can take out insurance by easing the stance of policy further than if the distribution of probable outcomes were perceived as fairly symmetric around the modal forecast. Moreover, in such circumstances, the monetary policy authorities can argue that these policy actions do not imply a deterioration of the central bank's assessment of the most likely outcome for the economy, but rather constitute an appropriate form of risk management that reduces the risk of particularly adverse outcomes.

Third, *policy flexibility* is especially valuable throughout the evolution of a financial market disruption. During the onset of the episode, this flexibility may be evident from the decisive easing of policy that is intended to forestall the contractionary effects of the disruption and provide insurance against the downside risks to the macroeconomy. However, it is important to recognise that in some instances financial markets can also turn around quickly, thereby reducing the drag on the economy as well as the degree of tail risk. Therefore, the central bank would monitor credit spreads and other incoming data for signs of financial market recovery and, if necessary, take back some of the insurance; thus, at each stage of the episode, the appropriate monetary policy may exhibit much less smoothing than would be typical in other circumstances.

The risk management approach outlined here is one that abandons the prescription of the linear-quadratic framework that the optimal monetary policy would involve gradual changes. Instead, with this approach aggressive actions by central banks to minimise macroeconomic risk would result in pre-emptive, large changes in monetary policy. This was an important feature of the conduct

of conventional monetary policy by the Federal Reserve during the crisis. In September 2007, just after the initial disruption to financial markets in August, the Federal Reserve lowered the federal funds rate target by 50 basis points (0.5 percentage point) even though the economy was displaying substantial positive momentum, with real GDP growth quite strong in the third quarter. The Federal Reserve was clearly not reacting to current economic conditions, but rather to the downside risks to the economy from the financial disruption. Subsequently, the Federal Reserve very rapidly brought the federal funds rate target from its level of 5¼% before the crisis, in September 2007, to 2% in April 2008. Then, after the Lehman Brothers collapse in September 2008, the Federal Reserve began another round of rapid interest rate cuts, with the federal funds rate target lowered by 75 basis points in December 2008, bringing it down to the zero lower bound. Clearly, the Federal Reserve had abandoned gradualism.[34]

One danger from aggressive, pre-emptive actions that are taken as part of the risk management approach is that they might create the perception that the monetary policy authorities are too focused on stabilising economic activity and not enough on price stability. If this perception occurs, the pre-emptive actions might lead to an increase in inflation expectations. The flexibility to act pre-emptively against a financial disruption presupposes that inflation expectations are well anchored and unlikely to rise during a period of temporary monetary easing. To work effectively, the risk management approach outlined here thus requires a commitment to a strong nominal anchor. A risk management approach therefore provides an additional rationale for a flexible inflation targeting framework, and, as I have argued elsewhere (Mishkin (2008)), a strong nominal anchor can be especially valuable in periods of financial market stress, when prompt and decisive policy action may be required as part of a risk management approach in order to forestall an adverse feedback loop.

6.3 THE LEAN VERSUS CLEAN DEBATE

The lean versus clean debate initially focused on whether monetary policy should react to potential asset price bubbles. In thinking about this debate, it is worth first distinguishing between two different types of asset price bubbles. We can then see how this bears on the lean versus clean debate and go on to examine the different policy options for responding to potential bubbles.

6.3.1 TWO TYPES OF ASSET PRICE BUBBLES

34 One period before the crisis when the Federal Reserve abandoned gradualism was during the LTCM (Long-Term Capital Management) episode, when it lowered the federal funds rate target by 75 basis points within a period of a month and a half in the autumn of 1998. This action fits into the risk management approach described here. However, once the shock dissipated, the Federal Reserve did not take away the insurance provided by the funds rate cuts, as the risk management approach outlined here suggests would have been appropriate. I consider this to be one of the serious monetary policy mistakes made by the Federal Reserve under Greenspan. Not only did inflation subsequently rise above the desired level, but the actions also indicated that the Federal Reserve would react asymmetrically to shocks, lowering interest rates in the event of a financial disruption, but not raising them upon reversal of the adverse shock. This helped contribute to the belief in the "Greenspan put" that will be discussed below.

As pointed out in Mishkin (2010b), not all asset price bubbles are alike. Financial history and the financial crisis of 2007-09 indicate that one type of bubble, which is best referred to as a *credit-driven bubble*, can be highly dangerous. With this type of bubble, there is the following typical chain of events: as a result of either exuberant expectations about economic prospects or structural changes in financial markets, a credit boom begins, increasing the demand for some assets and thereby raising their prices. The rise in asset values, in turn, encourages further lending against these assets, increasing demand, and hence their prices, even more. This feedback loop can generate a bubble, and the bubble can cause credit standards to ease as lenders become less concerned about the ability of the borrowers to repay loans and instead rely on further appreciation of the asset to shield themselves from losses.

At some point, however, the bubble bursts. The collapse in asset prices then leads to a reversal of the feedback loop in which loans go sour, lenders cut back on credit supply, the demand for the assets declines further, and prices drop even more. The resulting loan losses and declines in asset prices erode the balance sheets at financial institutions, further diminishing credit and investment across a broad range of assets. The decline in lending depresses business and household spending, which weakens economic activity and increases macroeconomic risk in credit markets. In extreme cases, the interaction between asset prices and the health of financial institutions following the collapse of an asset price bubble can endanger the operation of the financial system as a whole.

However, there is a second type of bubble that is far less dangerous, which can be referred to as an *irrational exuberance bubble*. This type of bubble is driven solely by overly optimistic expectations and poses much less risk to the financial system than credit-driven bubbles. For example, the bubble in technology stocks in the late 1990s was not fuelled by a feedback loop between bank lending and rising equity values, so the bursting of the bubble was not accompanied by a marked deterioration in bank balance sheets. The bursting of the tech-stock bubble thus did not have a very severe impact on the economy, and the recession that followed was quite mild.

6.3.2 THE CASE FOR LEANING VERSUS CLEANING

We have learned from the recent crisis that not only can the bursting of credit-driven bubbles be extremely costly, but also very hard to clean up after. Furthermore, bubbles of this type can occur even if there is price and output stability in the period leading up to them. Indeed, a period of price and output stability might actually encourage credit-driven bubbles because it leads market participants to underestimate the amount of risk in the economy. The case for leaning against potential bubbles rather than cleaning up after them has therefore become much stronger.

However, the distinction between the two types of bubbles, one of which (credit-driven) is much more costly than the other, suggests that the lean versus clean debate may have been misguided, as White (2009) indicates. Rather than leaning against potential asset price bubbles – including both credit-driven and irrational exuberance bubbles – there is a much stronger case for only leaning

against credit-driven bubbles, and not irrational exuberance bubbles. As White (2009) and Mishkin (2010b) have pointed out, it is much easier to identify credit bubbles than it is to identify whether asset prices are deviating from fundamental values. Financial regulators and central banks often have information indicating that lenders have weakened their underwriting standards, that risk premia appear to be inordinately low or that credit extension is rising at abnormally high rates. The argument that it is hard to identify asset price bubbles is therefore not a valid argument against leaning against credit bubbles.

6.3.3 MACRO-PRUDENTIAL POLICIES

There is a strong case for leaning against credit bubbles, but what policies will be most effective? First, it is important to recognise that the key principle to consider in designing effective policies to lean against credit bubbles is whether they fix market failures. Credit extension necessarily involves risk-taking. It is only when this risk-taking is excessive because of market failures that credit bubbles are likely to develop. Upon recognising that market failures are the problem, it is natural to look to prudential regulatory measures to constrain credit bubbles.

Some of these regulatory measures are simply the usual elements of a well-functioning prudential regulatory and supervisory system. These elements include adequate disclosure and capital requirements, liquidity requirements, prompt corrective action, careful monitoring of an institution's risk-management procedures, close supervision of financial institutions to enforce compliance with regulations, and sufficient resources and accountability for supervisors. The standard measures mentioned above focus on promoting the safety and soundness of *individual* firms and fall into the category of what is referred to as micro-prudential supervision. However, even if individual firms are operating prudently, there is still a danger of excessive risk-taking because of the interactions between financial firms that promote externalities. An alternative regulatory approach, which deals with these interactions, focuses on what is happening in credit markets in the aggregate, and is referred to as *macro-prudential regulation and supervision.*

Macro-prudential regulations can be used to dampen the interaction between asset price bubbles and credit provision. For example, research has shown that the rise in asset values that accompanies a boom results in higher capital buffers at financial institutions, supporting further lending in the context of an unchanging benchmark for capital adequacy; in the bust, the value of this capital can drop precipitously, possibly even necessitating a cut in lending.[35] It is important for research to continue to analyse the role of bank capital requirements in promoting financial stability, including whether capital requirements should be adjusted over the business cycle. Other macro-prudential policies to constrain credit bubbles include dynamic provisioning by banks; lower ceilings on loan-to-value ratios or higher haircut requirements for repo lending during credit expansions; and Pigouvian-type taxes on certain liabilities of financial institutions.[36]

35 For example, see Kashyap and Stein (2004) and Adrian and Shin (2009).
36 For example, see Bank of England (2009) and French et al. (2010).

Some policies aimed at addressing the risks to financial stability from asset price bubbles could be made a standard part of the regulatory system, to be operational at all times – whether a bubble was in progress or not. However, because specific or new types of market failures might be driving a particular credit bubble, there is a case for discretionary prudential policies aimed at limiting the market failures in such a case. For example, during certain periods risks across institutions might become highly correlated, and discretionary policy aimed at responding to these higher-stress environments could help reduce systemic risk.

6.3.4 MONETARY POLICY

The fact that the low interest rate policies of the Federal Reserve from 2002 to 2005 were followed by excessive risk-taking suggests to many that overly easy monetary policy might promote financial instability. Using aggregate data, Taylor (2007) has argued that excessively low policy rates led to the housing bubble, while Bernanke (2010), Bean, Paustian, Penalver and Taylor (2010), Turner (2010) and Posen (2009) have argued otherwise. Although it is far from clear that the Federal Reserve is to blame for the housing bubble, the explosion of microeconomic research, both theoretical and empirical, provides support for monetary policy playing a role in creating credit bubbles. Borio and Zhu (2008) have called this mechanism the "risk-taking channel of monetary policy".

The literature provides two basic reasons why low interest rates might promote excessive risk-taking. First, as Rajan (2005, 2006) points out, low interest rates can increase the incentives for asset managers in financial institutions to search for yield and hence increase risk-taking. These incentives could come from contractual arrangements that compensate asset managers for returns above a minimum level, often zero, and with low nominal interest rates only high-risk investments will lead to high compensation. They could also come from fixed-rate commitments, such as those provided by insurance companies, forcing the firm to seek out higher-yielding, riskier investments. Or they could arise from behavioural tendencies such as money illusion, as a result of which the managers believe that low nominal rates indicate that real returns are low, encouraging them to purchase riskier assets to obtain a higher target return.

A second mechanism through which low interest rates could promote risk-taking is through income and valuation effects. Low interest rates increase net interest margins and increase the value of financial firms, expanding their capacity to increase their leverage and take on risk (Adrian and Shin (2009, 2010) and Adrian, Moench and Shin (2010)). In addition, low interest rates can boost collateral values, again enabling increased lending. This mechanism is closely related to the financial accelerator of Bernanke and Gertler (1999) and Bernanke, Gertler and Gilchrist (1999), except in that it derives from financial frictions for lenders rather than borrowers.

Monetary policy can also encourage risk-taking in two other ways. Although desirable from the viewpoint of establishing credibility and a strong nominal anchor, more predictable monetary policy can reduce uncertainty and encourage asset managers to underestimate risk (Gambacorta (2009)). Monetary policy that cleans up after financial disruptions by lowering interest rates, which has been named the "Greenspan put" because this was the actual and stated policy of the

Federal Reserve when Alan Greenspan was at the helm, can lead to a form of moral hazard in which financial institutions expect monetary policy to help them recover from bad investments (e.g. see Tirole and Farhi (2009), Keister (2010), and Wilson and Wu (2010)). The Greenspan put can also increase systemic risk because it is only exercised when many financial firms are in trouble simultaneously, and so they may be encouraged to pursue similar investment strategies, thereby increasing the correlation of returns.

Micro-empirical analysis provides a fair amount of support for the theory of the risk-taking channel of monetary policy. Jimenez, Ongena, Peydro and Saurina (2009), using Spanish credit registry data, find that low nominal interest rates, despite decreasing the probability of defaults in the short term, lead to riskier lending and more defaults in the medium term. Ioannidou, Ongena and Peydro (2009) examine a quasi-controlled experiment in Bolivia and find that lower US federal funds rates increase lending to low-quality borrowers, which leads to a higher rate of defaults and yet at lower interest rate spreads. Delis and Kouretas (2010), using data from euro area banks, finds a negative relationship between the level of interest rates and the riskiness of bank lending.

Adrian and Shin (2010) discuss and provide evidence relating to the risk-taking channel of monetary policy, using more aggregate data. They find that reductions in the federal funds rate increase term spreads and hence the net interest margin for financial intermediaries. The higher net interest margin, which makes financial intermediaries more profitable, is then associated with higher asset growth, and higher asset growth, which they interpret as a shift in credit supply, serves as a prediction for higher real GDP growth.

Given the evidence relating to the risk-taking channel, should monetary policy be used to lean against credit bubbles? There are several objections to doing so. First, if monetary policy is used to lean against credit bubbles, it is a violation of the Tinbergen (1939) principle, because one instrument is being asked to do two jobs: 1) stabilise the financial sector; and 2) stabilise the economy.[37] Given that there is another instrument with which to stabilise the financial sector – macro-prudential supervision – wouldn't it be better to use macro-prudential supervision to deal with financial stability, leaving monetary policy to focus on price and output stability?

This argument would be quite strong if macro-prudential policies were able to do the job. However, there are doubts on this score. Prudential supervision is subject to more political pressure than monetary policy because it affects the bottom line of financial institutions more directly. Thus they have greater incentives to lobby politicians to discourage macro-prudential policies that would rein in credit bubbles. After all, during a credit bubble financial

37 Stabilising the financial sector is not a completely separate objective from stabilising the economy because financial instability leads to instability in economic activity and inflation. However, because the dynamics of financial instability are so different than the dynamics of inflation and economic activity, for the purposes of the Tinbergen principle, promoting financial instability can be viewed as a separate policy objective from stabilising the economy.

institutions make the most money, and they therefore have greater incentives and more resources to lobby politicians to prevent restrictive macro-prudential policies. A case in point is the recent Basel III accord. Press reports suggest that the capital standards in the accord were substantially weakened because of complaints by the German Landesbanken. Furthermore, implementation of the accord was put off for ten years, and it did not contain measures to deal with systemic risk considerations such as having higher capital requirements on systemically more important financial institutions. The Basel III episode suggests that political considerations may make it extremely difficult to have effective macro-prudential supervision.

The possibility that macro-prudential policies may not be implemented sufficiently well to constrain credit bubbles suggests that monetary policy may have to be used instead.[38] But this raises another objection to using monetary policy to lean against credit bubbles: it may not work. I am sympathetic to the view discussed earlier that tightening monetary policy may be ineffective in restraining a particular asset bubble because market participants expect such high rates of return from purchasing bubble-driven assets. On the other hand, the evidence relating to the risk-taking channel of monetary policy suggests more strongly that raising interest rates would help restrain lending growth and excessive risk-taking. Furthermore, the theoretical analysis discussed immediately above suggests that if a central bank credibly commits to raising interest rates when a credit bubble seems to be forming, then expectations in credit markets will work to make this policy more effective. The expectation that rates will go up with increased risk-taking will make this kind of activity less profitable and thus make it less likely to occur. Furthermore, expectations that rates will rise with increased risk-taking means that interest rates will *not* have to be raised as much to have their intended effect.[39]

Nonetheless, using monetary policy to lean against credit bubbles is not a monetary policy strategy that can be taken lightly. Doing so could at times result in a weaker economy than the monetary authorities would desire, or inflation that is too low. This suggests that there is a monetary policy tradeoff between the pursuit of financial stability and the pursuit of price and output stability. Also as mentioned earlier, giving monetary policy another objective might lead to confusion about the central bank's commitment to price stability, thereby weakening the nominal anchor, with potentially adverse effects on economic outcomes.

38 However, as pointed out in Boivin, Lane and Meh (2010), whether monetary policy will be effective in countering financial imbalances depends on the nature of shocks. Boivin, Lane and Meh conduct simulations that show that where financial imbalances reflect specific market failures and regulatory policies can be directed to such failures, monetary policy is less likely to be effective. Monetary policy is likely to be more effective when financial imbalances arise from economy-wide factors.

39 Monetary policy leaning against credit bubbles can also be thought of as a form of risk management because it pre-emptively takes measures to restrain credit bubbles. As in the risk management approach discussed earlier, the justification for pre-emptively leaning against credit bubbles is the presence of nonlinearities in the economy, so that monetary policy is used to take out insurance against the high cost of the bubble when it bursts.

Another danger from having monetary policy as a tool to promote financial stability is that it might lead to decisions to tighten monetary policy when it is not needed to constrain credit bubbles. A situation of low interest rates does not necessarily indicate that monetary policy is promoting excessive risk-taking. One lesson from the analysis here is that policy-makers, and especially monetary policy-makers, want tools to assess whether credit bubbles are developing. Research is underway (e.g. as described in Borio and Lowe (2002) and Adrian and Shin (2010)) to find measures that will signal whether credit bubbles are likely to be forming. High credit growth, increasing leverage, low risk spreads, and surveys to assess whether credit underwriting standards are being eased are factors that can help central banks decide if there is an imminent danger of credit bubbles. Monitoring of credit market conditions will become an essential activity of central banks in the future, and research on the best ways of doing so will have a high priority.

This danger of considering using monetary policy to promote financial stability is highly relevant today. Some economists, for example Hoenig (2010) and Rajan (2010), have called for the Federal Reserve to raise interest rates because they argue that the current low rates are encouraging excessive risk-taking. However, the US economy is currently not in a situation of rapid credit growth, low risk premiums and increasing leverage. Indeed, it still seems to be mired in a deleveraging cycle that is producing serious headwinds for the economy. This doesn't mean that the situation cannot change. However, at the current juncture, low interest rates do not appear to be creating the next credit bubble in the United States, and justification for raising them to curb risk-taking is lacking.

On the other hand, many emerging market economies and some advanced economies like Israel are currently in a very different environment because they did not go through a deleveraging cycle such as occurred in the United States and Europe. They thus have the potential for a credit bubble to develop, and low US interest rates are a potential danger because they could promote excessive risk-taking.[40] In these countries, however, the option of tightening monetary policy to restrict risk-taking may not be available because raising interest rates would just encourage capital inflows that could also promote a credit boom. For these countries the only option may be to pursue macro-prudential policies to limit credit growth.[41]

6.4 DICHOTOMY BETWEEN MONETARY POLICY AND FINANCIAL STABILITY POLICY

Another lesson learned from the financial crisis and the discussion above is that monetary policy and financial stability policy are intrinsically linked to each other, and so the dichotomy between them is a false one. As we have seen, monetary policy can affect financial stability, while macro-prudential policies to promote financial stability can have an impact on monetary policy. If macro-prudential

40 The empirical research in Ioannidou et al. (2009), which indicated that loans became riskier in Bolivia when US interest rates were low, is particularly relevant on this point.

41 These might take the form of policies to restrict capital inflows, but with a focus on restricting credit growth rather than blocking financial globalisation.

policies are implemented to restrain a credit bubble, they will slow credit growth and will slow the growth of aggregate demand. In this case, monetary policy may need to be easier in order to offset weaker aggregate demand.

Alternatively, if policy rates are kept low to stimulate the economy, as is true currently, there is a greater risk that a credit bubble might occur. This may require tighter macro-prudential policies to ensure that a credit bubble does not develop. Coordination of monetary and macro-prudential policies becomes of greater value when all three objectives of price stability, output stability and financial stability are to be pursued.

I have argued elsewhere (Mishkin (2009c) and in French et al. (2010)) that the recent financial crisis provides strong support for a systemic regulator and that central banks are the natural choice for this role. The benefits of coordination between monetary policy and macro-prudential policy provide another reason for having central banks take on the systemic regulator role. Coordination of monetary policy and macro-prudential policy is more likely to be effective if one government agency is in charge of both. As anyone who has had the pleasure of experiencing the turf battles between different government agencies knows, coordination of policies is extremely difficult when different entities control these policies.

7 CONCLUDING REMARKS

The bad news is that we have just been through a once-in-a-century credit tsunami that has had a devastating impact on the economy, one that will last for years to come. The good news is that macro/monetary economists and central bankers do not have to go back to the drawing board and throw out all that they have learned over the last forty years. Much of the science of monetary policy remains intact. The case for the basic monetary policy strategy, which for want of a better name I have called flexible inflation targeting, is still as strong as ever, and in some ways more so.

The recent financial crisis, however, has necessitated some major rethinking regarding the details of this basic framework for monetary policy strategy. We now recognise that the financial sector plays a very prominent role in the macroeconomy, and makes it highly nonlinear at times. This requires that we abandon the linear-quadratic framework for considering how to conduct monetary policy when there is a financial disruption. There is now a stronger case for a risk management framework that factors in tail risks that can produce very adverse outcomes for the economy. Another lesson is that there is a stronger case in favour of monetary policy leaning against credit bubbles (but not asset price bubbles per se), rather than just cleaning up after the bubble has burst. Using monetary policy to pursue financial stability goals is not an easy task, however, and research on how to monitor credit conditions so that decisions to use monetary policy to restrict excessive risk are based on the correct information will be a high priority for researchers in the future. Finally, the financial crisis has made it clear that the

interactions between the financial sector and the aggregate economy imply that monetary policy and financial stability policy are closely intertwined.

There is one other piece of good news that has emerged from this crisis. The field of macro/monetary economics has become considerably more exciting. We are now faced with a whole new agenda for research that should keep people in the field very busy for a very long time. It has also made the work of central bankers more exciting as well. They now have to think about a much wider range of policy issues than they had to previously. This will surely be exhausting, but central banking will be a far more stimulating profession as a result.

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COMMENT

BY GUIDO TABELLINI, BOCCONI UNIVERSITY

Both papers are very interesting, and contain much more than you have heard. I will comment on both papers simultaneously, discussing the main questions that they address. I would like to organise my discussion around two points: crisis prevention, for the most part, and one final comment on crisis management.

On crisis prevention, both papers agree – and so do I – that the most important lesson we have learned is that price and output stability does not imply financial stability. The reason is that in periods of price and output stability there could be an accumulation of financial imbalances that may suddenly unwind. The prices that rise in these periods are those of assets that are used as collateral or that may be related to the expansion of leverage. We now also have a better understanding of how the credit cycle can amplify business fluctuations. Moreover, the high cost of cleaning up is a result of the misallocation of real investment that accompanies these changes in asset prices.

The main questions raised by these lessons are as follows. First of all, should we change the flexible inflation targeting framework in the pursuit of financial stability, and, if so, how? And second, what instrument should be used to achieve financial stability? Should it be the interest rate or regulatory tools? These are very difficult questions, because the science of monetary policy, as Mishkin called it, is still not equipped to address them. In particular, the ninth principle of monetary policy in the paper by Mishkin is not really on a par with the others. Although we have very promising work by Geanakoplos and by Shin and Adrian on the importance of the leverage cycle, the ninth principle has not yet fully developed to the same operational stage as the "neoclassical synthesis".

Nevertheless, with these caveats in mind, I would give the following answers. On inflation targeting, I fully agree with Mishkin. The first eight principles that he mentions are very much valid and they continue to imply that inflation expectations play a central role. They also imply the need to anchor those expectations through appropriate central bank incentives and through an institutional framework. A framework means a structured decision process with clear goals that enables central banks to implement state-contingent policy rules and not just isolated actions; a mechanism for communicating intentions about the long run; a mechanism to hold central banks accountable and to shape their incentives. The crisis has very much enhanced the need for this framework, because it is now clear that we have to use a wider set of policy tools with a lot of judgement. It's also clear that incentives to create unexpected inflation are much stronger, because, if we could do that, it would reduce the debt burden. So we need to anchor expectations even more firmly than before. Flexible inflation targeting is helpful in that regard, because it focuses on the final goal and it is consistent with a very wide range of indicators. Nevertheless there are some possible adjustments that may be usefully added to the inflation targeting framework. Some of them have not actually been mentioned in either paper.

One possible adjustment is to include measures of housing prices to a relevant degree in the inflation target, because those prices react more quickly than others to the financial imbalances. This is an important issue in Europe, where house prices are not so fully reflected in the harmonised price index. One might also want to incorporate the risk-taking channel of monetary policy by adjusting interest rates for risk so as to assess the stance of monetary policy, as was stressed in the ECB paper. Finally, one may want to condition policy decisions on a broad set of financial indicators, and perhaps be prepared to lean against the wind identified by such indicators.

I would also stress my reservations with regard to the emphasis that Mishkin put on the risk management approach. We understand the need for a pre-emptive policy because of the costs of cleaning up. But in the past the risk management approach could have led to excessive accumulation of financial imbalances. Taylor offered the following assessment of US monetary policy in the period 2002-05: maybe the Federal Reserve was too expansionary precisely because there was a need to buy insurance against the risk of deflation.

But these marginal changes to the inflation targeting framework are not enough, because the problem of how to achieve financial stability remains. Here we need to develop a framework to manage the leverage cycle with policy tools other than the interest rate – regulatory tools in particular. Some of the arguments for relying on other policy tools, rather than interest rates, have been mentioned by Mishkin. In particular, we don't want to destabilise the economy in order to reduce the accumulation of credit imbalances.

But to be sure of this point, we would need more empirical research. A recent paper by Bean (Bean et al. (2010)) suggests that interest rate changes are not so powerful in influencing credit aggregates and removing the credit imbalances. But he obtained this result using a VAR framework, to which the Lucas critique applies: as you change the policy rule, the parameters also change. Nevertheless, this evidence seems to suggest that interest rates do not have a powerful effect on the credit imbalances.

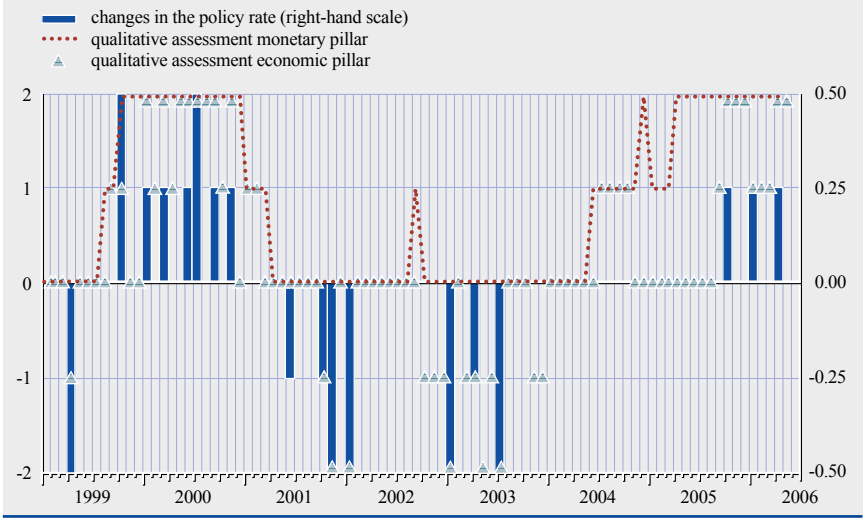
If you believe that you should rely on other policy tools, there are at least two issues to address. First, do you want to target securities through margin requirements, or do you want to target intermediaries through capital requirements? I think the question here is which approach is more likely to win a race against financial innovation. Perhaps you want to rely on both. The second issue is that you really need to develop a framework, as with inflation targeting, with which to manage expectations in a practical way. We don't just want a predetermined set of rules: we need to manage the leverage cycles with administrative rules, and that requires creating a framework as defined above.

I think there is a strong argument for putting the central bank in charge of both policy tools – interest rates and administrative tools. One rationale in support of this was emphasised in the paper by Mishkin, namely the need to coordinate policies because of the complementarities between them. I think there is

a second argument, and it concerns the skills that are needed. We are talking about macro issues, not micro issues, and those skills you find in central banks. It is true that there is the political economy concern, but I would regard that as a concern which is particularly powerful only because we don't have a framework at present. If we had a more transparent and complete framework, then perhaps those political influences would be easier to resist. To put it more bluntly, the institutional framework that we have now reflects the intellectual dichotomy between monetary policy and financial stability policy. If this dichotomy is false, then the institutional framework and architecture should be reconsidered much more deeply. This is also because of the incentive issues, not just because of the required skills.

I will now turn to the ECB paper and the ECB approach. The question that I would like to address is whether the monetary pillar is really an alternative framework for the pursuit of financial stability. By that I mean whether it did indeed prevent an accumulation of leverage, a fall in risk and a surge in asset prices, and, if so, how. My answer is no, it is not really an alternative framework. The ECB paper argues that the monetary pillar improves stability of prices and output in the long run, but that is different from financial stability. In fact, the monetary pillar was not conceived to promote financial stability. It was conceived to improve inflation forecasts in the long run. Indeed, if the goal was financial stability, it is not clear why one would want to condition on money; in fact, the ECB paper considers credit, not money. Besides credit, one may want to condition on measures of the price of risk, such as interest rate spreads and margin requirements, which of course is not what the monetary pillar did.

How important the M pillar in practice



Source: Fischer et al. 2008.

Note: The qualitative coding goes from -2 (clear downward risks to price stability) to +2 (clear upward risks to price stability).

Finally, there is also evidence that the monetary pillar on its own was not so influential in driving interest rate decisions. Here I would like to show a chart from another ECB paper by another group of ECB economists (Fischer, Lenza, Pill and Reichlin) that supports this conclusion. In their research they look at the narrative of the ECB statements to quantify the monetary and economic pillar. Perhaps this is a better way to assess the evidence, because it is so difficult to estimate money demand shocks. The solid line in the graph represents the risks to price stability suggested by the monetary analysis, as reflected in the language used by the ECB President after each Council meeting. The triangles are the same indicators obtained from the economic analysis, also from the ECB statement, and the histograms are the changes in interest rates.

As you can see, typically monetary and economic indicators move in the same direction. When they don't, the economic analysis seems to be more important. This is certainly true for the period 2001-03, when the monetary analysis suggested no risk to price stability. Based on this graph it seems that maybe only in late 2005 was there an instance in which the monetary pillar induced an earlier increase in interest rates than would otherwise have occurred. But overall, I would say that the monetary pillar was not something that significantly altered the framework relative to what I would describe as a form of flexible inflation targeting.

And now one last point on the management of the crisis. Here I agree with both papers, which provided a very rich discussion that I will not repeat. There is, however, a very important lesson to be drawn from the crisis that is not mentioned in either paper. It is the need to manage expectations. In situations of extreme uncertainty, such uncertainty may precipitate contagion, and lead to what Ricardo Caballero has called a sudden financial arrest. This is not surprising, because a crisis can be thought of as a situation of multiple equilibria. The good equilibrium is typically supported by the implicit expectation that there is a lender of last resort that can provide insurance against sudden financial arrest. Disappointing the expectation is very, very dangerous. I think that was a mistake that was probably made in the early phase of the crisis in the United Kingdom and the United States. Perhaps it is a mistake that is going to be made now in Europe. This mistake reflects a genuine dilemma among policy-makers regarding whether to bail out institutions to prevent contagion, or avoid creating incentives for moral hazard in the future. But I think this is to some extent a false dilemma, because moral hazard should be addressed by regulation, not by the threat of withholding insurance. If you withhold insurance you really risk precipitating the crisis.

This is an important lesson for Europe, because there is a fundamental fragility in the euro area that comes from the separation of monetary and fiscal policy. This separation implies that central banks cannot easily act as lenders of last resort to stop a sudden financial arrest in the worst case scenario, and of course this raises the risk of a sovereign debt crisis. It is a relevant lesson to bear in mind, because the main threat will not come from the housing market now; it will come from sovereign debt. It may still be that we have other lessons to learn before the crisis is over.

To summarise, the main points I want to stress are first, that we should preserve the inflation targeting framework, although with some adaptations. Second, we should work hard on developing a framework in which financial stability can be managed with policy tools other than the interest rate. Third, I don't think that the ECB monetary pillar was really an alternative framework. And finally, central banks should be able to provide insurance against a sudden financial arrest.

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COMMENT

BY WILLIAM R. WHITE, OECD

I INTRODUCTION

I wish to begin with a crucial introductory point. According to all of the models commonly in use at central banks and international financial institutions, this crisis was not supposed to happen. Indeed, it could not happen. Modern macro models such as the New Classical, New Keynesian, and DSGE models rule out extended economic disequilibria by assumption. More traditional structural models rule out such outcomes inadvertently by paying too little (if any) attention to the factors now commonly believed to have both precipitated the crisis and to have contributed to its longevity. Here I am referring to the whole gamut of credit, leverage, stocks (especially of debt), and the gradual build-up (now unwinding) of "imbalances" in the real economy.

By "imbalances" I mean asset prices that rose to levels that were increasingly hard to explain in terms of fundamentals, as well as financial institutions that became exposed to a variety of risks that threatened their solvency. The dangers posed by these financial imbalances are now being addressed in the context of the broader search for "financial stability". However, other imbalances also built up, affecting the real side of the global economy. Household savings rates in English-speaking countries (and some others) fell to zero, and sometimes well below. Fixed investment ratios in China rose to over 50% of GDP, a level never seen before in market-based economies. And, as a by product of these domestic imbalances, global trade imbalances also rose to unprecedented levels. Finally, as supply responded to demand-side pressures, whole industries expanded beyond sustainable levels (construction, financial services, global distribution networks, etc.), implying a need for subsequent downsizing. These real-side imbalances are still not receiving the attention they deserve.

The crisis was triggered in the summer of 2007 by the recognition of problems in the financial sector, but could just as easily have started on the real side of the economy. Whatever the trigger, the fundamental point is that the imbalances on the real and financial sides interact in both the upswing ("boom") and the downswing ("bust") of the credit cycle. While some of the imbalances revealed by the crisis have subsequently been reduced, most of them still remain. This is the fundamental reason for doubting the robustness and sustainability of the recovery seen recently in the global economy.

Of course, the fact that commonly used models failed to foresee the crisis was only part of the broader analytical failure. If crises cannot happen, there is no need for pre-emptive action to prevent them. Nor is there any need for ex ante measures to improve crisis management (appropriate insolvency laws for both banks and other entities, Memoranda of Understanding between official bodies, adequate deposit insurance, burden-sharing agreements, etc.). And, of course,

without an understanding of the deep roots of the crisis, there was also a tendency for insolvency problems to be first misdiagnosed as liquidity problems, and for any positive economic indicators to be interpreted wrongly as the "green shoots" of a lasting recovery.

So we need a profound re-evaluation of how our modern economies work, and of the role of money and credit in such economies.[1] In effect, we need to reopen the Keynes-Hayek debate of the 1930s, which effectively pitted a one-period model (Keynes), which focused on how to get out of a deep slump, against a multi-period model (Hayek), which focused, quite differently, on the dynamics of how the economy got into such a terrible muddle in the first place. And I would add that attention to some of the insights of Minsky[2] (how stability breeds instability) and Koo[3] (on balance sheet recessions) would not go amiss either.

Evidently, such a re-evaluation could have profound implications for monetary strategy. However, just *how* profound, for any given central bank, would depend very much on what it believed before the crisis. I would contend that the beliefs of central banks actually differed significantly before the crisis arrived, and that these differences contributed at times (for example in the summer of 2008) to significant differences in policy stance.[4] While there are many reasons for these differences between central banks, history has certainly had an important role to play. Let me expand.

The Federal Reserve seems to have a "one pillar" strategy, which relies on the output gap to drive inflation. The insurance policy they commonly refer to is insurance against deflation. This reflects the fact that the Great Depression was historically the defining economic moment for the United States. In contrast, the European Central Bank (ECB) has a "two pillar" strategy (the gap pillar and the monetary pillar), and has traditionally been on the lookout for inflationary pressures. I think this reflects the fact that the defining historical moment for Europeans (the legacy of the Bundesbank) was the hyperinflation in central Europe in the 1920s. Finally, the Bank of Japan has a strategy based on "two perspectives". As with the other central banks, the first perspective relates prospective inflationary pressures to the output gap. However, the second perspective involves looking out for signs of "imbalances" and bubble-like behaviour leading eventually to a bust and deflation. It is in effect a pledge not to repeat the Japanese excesses of the 1980s, and is thus very different from a traditional interpretation of the second pillar of the ECB. Against the backdrop of these fundamental differences, it is very hard to see how the conduct of monetary policy can be described as a "science", as many (largely American) economists seem inclined to do.

My own belief is that excessive credit/monetary creation is at the heart of all the problems feared by these different central banks. Moreover, each of them is right,

1 For a fuller discussion of such issues see White (2010).
2 Minsky (1992).
3 Koo (2009).
4 For a fuller discussion, see White (forthcoming).

though they fear different things, since historically some episodes of excessive credit expansion have led to inflation while other episodes (via imbalances and eventual busts) have led to deflation. It is like a horse race, with the winner being revealed only at the end. These views about the importance of credit seem to be well supported by the historical analysis carried out by those such as Bordo and Filardo (2005), Reinhart and Rogoff (2009), Reinhart and Reinhart (2010), and Eichengreen and Mitchener (2003), as well as research carried out by the Bank for International Settlements (BIS)[5] and the International Monetary Fund (2008, 2009).

Let me now turn to the two papers I am going to discuss. One is by Rick Mishkin, who has had a long and close association with the Federal Reserve System, and the other is by staff members of the European Central Bank. Without questioning their objectivity, I must first note that both wind up strongly supporting the basic positions of their respective institutions. That said, both are excellent papers. The Mishkin paper is more wide-ranging, but the ECB paper is particularly insightful and innovative in dealing with the more limited number of issues it chose to address.

2 COMMENTS ON THE PAPER BY RICK MISHKIN

In important respects, Mishkin seems rather unrepentant. He states that "the case for the basic monetary policy strategy (flexible inflation targeting)... is still as strong as ever". In light of the magnitude and depth of the crisis, this seems, at first glance, astonishing. However, he then goes on almost immediately to say that we require "major rethinking regarding the details of the basic framework". Since the devil is always in the details, let me turn to some of his suggestions about possible changes to monetary policy strategy. Here I distinguish between lessons for the "leaning" phase (the upswing of the credit cycle) and lessons for the "cleaning" phase (the downswing of the credit cycle).

2.1 LESSONS FOR THE "LEANING" PHASE

Mishkin makes a number of points with which I agree. His description of how monetary policy can contribute to credit excesses via the "risk-taking channel" is something that my former colleague at the BIS, Claudio Borio, has been writing about for years.[6] I also agree that a clearly articulated and credible policy commitment to leaning against financial excesses could well steer behaviour in a stabilising direction.[7] After all, is that not what we believe happened after central banks became serious about resisting inflation?

I also agree that identifying credit bubbles is a lot easier than identifying irrational exuberance bubbles. I must add, however, that at the BIS our analysis of emerging problems was always couched in terms of credit rather than asset prices. To put it differently, we always felt that it was important to deal with

5 The BIS has published an immense amount of work on these general themes. For a careful look at one aspect of the historical record, see Borio and Filardo (2004).
6 See Borio and Zhu (2008).
7 As suggested in a previous paper. See White (2006).

the underlying causes of imbalances rather than focus on just one of their many symptoms. Indeed, the vigour with which this narrow asset-price theme was pursued before the crisis may have reflected a more sinister motivation. By creating a straw man, it would evidently be easier to undermine the arguments for the more fundamental rethink of the policy framework that we were suggesting.

I must, however, also disagree with Mishkin on a number of points. He refers (as did Chairman Greenspan) to what we have just gone through as "a once-in-a-century credit tsunami". And he adds that that, in light of this rare event, "The case for leaning... has therefore become much stronger". This is simply not true. The historical analysis to which I referred earlier shows that credit-driven bubbles occur with very high frequency and cause enormous damage – whether the result is rising inflation or deflation or just general stagnation. The fundamental policy error in the United States derived, then, not only from a failure to learn from the history of economic thought, but also a failure to take the right lessons from economic history.

On one other matter concerning policy in the upswing, I am not sure whether I disagree with Mishkin or not, since he seems to say two contradictory things. On the one hand, he argues against monetary policy playing a role in resisting credit excesses, and potentially leading to financial instability, since "one instrument is being asked to do two jobs". On the other hand, he stresses, that the distinction between price stability and financial stability is not only overdrawn, but wrong. I agree with this latter point. The underlying problem is a macro problem: excessive credit, leading to excessive real growth, and potentially to both inflation and imbalances, each of which could lead to financial instability. Leaning against one is to lean against them all, even if this obviously implies more "fuzziness" in achieving all three objectives, given only one instrument. Mishkin is also right in suggesting that the responsibility for such macro policy decisions should be in the hands of the central bank, and that macro-prudential policies (more instruments) must be very important complements to the use of monetary policy.

Finally, with respect to "leaning", I think Mishkin's analysis misses a crucial point in that it justifies leaning against financial imbalances solely in terms of avoiding financial instability. As noted above, real-side imbalances are equally costly to the economy. Indeed, it is the interaction of real-side imbalances with financial imbalances that commonly cause such huge losses in the "bust" phase of credit cycles. As households and corporations cut back spending in the face of accumulated debt, we are confronted with what Keynes called the "paradox of saving". Similarly, as exposed lenders cut back, we are confronted with what Fisher called the "paradox of deleverage". Interacting with each other, these constitute powerful forces pushing the economy away from full employment equilibrium.

The influence of real-side imbalances are also attested to by Reinhart and Rogoff (2009). They note that over half of the crises they looked at began on the real side of the economy, with the financial sector being damaged only subsequently as

recession affected the capacity of borrowers to repay. They also note numerous cases in history where the real economy suffered badly even though the financial sector seemed to be in a relatively good state of health. The experience of my home country, Canada, during the Great Depression is a good example of this phenomenon.

2.2 LESSONS FOR THE "CLEANING" PHASE

In spite of his more positive comments on "leaning", Mishkin still seems to believe that "cleaning" is a better alternative – if done properly. To this end, he suggests a pre-emptive reduction in interest rates when the probability of a financial crisis rises above some threshold. I think this would not work for at least four reasons.

First, if the imbalances are building up on the real side of the economy then looking primarily at financial indicators would be looking in the wrong place. Second, during credit booms, the financial sector generally looks in fantastic shape right up until the "Minsky moment", when everything changes. This means that identifying the appropriate time to ease would not be easy. Third, lowering interest rates at the height of a boom would only encourage more risk-seeking behaviour. And fourth, Mishkin's "risk management" seems suspiciously like Chairman Greenspan's "risk management paradigm", which I believe contributed significantly to our current problems in the first place.

On a similar note, Mishkin also fails to mention an important fact. Whatever its possible merits in encouraging near-term increases in aggregate demand, there are also many downsides to aggressive monetary easing in the bust phase of a credit bubble. One possible consequence is that it will just encourage another unsustainable bubble. Indeed, as we speak, fears are increasing over asset price increases globally (with the exception of house prices in some important countries) and over massive capital flows to emerging markets. Another concern is that low interest rates encourage "zombie" companies and "zombie" banks that reduce aggregate productivity growth in turn. Low savings rates and misallocated capital can reduce potential growth even further. While I have no time here to go into the details, let me say for the record that I believe such forces have contributed significantly to Japan's secular stagnation. Put differently, these issues are not so unimportant that they can be safely ignored by policy-makers.

Finally, Mishkin provides some comments on inflation targets and price-level targets going forward. On the former, I agree with him that Blanchard's recent suggestion (a throwaway comment, to be fair) – that we should raise our inflation targets to provide more room for interest rates to fall in downturns – is not acceptable.[8] Not only does higher inflation have significant costs, but also Blanchard's suggestion again focuses on making it easier to clean up after a crisis rather than trying to avoid the problem in the first place. As for price-level targets, Mishkin seems to like them because they also allow more stimulus in downturns. However, it is instructive to look at the period 2003-07, when

8 Blanchard *et al*. (2010).

inflation was constantly registering below both target and forecast. For those (like me) who think monetary policy was too easy during that period, a price-level target would have made things even worse.

3 THE PAPER BY FAHR, MOTTO, ROSTAGNO, SMETS AND TRISTANI

This brings me to the ECB paper. Unlike Mishkin's analysis, which focuses almost totally on aggregate demand, this paper gives much more balanced attention to demand-side and supply-side issues. While my introductory comments indicate that I am not the greatest fan of DSGE modelling, I found the authors' decomposition of shocks extremely useful. Moreover, their analysis of the implications for policy was both interesting and important.

I particularly welcome the attention to supply-side issues and how important supply shocks can complicate the strategy of monetary policy. For example, positive supply shocks push down prices, even as they increase demand. With time, however, the latter phenomenon is likely to get out of hand (given monetary accommodation), and this could potentially push prices back up above desired levels. This is one rationale for the ECB looking past the immediate effect on prices to the potential longer-term effects.

The observation that the source of a shock matters for policy is not only interesting, but also important. While the ECB paper is based on the use of a closed-economy model, it still throws light on a bigger problem. Globalisation led for a decade or more to significant downside pressure on world prices. The reaction in most central banks was to follow an easier than normal monetary policy. In a way this is curious. Given the rise in potential growth, and thus in the longer-term natural rate of interest, the very opposite reaction would seem to have been called for. Indeed, there is an extensive body of pre-war literature[9] that argues for inflation targets to be reduced in response to such productivity increases. In a nutshell, if prices "want to go down" and monetary policy refuses to let them, then monetary expansion creates the imbalances that lead to recession or worse. This was Hayek's particular insight when (almost alone) he predicted the Great Depression in the United States.[10]

Another interesting question raised in this paper has to do with communications policy. It comes up in the discussion of the medium-term orientation of the ECB. It is also raised in the discussion of the use of non-standard instruments, where the authors repeatedly note that the ECB (unlike the Federal Reserve) never offers "pre-commitments" concerning future changes in the policy rate. The authors apparently agree (not surprisingly in their assumed world of rational

9 This body of literature was well summarised by Selgin (1997). For a more recent analysis, see Beckworth (2008).

10 This is well described in Haberler (1986). While many believed in the 1920s that the stability of US prices meant the business cycle had been abolished, "Hayek demurred; he argued that under the smooth surface of stable prices basic maladjustments were bound to develop that would eventually lead to a severe crisis".

expectations) that pre-commitment can be a very powerful monetary instrument. However, once one allows for supply-side shocks, that same power can lead to very bad outcomes as well as good ones. I found their counterfactual simulations about the use of such policies by the ECB in the late 1990s very convincing.

The paper also contains an interesting discussion of the Federal Reserve's communication strategy when it was raising policy rates in a "measured" way between 2003 and 2007. Apparently, it was worried that a more aggressive tightening might tip the economy into deflation, even though it was also aware that much of the downside risk to prices was arising from supply-side shocks. This in itself might lead one to question the appropriateness of the Federal Reserve's policy, but it is possible there was another important downside. With the yield from maturity transformation constantly declining, but with clear "communication" implying an even greater reduction in the risks associated with the carry, there was a strong incentive to increase leverage. This might well have contributed to the severity of the subsequent financial meltdown.

The role of the second monetary pillar is illustrated in the paper through simulations using a Taylor type rule, augmented with a "monetary" variable (deviations from trend of credit to the non-financial sector). It is demonstrated that such a rule leads to better economic performance than a rule without such a variable, and that it also dominates a standard Taylor rule premised on a more aggressive response to deviations of inflation from target.

However, the substitution in their work of "credit" for "money" raises a truly fundamental question. What is the second pillar for? Is it just another indicator of latent inflationary pressures (money growth predicts inflation at low frequencies), or is it rather an indicator of the dangers of a boom-bust cycle (credit growth leading to "imbalances") and potential deflation? And does the answer to this question have implications for the conduct of monetary policy, or not?

I will touch only briefly on the issue of the ECB's approach to the use of non-standard instruments in responding to the crisis. The single most important point that emerges is that the ECB's approach differs from that of the Federal Reserve in a number of ways. First, the authors contend that non-standard instruments were a complement to standard monetary policy for the ECB, but were used by the Federal Reserve as a substitute only after standard policy had reached its limits. Second, the ECB lent only to the banking sector while the Federal Reserve purchased the liabilities of non-financial corporations. Third, to facilitate an "exit" from the non-standard measures, the ECB conducted only repos whereas the Federal Reserve made outright purchases. Fourth, as already noted, the ECB made no pre-commitments on policy rates, whereas the Federal Reserve did.

I do not feel qualified to comment on the merits of each institution's position. I would only note that the evident differences between them indicate that they were certainly not guided by the "science" of monetary policy. Of course, this cannot be considered a shortcoming, for the ECB at least, since they did not consider the use of these non-standard instruments to be an instrument of monetary policy in the first place.

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GENERAL DISCUSSION

Otmar Issing (Center for Financial Studies) stressed that the ECB was never part of the "Jackson Hole" consensus on monetary policy strategy. In his view the ECB is the only central bank to have fully embraced Mishkin's principle 1 ("Inflation is always and everywhere a monetary phenomenon"). Tabellini was right in his assertion that the monetary pillar was not invented for financial stability purposes, but very early on these considerations were incorporated into the monetary analysis. In particular, the ECB also looks at credit and not just at M3. Issing expressed the concern that a policy that is asymmetric towards asset prices could result in a sequence of ever greater bubbles. Central banks should avoid identifying bubbles in individual assets, but rather look at aggregate money and credit. In his view there is no conflict between the monetary pillar and leaning against the wind. He concluded: "Welcome, Rick – you have arrived where we started years ago".

Thomas Hoenig (Kansas City Fed) disagreed with Mishkin's view that prudential policies are more subject to political pressure than monetary policy. In his view both policies become very political in the crunch. On the issue of quantitative easing he characterised himself as "multi-period oriented". That is, he is concerned not only about its current effects, but also about the long run. It is hard to withdraw the stimulus at the right time, and withdrawing it too late creates conditions for a subsequent crisis.

Jacques Cailloux (Royal Bank of Scotland) referred to the nonlinearities in financial markets identified by Mishkin and Tabellini, and asked them to elaborate on which responses on the part of central banks to the current crisis on the periphery of Europe would satisfy the conditions of being "timely (pre-emptive), decisive and flexible".

Smets agreed that the crisis gives rise to risks owing to an extended use of central bank instruments and their interaction with fiscal policy. For that reason a clear policy framework with a focus on medium-term price stability is important. He argued that separate institutions or frameworks are needed for price stability and financial stability (although with the central bank playing an important role in the latter). The fact that the frictions impinging on price stability and financial stability are different calls for the use of separate tools. In response to Pisani-Ferry's criticism that some of the counterfactuals without full allotment are too extreme, Smets explained that the whole point of the counterfactual exercise was to show outcomes which we do not see in the data, but which may have been possible without the forceful response of policy-makers.

Mishkin agreed that cleaning up after crises creates moral hazard and recognised that low interest rates can (though not always) fuel leverage cycles. This may be an issue now in some emerging countries, e.g. China. Regarding the monetary pillar, he recalled that it was originally focused on inflation. His main reason for scepticism was that if money supply changes are the signal and money velocity the noise, then under normal circumstances the signal to noise ratio is likely to be

very low. Regarding a broader definition of the monetary pillar, he agreed with the concern about credit imbalances but disagreed with calling it a 'monetary pillar'. He called for abandoning the label of 'monetary pillar', which may be distracting, and focusing on what is important, i.e. identifying risks to financial stability. Standard monetary aggregates may only be imperfect indicators of such risks. For example, in the United States there is a large shadow banking sector, and monetary aggregates are certainly not important there. Miskhin agreed with Hoenig's concerns about the long run and expressed regret that the Federal Reserve has not adopted a long-run framework, such as explicit inflation targeting. Mishkin agreed with Tabellini's comments on the pros and cons of having one institution in charge of both monetary policy and macro-prudential supervision, and referred him to the *Squam Lake Report* (French et al. (2010)). Mishkin said he was never sure what Greenspan meant by risk management. It was right to be expansionary in the wake of the 1998 LTCM bankruptcy, but it was a huge mistake not to reverse this policy later on. He stressed that the moral hazard problem is pervasive, since no country will fail to bail out systemically important institutions.

Mishkin agreed with Pisani-Ferry that the basic principles of monetary policy were established before the 1990s and that there was an element of a wrong turn in the post-1990 research. In particular, he was never a fan of the representative-agent framework, which can be a trap. However, he warned that the current backlash against economic theory is making many economists switch to thinking that expectations do not matter at all, which is going too far in his view. For example, some economists think fiscal stimulus will always work in the same way, regardless of the fiscal position. Mishkin agreed that the international dimension is very important and that policies appropriate for one country do have effects on others. However, he protested against comparing current quantitative easing, which is clearly appropriate in the US situation, with beggar-thy-neighbour policies. He also touched upon the international dimension of policies within Europe: he pointed out that countries such as Ireland and Greece are being forced to pursue very contractionary fiscal policies. In this situation the ECB should, in his view, adopt an easier monetary policy, to help them and to compensate for the fiscal contraction.

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Lorenzo Bini Smaghi

SESSION 2

PANEL
THE FINANCIAL CRISIS – WHAT DID CENTRAL BANKERS FORGET AND WHAT DID THEY LEARN? A HISTORICAL PERSPECTIVE

PANEL STATEMENT

NO BAGEHOT: HISTORICAL PERSPECTIVES ON CENTRAL BANK POLICIES DURING THE SUB-PRIME CRISIS

BY MARC FLANDREAU, GRADUATE INSTITUTE OF INTERNATIONAL AND DEVELOPMENT STUDIES

Economic history, or rather, a certain reading of economic history is playing a key role in shaping policy responses to the current "sub-prime" crisis. This is, in part, due to the feeling, expressed for instance in President Trichet's remarks at this conference, that economic theory was taken by surprise at the beginning of the crisis and policy-makers were forced to act in a vacuum where the work of economic historians or economists inspired by history provided, if not a guidebook, at least relevant insight. This approach was pioneered by Friedman and Schwartz (1963) and expanded more recently into a multi-pronged body of literature, in which contributions such as Bernanke and James (1991) on financial and credit channels as well as that of Eichengreen (1992) on the role of exchange rate regimes and monetary rules represent important contributions. A pressing policy question put to economic historians these days is whether or not we have found the adequate policy instruments to contain episodes of panic such as the ones that have erupted repeatedly during the sub-prime crisis.

This question is a difficult one to ask as the crisis seems to be defying repeated attempts to address it once and for all. In fact, the development of the crisis raises further interesting questions and it is to be predicted that just as readings of the past have encouraged a certain perspective on the current crisis, the current crisis will lead to reinterpretation of the past. One issue is that of relevant historical parallels. Parallels in economic history are never perfect but they are intended to provide added insight. One such parallel is put forward by Gorton (2009), who suggests that the relevant parallel is not the inter-war crisis but rather the crises of the 19th century. According to Gorton: "The events starting in August 2007 are a banking panic. But unlike the historical banking panics of the 19th and early 20th centuries, the current banking panic is a wholesale panic, not a retail panic. In the earlier episodes, depositors ran to their banks and demanded cash in exchange for their checking accounts. Unable to meet those demands, the banking system became insolvent. The current panic involved financial firms 'running' on other financial firms by not renewing sale and repurchase agreements (repo) or increasing the repo margin ('haircut'), forcing massive deleveraging, and resulting in the banking system being insolvent."

I argue that the parallel is in fact even closer than suggested by Gorton, who had the US banking system in mind, if (and perhaps more adequately when it comes to discussing ECB policy) we use the European experience instead and focus on panics in the London money market during the 19th century. I find it particularly valuable to draw a systematic parallel between the current crisis and the 1866 "Overend Gurney Panic" that stormed the London money market and led the Bank of England to intervene in ways which later came to be incorporated in the

"new wisdom" on central bank policy during crises, encapsulated in Bagehot's teachings (1873). As I proceed to argue, the crisis of 1866 was very much a wholesale run. Plus, it was associated with the growth of a "shadow banking system" that presented the Bank of England with some thorny policy issues. The way it was dealt with has much relevance for today.

The focal point of the crisis was a forerunner of the modern collateralised debt obligation (CDO) known at the time as "acceptances". Acceptances could be drawn by a bank anywhere in the world on another bank in London. The bank in London, after reviewing guarantees, "accepted" the bill. The bill was secured by the drawer's credit and also, in the case of trade acceptances, by the consignment, which usually travelled on British boats and was subject to British commercial law, making the seizure of the collateral easier. The acceptances could have many maturities, but those with short maturities came to dominate the market. This market was operated by "bill brokers", which were really money market funds. They acted as brokers for "parcels" of acceptances (a collection of bills which they structured) and also offered to collect the funds of banks with liquid balances (as well as financial institutions, corporations and even foreign "sovereign funds") at competitive interest rates, which they then used to invest in bills. As a result, those money market funds could be leveraged to quite some extent (although the numbers may appear small by modern standards): up to 10 or 15 times the bill brokers' own capital. Of course, there was an incentive to spice up returns by investing in riskier, longer-term or less liquid instruments, thus increasing the vulnerability of this "shadow banking system" to liquidity shocks. At the same time, the reputation of bill brokers was a major source of revenue (it determined their ability to attract funds) and this discouraged risk-taking. At the beginning of the 1847 crisis, for instance, it was said that the house of Overend Gurney, then the largest and most prestigious bill broker, managed to attract funds from institutional investors seeking safety.

The Bank of England was the cornerstone of this system. When there was anxiety in the money market (for instance, when commodity prices plummeted, raising fears regarding the credit of intermediaries and the value of collateral), a wholesale run occurred in a fashion that foreshadowed the run on banks that have taken place at various stages of the present crisis. At that stage, bill brokers at large were confronted by many withdrawals. To meet liquidity needs, they turned to the Bank of England to whom they sold (or "re-discounted", which was the expression used at the time) acceptances. They also undertook repo operations with the Bank of England, pledging eligible securities such as British or certain colonial government bonds. This occurred during the crisis of 1847 and again during the crisis of 1857.

The Bank of England worried that, in so doing, it was really encouraging moral hazard and the Bank gradually lost control of the shadow banking system. The availability of the Bank of England's discount and repo window in crises encouraged higher levels of risk-taking. This evolved into an increasingly hostile relationship between the Bank of England and the bill brokers, intensifying during the 1860s. Overend Gurney sought to establish that the Bank of England needed the market just as much as the market needed the Bank of England

by brutally withdrawing its deposits with the Bank and forcing the Bank to abruptly tighten monetary policy. In retaliation, the Bank of England announced that it would begin discriminating against those bill brokers that would not have access to its credit facilities in normal times and began monitoring them with the help of specific files (Flandreau and Ugolini (2010)).

The international trade boom of the 1850s and 1860s was supported by the rise of money market funds that sought to avail of the facilities in London and increased the pressure on the Bank of England. Several bill brokers, prominently Overend Gurney, started expanding into new areas. For instance, as a result of debtors' failures, Overend Gurney found itself in possession of several loss-making commercial fleets operating in the Mediterranean, which it proved unable to reorganise. Tension escalated when, as the boom was losing steam and as prices of certain commodities such as cotton started to collapse (a result of the end of the US civil war), Overend Gurney raised doubts regarding the creditworthiness of several bill brokers. In early May, Overend Gurney approached the Bank of England. When it became known that the Bank had refused to support Overend Gurney, a massive panic ensued in the form of a wholesale run. Banks removed funds from bill brokers and from one another. They sought refuge by depositing money at the Bank of England. At the same time, those financial institutions that were subject to withdrawals were forced to approach the Bank of England.

New data collected by Flandreau and Ugolini (2010) show how this occurred. The Bank of England suspended the rules of the gold standard and used the newly acquired freedom to provide massive support to customers in the form of re-discounts (outright purchases of acceptances) and advances (repos of securities). In particular, bill brokers received substantial amounts of money (about one third) and so did bankers (another third). The rest was for the "regular" customers of the Bank of England (i.e. those who dealt with the Bank of England in normal times, meaning that the Bank had detailed information on them – at that time central banks also had commercial bank functions). Bank of England support operations were provided at very high interest rates: in two days, the nominal interest rate for Bank of England re-discounts was raised from 6% to 10%. As a result of the massive interventions, the balance sheet of the Bank of England expanded substantially, increasing by close to 25% in only a few days. Investment in securities (bills and others) increased massively. This was largely financed through an increase in deposits at the Bank of England, but also, to a smaller extent, by note issues.

The parallel between this and the events following the collapse of Lehman Brothers in September 2008 is probably too obvious to require further discussion, given space constraints. It may thus be more interesting to focus on the differences. First, there were differences in outcome. While initially described in a language reminiscent of a more modern experience – King (1936) writes that it is "impossible to describe the terror and anxiety which took possession of men's minds for the remainder of that and the whole of the succeeding day" – the Overend Gurney crisis took a rather different turn. During the few weeks when cash was generously distributed by the Bank, outstanding acceptances matured,

revealing information and facilitating orderly settlement. The panic subsided. By the end of the summer, the Bank of England's balance sheet had returned to more normal levels.

This is in stark contrast with the current situation. Three important aspects may be identified to account for this difference. The first is the type of instruments that were taken on by the Bank of England. These comprised short-term instruments that were, as the expression went, "self-liquidating", meaning that information on their true worth was not a distant test since maturity was never more than a few days or weeks ahead. In other words, the Bank of England provided forbearance, but it did not really stand in the way of information production. Today, by contrast, massive purchases by leading central banks of instruments with long maturities (such as mortgage-backed instruments) have contributed to the lack of information on the actual worth of structured products. Forbearance, combined with long-term maturities, may be seen to produce a kind of "lemons problem", which (compared with the Bank of England's experience with addressing crises in a few weeks) has stood in the way of a quick and sustained revival of interbank markets.

A second difference has to do with the extent to which central banks have access to information. Exploring structural differences between pre-crisis and crisis portfolios of investment in acceptances by the Bank of England, Flandreau and Ugolini (2010) find that crisis lending during 1866 was not a step into the unknown. Many more customers did receive many more funds, but the funds they received were the counterpart of a greater intake of the usual instruments. In other words, the Bank of England was not entering into a new market, but rather providing more support to a market it knew well and with which it was fully conversant. Related to this was the fact that the Bank of England had de facto regulatory powers. It monitored the position of individual banks and acceptors, and was thus equipped with the relevant technology to identify any localised drift. Had some acceptor extended lending too aggressively, its bills would have inevitably ebbed at the Bank window, leading to inquiry by the Bank. This "normal time" monitoring provided a technology for identifying "good collateral" and was the counterpart to generous crisis lending. In other words, an unwritten rule of the time of Bagehot (implicit in the recommendation to lend on good collateral only) is that the generous lender of last resort should also be the regulator. This differs from the situation today.

A final difference between then and now is that the immediate reaction of the Bank of England was to raise the interest rate, while modern central banks have followed the recommendation by Friedman and Schwartz to lower it. The modern policy is usually rationalised in reference to the need to avoid deflation. 19th century monetary policy was motivated by the concern to restore competitive conditions in money markets. When crises occurred, banks and other intermediaries stopped lending to one another. The flight to safety led them to increase deposits with the Bank of England. By raising the interest rate and refusing to pay interest on deposits, the 19th century Bank of England increased the opportunity cost of not lending (Bagehot called this a "fine on unreasonable timidity"). In other words, while monetary authorities accepted the task of acting as a substitute for malfunctioning markets, they would only do so at a high

cost for market participants and for a short time period (Bignon, Flandreau and Ugolini (2009)).

This brief overview provides a number of lessons for the current crisis. One is that the current crisis represents a step into the unknown, as illustrated by the bloated balance sheets of the ECB and the Federal Reserve System. Unlike their historical predecessors, the European and US central banks have moved into providing durable support to failing markets rather than applying policies to jump start them again. This obviously has to do with the more extensive mandate of modern central banks which, on top of being tasked with maintaining price stability, are under considerable political pressure to limit the economic damage brought about by financial crises. A second lesson is that the reason why 19th-century central banks such as the Bank of England could be so generous during financial crises was that they were so powerful. As seen, the Bank of England, in practice, combined monetary policy, regulatory and competition authority. As a result, one is led to conclude that modern central banks have to achieve more with less.

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PANEL STATEMENT

BY CARL-LUDWIG HOLTFRERICH, FREIE UNIVERSITÄT BERLIN

I focus my remarks on the implications of the monetary policy response to the crisis for inflation and/or deflation and discuss the following questions:

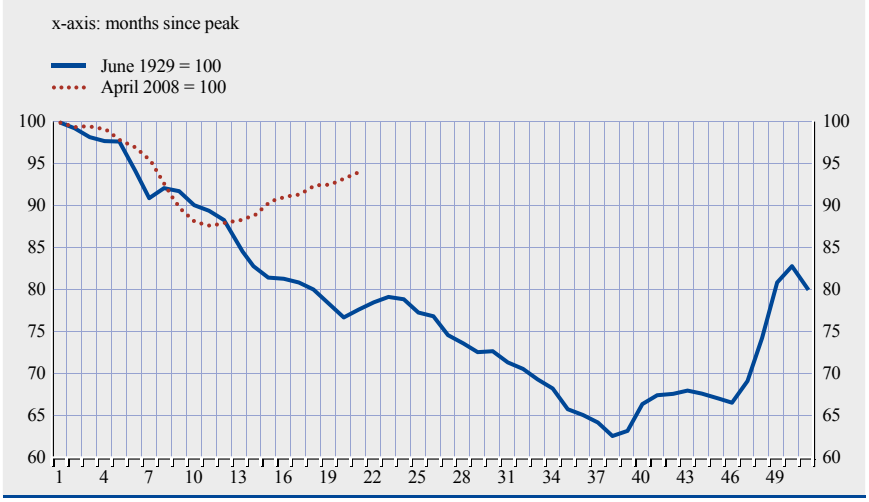
- Have we successfully avoided deflation and a great depression in its wake?
- Will the expansion of central banks' balance sheets eventually result in unacceptable inflation?
- Have unconventional measures impaired central bank credibility and/or compromised central bank independence?
- What are the potential lessons from history for central bank policies in the future?

1 HAVE WE SUCCESSFULLY AVOIDED DEFLATION AND A GREAT DEPRESSION IN ITS WAKE?

Yes, we have.

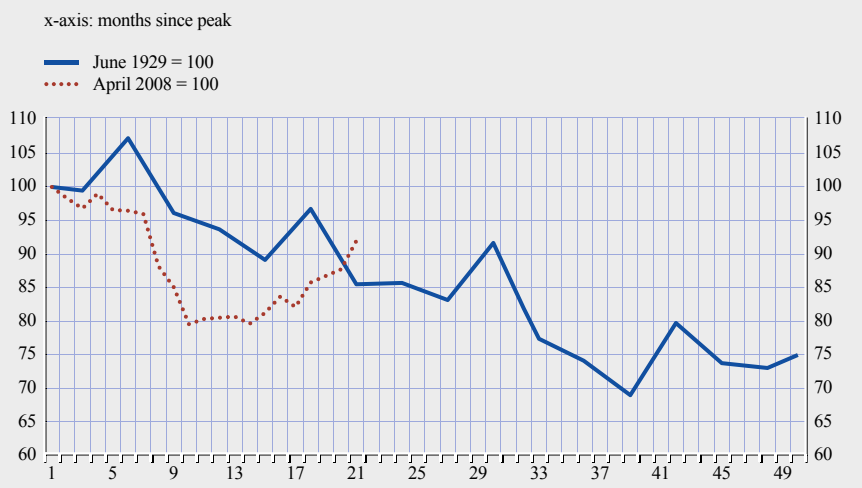
With regard to deflation, consumer prices in the United States and the euro area fell for three months in a row after the crash of Lehman Brothers, then stabilised at the start of 2009 and have since recovered to their pre-Lehman levels. It is true

Chart 1 World industrial production



Source: Eichengreen and O'Rourke (2010).

Chart 2 Volume of world trade

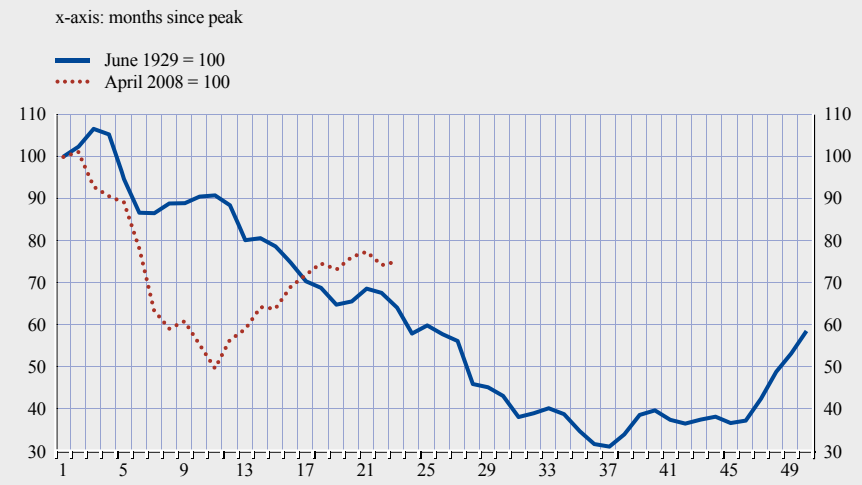


Source: Eichengreen and O'Rourke (2010).

that raw material prices displayed much stronger deflation. But they also quickly moved back up. Some have even surpassed pre-Lehman levels.

With regard to avoiding another great depression, the three charts shown here demonstrate that the initial declines in industrial production, in the volume of international trade and in stock prices in 2008-09 were as great as or even greater than those that occurred during the Great Depression that started in 1929. However, they also show that these declines reversed after less than a year this

Chart 3 World equity markets



Source: Eichengreen and O'Rourke (2010).

time, whereas it took more than three years of continued decline before the trough was reached in the 1930s.

In my opinion there are several reasons for the relative success of monetary and economic policies in coping with the recent crisis, as opposed to the great crisis of the inter-war period.

(i) This time, the economic dynamism of emerging markets – especially the BRICs (Brazil, Russia, India and China), which comprise more than 40% of the world's population and produce, adjusted for purchasing power parity, almost one-quarter of world GDP – contrasted sharply with the role played by peripheral countries during the inter-war period. The latter had already been in crisis since 1925 (Kindleberger (1986), Rothermund (1996), Aldcroft (1977)). During the recent crisis, emerging markets' dynamism played a prominent role in keeping the incipient depression in check and thus contributed strongly to supporting expansionary monetary and fiscal policy measures in OECD countries.

(ii) Decision-makers this time were aware of the much studied monetary and fiscal policy mistakes that were made during the Great Depression of the 1930s.

(iii) This time an unprecedented degree of international cooperation of central banks and governments was the immediate response. During the inter-war period (also known as the Second Thirty Years War from 1914 to 1945) political antagonism, trade protectionism and the scramble for gold prompted by the resurrected gold standard all worked to preclude such cooperation.

(iv) Central bankers and politicians alike demonstrated courage by breaching standard rules of monetary and fiscal policies and resorting to unorthodox measures. Judgement prevailed over the rigid adherence to rules.

(v) This resulted in a broadside of expansionary monetary and fiscal policy measures to check the collapse of prices and of effective demand. The effectiveness of fiscal policy this time was higher than during the post-1929 Great Depression due to the much greater share of government expenditure in GDP.[1]

(vi) This time the measures taken by central banks and their communicated targets primarily aimed to prevent the anchoring of deflation expectations and to anchor inflation expectations at the desired level instead.

The usual indicators for medium and long-term inflation expectations in the euro area and the United States show that their range is close to the inflation targets set by the ECB and the Federal Reserve System, respectively. In my view,

1 When US President Herbert Hoover took office in March 1929, US federal outlays amounted to slightly more than 3% of GNP (U.S. Census Bureau (1975)). In 2007, US federal government expenditure came to more than 20% of GDP.

the concentration of monetary policy measures on anchoring these expectations at the desired levels has been the key to successfully avoiding deflation and prolonged depression. The Federal Reserve's recent announcement and decision in favour of more quantitative easing again primarily aims to avoid deflation by helping to raise the extremely low inflation expectations.

Debt-financed fiscal policy measures supported monetary policy by anchoring price expectations on the deflation-safe side. But in doing so, the mere existence of a fiscal programme seems to have been more important than the actual size of the fiscal stimulus package. This can be seen in a German/American comparison.[2]

2 WILL THE EXPANSION OF CENTRAL BANKS' BALANCE SHEETS EVENTUALLY RESULT IN UNACCEPTABLE INFLATION?

During the three-year span running from July 2007, i.e. the month before the financial crisis broke out, to July 2010 the balance sheets of the world's two leading central banks expanded as follows:

- Federal Reserve: from USD 868 billion to USD 2,329 billion (168%);
- ECB: from €1,213 billion to €2,000 billion (65%).

During the same period (i.e. from July 2007 to July 2010) broad money supply (M2) in the two currency areas increased by almost exactly the same proportion:

- United States: from USD 7,249 billion to USD 8,546 billion (17.9%);
- euro area: from €7,064 billion to €8,337 billion (18.0%).

We know from Friedman and Schwartz (1971) that broad money supply, not central bank money as such, is the driving force behind inflation. But central bank money is the control lever for money creation by the banking system. It works best as a decelerator and less reliably as an accelerator of money creation by the financial sector.

Here is a less well-known example of divergent developments in central bank and broad money supply taken from monetary history in Germany during the Great Depression. James (1985) dubbed the expansion of the Deutsche Reichsbank's balance sheet after the banking crisis of July 1931 "Luther's secret reflation" (Hans Luther was president of the Reichsbank at that time). The decline in consumer and asset prices, however, continued.

As a lender of last resort measure, the Reichsbank had pumped liquidity into the shattered and partially collapsing banking system. The debt/deflation shrinkage of broad money supply in the sense of Fisher (1933) was thereby

2 For data showing that the US fiscal stimulus package was much larger than the German (and even the EU) package, see Prasad and Sorkin (2009) and IMF (2009). Especially the latter publication offers explanations for these differences.

not halted. "Luther's secret reflation" in combination with Chancellor Heinrich Brüning's fiscal austerity failed. These measures did not even aim to reverse price expectations from deflation to price stability. Two years into the Great Depression, fears of inflation, triggered by inflation expectations of a populace allegedly hypersensitised by the experience of Germany's post-First World War hyperinflation, were still shaping monetary and fiscal policies. It was Reichsbank liquidity created from 1933 onward under Hjalmar Schacht, who was at the helm of Germany's central bank during the Hitler government until he was dismissed in early 1939, that permitted broad money supply to expand. This caused inflation after full employment had been re-attained in 1936 and afterwards.

The answer to this section's question would only be yes if the recent flood of central bank money was not retracted at the right time, at the *kairos* in ancient Greek parlance. Too early retraction – out of fear of inflation – poses the threat of a double dip, a blunder that the Federal Reserve System committed in 1936-37 (Meltzer (2003), Friedman and Schwartz (1971)). The time for unwinding arrives as soon as the financial system returns to its normal functioning and the economy gathers steam and approaches potential output, and before inflation expectations become anchored at too high a level.

Central banks will have to sell those government bonds and government-guaranteed securities that they bought when executing their unconventional measures in order to keep financial institutions and the economy afloat. They will have to quit playing the role of investment banks that they had in practice assumed during the crisis. There is no indication as yet that the market for government bonds, especially those of the United States and Germany (rated AAA), will not be able to absorb what the central banks will need to sell. And the rescue umbrella for the fiscally weak members of the euro area should suffice to enable the ECB to privatise again with a profit the Greek, Irish, Portuguese, Spanish and other government bonds that it purchased in support of those countries' borrowing capacities.

Danger looms only if the creditworthiness of not only the poorly rated but also of the thus far best-rated governments becomes heavily impaired. This could happen, for example, via a large extension of accumulated debt financing of budget expenditures. Then, not only the rating, but also the quotation for government bonds could fall so low that a government could no longer afford to pay the interest on its borrowings. The central bank could thus be forced to abstain from shortening its balance sheet again, otherwise playing havoc with the financial, economic and – last but not least – the political system.[3] Such circumstances could trigger inflation in the future. But in my view, the inflation probability remains extremely low.

3 After the First World War the Deutsche Reichsbank saw the need to shorten its balance sheet in order to avoid further inflation. But the financial, economic and political system was not to be endangered. The Reichsbank informed the German government that the continued issuance of Treasury bills to be discounted by the Reichsbank would fuel inflation further. It demanded an end to the huge deficit financing of government expenditures, but also expressed its loyalty as long as the German government was exposed to excessive reparation demands and payments (see Holtfrerich (1986)). Haller (1976) argued explicitly that the parliamentary system of the Weimar Republic would not have survived its stormy first few years without these inflationary policies.

3 HAVE UNCONVENTIONAL MEASURES IMPAIRED CENTRAL BANK CREDIBILITY AND/OR COMPROMISED CENTRAL BANK INDEPENDENCE?

Central bank credibility is an indispensable pre-requisite for a successful communication policy aimed at anchoring inflation expectations at a low level.

The unconventional measures taken to counter the recent financial crisis implied risks to credibility. The expansion of central banks' balance sheets did, indeed, provoke some journalists and financial experts to resurrect the spectre of rampant inflation. But so far current and expected price developments have not supported this fear.

In Europe the most controversial unconventional measure and the biggest threat to the ECB's credibility was the decision taken in May 2010 to buy Greek government bonds irrespective of just how low they were rated. This action was intended to save the Greek government from bankruptcy and the euro from collapse. The purchase of government bonds issued by other weak euro area countries started a week later. This came as a total about-face by the ECB compared with its position earlier in the year and was the result of an emergency conference with euro area governments.

The media reported this step as the heaviest blow to the ECB's reputation so far, saying it would raise inflation expectations and weaken the euro even further. The ECB's credibility would allegedly suffer on three counts:

- the threat posed to the ECB's independence from governments;
- an inflationary increase of liquidity;
- a significant deterioration in the quality of the ECB's assets.

Polls conducted by Allensbach in April 2010, i.e. one month before the unconventional measures were taken, had already shown that confidence in the euro had dropped considerably among the German population. Polls that followed revealed an even further decline of confidence in the euro.

While confidence in the future stability of the euro had crumbled in Germany, six months later the facts of the case demonstrated quite the opposite.

- External stability: the euro has become stronger, not weaker.
- Internal stability: an inflation rate of 1.9% (HICP in October 2010) in the euro area almost exactly hits the ECB's price stability goal.

The Greek government did not go bust. On the whole, its credit conditions improved. But the spread between the rate of return of German and Greek government bonds is still a rollercoaster ride. Recently the spreads of Irish and Portuguese over German government bonds have reached alarming proportions.

From this we see that the ECB's rescue measures for Greece and other weak euro members have had some positive effects, but not as much as had been hoped for. In my view, only significant progress towards political union can solve the problem. What is still missing is the "new stage in the process of European integration" that the Maastricht Treaty of 1992 referred to in the first sentence of its preamble. It was as clear then as it is now that a possible euro crisis should not trigger a rollback, but another "new stage in the process of European integration". This could take the form of an agreement on the transfer of national sovereignty in fiscal policy to an "economic government" at EU or at least euro area level.

Three questions appear to be of interest in this context.

(i) Is the ECB's independence impaired?
I am not an insider. But I doubt it. Even an independent central bank is a team player and has to interact with other economic policy-makers, especially with those responsible for fiscal policy.[4] And this is all the more true when the survival of a currency is at stake. Attempts by politicians to pressure a central bank are not the same as command-and-control by politicians, just as the virtually incessant admonitions and pressures exerted by central bankers on policy-makers do not undermine independent decision-making by governments.

(ii) Is there an inflationary increase of liquidity?
I have already dealt with this question above. So far the additional liquidity the ECB and the Federal Reserve have injected into the financial system during the crisis has not had inflationary consequences. On the contrary, and in contrast to the Great Depression following 1929, this action proved to be necessary and sufficient to thwart the imminent danger of deflation.

(iii) What about bad assets?
Like in a private bank or household portfolio, one never really knows *ex ante* whether one has picked a good, bad or neutral asset. What could be a good asset for the private sector is not necessarily a good asset for a central bank because the latter's primary responsibility is to protect and support the functioning of the currency, the financial sector as well as the economy and the state as a whole.

An example of this problem is the role gold played during the Great Depression of the 1930s. For private businesses and households gold turned out to be an asset increasing in value as a result of competitive currency devaluations. For central banks, however, gold holdings mandated by the gold cover requirement under the re-established gold standard turned out to be a shackle that prevented central banks from acting in accordance with their true mandates.

4 I learned this lesson from Sargent (1990).

This point is best illustrated by the case of Germany up to its banking crisis in mid-July 1931, after which foreign exchange controls severed the link to the gold standard,[5] and the case of the United States during its banking crisis of 1932 and up until Franklin D. Roosevelt released the US dollar from its "golden fetters" in 1933 (Eichengreen (1992)).

In my view, the quality of central bank assets must be judged by the outcome of central bank policy. Asset quality is excellent if – by whatever means – the stability of the currency (internal and external), of the financial sector, of the economy in terms of growth and employment and, last but not least, of the state and its democratic institutions is firmly secured on a sustained basis.

4 WHAT ARE THE POTENTIAL LESSONS FROM HISTORY FOR CENTRAL BANK POLICIES IN THE FUTURE?

Experience from the 19th century and from the Great Depression that started at the end of the 1920s has taught us that an unfettered market economy yields socially and politically unsustainable results. Thus, the Great Depression transformed especially the United States from a law-and-order state into a welfare-and-interventionist state. Strong financial and industrial regulation was put in place to prevent the repetition of such a calamity.

The world economy fared better than ever with strongly regulated market economies until, in the 1970s, the belief in the superiority of unfettered markets over state intervention and consequently deregulation became the preferred blueprint for economic policy. At that time, the "commanding heights" of economic policy were conquered by Friedrich A. Hayek (and his Mount Pelerin Society), displacing John M. Keynes (Yergin and Stanislaw (1998)). Since then the trend of economic growth has been lower and unemployment higher, on average, than before (Maddison (2001), Holtfrerich (1999)).

Central banks became advocates of deregulation, such as the removal of controls on international capital movements, i.e. of globalisation, and the dismantling

5 In order to defend the gold cover requirement and the fixed exchange rate of the Reichsmark, the Reichsbank raised its discount rate from 4.0% to 7.0% over the period from June 1930 to June 1931, while price indices of all sorts kept falling. In addition, Germany's central bank sharpened its credit restrictions on 10 July 1931 although it was well aware that this move would bring about the downfall of Danatbank, one of Berlin's eight big banks (Habedank (1981)). A run on all banks ensued and led the government to proclaim bank holidays for 14 and 15 July 1931. While the banking crisis was exacerbating deflation, the Reichsbank kept raising its discount rate: to 10.0% on 16 July 1931 and to a peak of 15.0% on 1 August 1931. The Lombard rate, which traditionally had been kept only 1 percentage point above the discount rate, was raised to 15% and 20%, respectively, i.e. 5 percentage points above the already high discount rate at that time. With real interest rates consequently even higher than this, the Reichsbank actively contributed to intensifying deflation, with prices and production shrinking further and unemployment increasing from 4.5 million persons on average in 1931 to 5.6 million in 1932 (see also Irmler (1976)). Irmler (1976) states convincingly that the Reichsbank should never have left the banks with their liquidity needs in the lurch and that it was one of those fateful hours in which the written law, which the Reichsbank and Reich government decision-makers obeyed, evidently clashed with the economic, and ultimately with the political, necessities.

of the regulatory apparatus that had been put in place in the 1930s to prevent excesses on financial markets and within financial institutions. They even neglected their own regulatory powers that lawmakers had not removed, such as margin requirements for security purchases or the control of mortgage lending in the sub-prime market.

Summing up, in my view, central banks have responsibly conducted their monetary policies using good judgement. However, they misjudged the importance of their own and other agencies' regulatory powers. In the future central banks should promote the expansion of financial regulation and make greater use of their regulatory powers.

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PANEL STATEMENT

THE GREAT DEPRESSION ANALOGY: IS IT DIFFERENT THIS TIME?

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The short and rather obvious answer is yes, today is different (and better). We are not in a Great Depression, although for six months such an outcome did seem to be a possibility. Monetary policy was much better than in the Great Depression: in particular, the lessons about central banks acting as lenders of last resort (associated with Walter Bagehot) and about central banks stopping a collapse of the money supply (associated with Milton Friedman and Anna Schwartz) have been learnt, with beneficial consequences.[1]

But there are very strong parallels between the very intense phase of the global financial crisis, the events that followed the collapse of Lehman Brothers in September 2008 and a particular and decisive part of the story of the Great Depression. A series of bank panics emanated from central Europe in the summer of 1931 and spread financial contagion to Great Britain and then, in September 1931, to the United States and on to France and the whole world. The Great Depression was not a single phenomenon with a single cause; rather, what turned a bad business downturn into the Great Depression was a series of bank collapses in Europe that raised a different problem to that identified by Friedman and Schwartz in their study of the United States. US banks were mostly small, but the very large European banks had the "too big to fail" characteristics of large financial institutions in 2008. The problems of these large institutions set off an international wave of contagion.

Another striking feature of the 1931 crisis was the linkage between banking crises and fiscal problems. Large bank failures required unanticipated increases in government spending; and governments found the financing of their debt increasingly precarious, in part also because of the difficulties banks were confronted with.

It is not difficult ex post to explain the causes of the 1931 panic, in the same way as the 2008 vulnerability of Lehman Brothers is (in retrospect) very clear. Central European bank collapses during the Great Depression were the result of bank weakness in countries that had been wrecked by the aftermath of bad policies that produced inflation, hyperinflation and a destruction of banks' balance sheets. Intrinsic vulnerability made for heightened exposure to political shocks, and disputes about the political implications of a central European customs union and about the post-war reparations issue were enough to topple banks like a house of cards.

1 See Bagehot (1873) and Friedman and Schwartz (1963).

But finding a remedy for the damage done by banking crises ("cleaning up" in contemporary parlance) was very tough – and it still is. There are actually no obvious macroeconomic answers to financial distress. Consequently, in the past some famous macroeconomists, including Larry Summers, have tried to play down the role of financial sector instability in causing depressions.[2] Policy-makers of the early 1930s wrestled with the difficulties caused by financial sector failure. Their remedies were surprisingly modern: government recapitalisation of failed banks, transferring non-performing assets to "bad banks", establishing new institutions to commercialise and be able to trade frozen debts as well as splitting up mega-banks and separating investment from commercial banks.

The answers to banking crises never produce stunning miracles of rebounding vigour: rather, the remedy lies in the slow and painful cleaning-up of balance sheets as well as in microeconomic restructuring, which cannot be simply imposed from above by an all-wise planner, but requires many businesses and individuals to change their outlook and behaviour. The improvement in regulation and supervision, while a good idea, is better suited to avoiding future crises than dealing with the consequences of a catastrophe that has already occurred.

Many economists had presented a quite different sort of lesson from the Great Depression: that the macroeconomic fallout can easily be tackled by counter-cyclical fiscal and monetary policy. And both these lessons were applied after 2007 – successfully in the case of monetary policy, more problematically in the case of fiscal policy.

Monetary policy has been better than it was in the Great Depression because it has not been subject to the gold standard constraint. But central bank policy is becoming more contentious because it is drifting away from an exclusive focus on monetary policy. Once central banks get involved in issues of financial stability, in discussions of which problematical securities they should buy and in the reordering of failed or vulnerable institutions, they are closer to doing redistribution than they are if they simply follow a rule-based approach to monetary policy. As a consequence, they are increasingly becoming subject to intense political scrutiny.

First, there is the consequence of financial sector problems. Bursting bubbles inevitably turn the conventional wisdom of the boom periods on its head. Central bankers used to be heroes (of the Great Moderation story). Now they have become villains (of the Financial Crisis story). In the Great Moderation, central banks were primarily concerned with price stability and with monetary policy. The financial crisis, however, has brought an involvement with financial sector stability issues and with issues of credit allocation and credit policy. Banks can refinance themselves easily and cheaply (indeed almost for free) from central banks, while small businesses that cannot tap capital markets directly and have their own bonds find borrowing expensive or even impossible. Credit policy raises quite different questions of political economy than monetary policy does.

2 See DeLong and Summers (1986).

The second source of political pressure is that a financial and economic crisis brings adjustment costs. People are really upset by big price changes that seem to raise general questions about the stance of monetary policy. Over the past two years, market sentiment has shifted abruptly from a fear of deflation to a fear of inflation. The crisis has produced a profound shock, with some prices (especially housing) moving down sharply, while others (notably foodstuffs and some raw materials) have increased. The movement of price relations is actually an important part of the adjustment process: that is, Americans should devote less of their resources to building and filling mega-size houses. But the price changes involved here are deeply discomforting: the goods whose prices are falling represent a major store of wealth, since people view their houses as a sort of source of cash; and the prices that are rising are a major part of daily expenditure.

As a consequence of the shift in emphasis from monetary policy to credit policy, central banks are subject to strong, and sometimes quite conflicting, political pressures. But even when political demands conflict, the complaints and demands are actually similar: the complaint that central banks are too internationally oriented and the demand that the central bank should act as a national carapace. If redistribution takes place, taxpayers will demand that it occur in a national setting and not involve international transfers: but such a demand undermines the logic of globalisation in which money moves – and in a European setting, it also runs counter to the demands of European integration.

In the course of his presidential campaign, Nicolas Sarkozy called for a weaker euro in order to resist US and Asian "dumping"; after the outbreak of the financial crisis, as President of the French Republic, he complained that the ECB did not lower interest rates: "They have facilitated things for speculators, while complicating them for entrepreneurs".[3] From a different angle, German Chancellor Angela Merkel criticised quite directly the ECB's purchases of covered bonds, which she described as "bowing to international pressure".[4]

Probably the most elaborately articulated, viscerally hostile response to central banking activity has been in the United States, where it feeds on a populist tradition that goes back to US President Andrew Jackson's campaign against the Second Bank of the United States. Jackson is now cited as a model for effective political action in dealing with the financial sector, even by distinguished economists.[5] At the end of July 2009, the Chairman of the Federal Reserve System, Ben Bernanke, was grilled on the financial crisis before the United States Congress, and the result was a series of viral YouTube videos that bounced around the world's electronic highways. From one side of the political spectrum, Republican Ron Paul accused Bernanke of causing inflation by buying Treasury bills. From the other side, more spectacularly and more aggressively, Florida Democrat Alan Grayson focused an attack on the previously rather obscure topic of central bank swaps. Exchanges of reserves on a short-term basis between

3 See Financial Times (2007) and The Times (2007).
4 See Financial Times (2009).
5 See Johnson and Kwak (2010).

central banks historically constituted one of the smoothing elements in forex markets. After the Lehman crisis their volume expanded as part of the global effort to provide liquidity with repurchase arrangements that avoided foreign exchange risk. On 21 July 2009, Grayson asked Bernanke why the swaps on the Federal Reserve's balance sheet had increased from USD 24 billion at the end of 2007 to USD 553 billion in 2008 and which foreign institutions were benefiting from such loans. Then he picked one foreign central bank that had done a swap – New Zealand, which is tiny and on the other side of the world. Why was the Federal Reserve giving USD 9 billion (or USD 3,000 to each inhabitant) to New Zealand when the money could have been better spent on Americans suffering from the credit crunch? In these circumstances, people do not think about central banks as facilitators of payment systems, but as the producers of wealth which is available for spending.

The answer about fiscal policy is not as clear as depicted in many popular analyses either. It is not really true that the Great Depression was caused by bad governments led by foolish men who needlessly and recklessly imposed fiscal deflation. US President Herbert Hoover's administration did not initially respond to the depression by emphasising the need for fiscal austerity. On the contrary, Hoover and other public figures argued in a perfectly modern, Keynesian fashion that large-scale public works programmes were needed to pull the economy out of the trough.

Today, we are more generally worried about fiscal difficulties than we were two years ago. The UK's policy of fiscal consolidation, recently announced by Chancellor of the Exchequer George Osborne, sent shock waves around the world. Osborne argued that the UK was on the brink: that there was no alternative to his policy if the country were to avoid a massive crisis of confidence. Other countries, such as Greece, needed to have a full-blown crisis in order to prompt such adjustment measures, whereas the UK was acting prudently and pre-emptively. If the UK, with a relatively low share of public debt to GDP (64.6%), is worried, the implication is that many other countries should be much more concerned.

The major question today should be whether the failure of capital markets (and the implication for government debt) since 2007 has been as severe as during the Great Depression. At the moment, there is no widespread revulsion against all government debt, and some countries today clearly have better access than others to capital markets, enabling them to finance their deficits externally.

The debate about room for fiscal manoeuvre in practice soon becomes a debate about whether countries that have easily financed debt in the past can automatically continue to do so. We are still in the last stages of a bubble in government debt that arose in the first stage of the financial crisis from the "flight to safety" into US Treasuries. When that bubble collapses, it will hit not just the weaker countries – the equivalent of sub-prime mortgages – but also the stronger creditors.

In the Great Depression, one of the big surprises was the devastating abruptness with which markets turned on the United States. In the late summer of 1931, the US dollar, alongside the French franc, appeared to be the strongest currency in the international financial system. That precedent should serve as a warning of how vulnerable governments and their finances can rapidly become and of how fiscal policy can stand in the way of a monetary approach oriented towards stability.

In the spring of 2010, Greece sent a wake-up call to the UK. The British response should prompt other industrial economies, above all the United States, to tackle their long-term fiscal weaknesses. In that sense, the longer answer to our question is no, but there should be a sustained debate about the problem: for even though we have largely escaped the collapse of the initial bubble, there are more bubbles down the road. We are not that different from our forefathers, and the lessons of the Great Depression should still give us nightmares.

Finally, it is often said that today we have much better cooperation, between governments and between central banks, than in the era of the Great Depression. In the six months following the 2008 collapse of Lehman Brothers, during the most intense phase of the financial crisis, the world's political leaders reassured themselves that international cooperation in the new millennium was working splendidly. They loved to contrast their apparently unique and novel harmony with the grim precedent of the nationalistic and autarkic 1930s. Indeed the self-praise of the global elite became a soothing mantra, constantly replayed. Heroic figures, led by UK Prime Minister Gordon Brown, were rescuing the world through far-sighted and beneficent public action.

In the course of the past months the self-confident belief about the capacity for international coordination has been decisively shattered. We are now in a more dangerous and more nationalistic world. Polite diplomacy has been shattered by the revelations of WikiLeaks. The United States Congress has produced its own version of WikiLeaks for the central banking world by unveiling the details of the enormous crisis support operations of the Federal Reserve. Both sets of revelations will make future cooperation much more difficult.

The European Union is polarised along national lines in its crisis response, with Germans blaming Greek extravagance, and Greeks bringing up history as an indictment of German brutality and irresponsibility. Stopgap crisis prevention measures are bitterly fought over.

Today's developments uncannily echo the earlier collapse of international efforts at reaching common understanding. In 1933, representatives of the major countries of the world met in London for a World Economic Conference, but in fact all of them had fundamentally misaligned policy preferences.

In the crises of globalisation, much depends on the position of the very large powers. In the second half of the 20th century, the United States remade globalisation by promoting an American internationalism based on a global

vision. That vision is now shattering, and to many critics, the United States looks as if it is returning to its 1930s (and earlier) isolationism.

Today's equivalent to US President Roosevelt's 1933 "bombshell" of non-cooperation is the Republican "shellacking" of US President Obama in the mid-term elections. The outcome is perfect from the point of view of the American political tradition. It is a restoration of the logical and beautifully designed system of checks and balances that the 18th century constitutional fathers drew up. The US political system will work, exactly as the founders intended, so as accurately to reflect the concerns of ordinary Americans. The political stalemate is likely to prevent further big bailouts, further economic stimulus measures, but it will also block efforts at government budget balancing. The election outcome means that the United States will turn in on itself and abandon attempts to steer a global economy. The Founding Fathers of the United States were not concerned with making a political system that would work in a highly integrated world economy.

The Federal Reserve's announcement of the new USD 600 billion quantitative easing programme fits in the same agenda. It makes perfect sense as a domestic strategy, but its spillovers produce difficulties for the rest of the world. No one can really have been surprised by the howl of outrage that followed from the finance ministries of every emerging market economy. The American complaint that China was deliberately undervaluing its exchange rate looked bizarre as the United States fuelled the currency wars by weakening the US dollar and providing cheap funds that would surge in a wave of lending to fuel emerging market bond bubbles.

International cooperation, in short, is in bad shape. In the second half of the 20th century, the United States formulated a new internationalism that it can no longer afford. Is there any sign that there is a new power that might stabilise the world? Europe might have been a model, but it is too consumed by its own internal problems. European divisions between surplus and deficit countries appear only to reproduce broad global rifts on a regional level. China in the 2000s contributed to stabilising the world economy, but there is absolutely no sign that it is evolving a vision of a new global order that goes beyond *xìng zāi lè huò* or *Schadenfreude* that the conventional platitudes of liberal and democratic politics and economics are collapsing.

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COMMENT

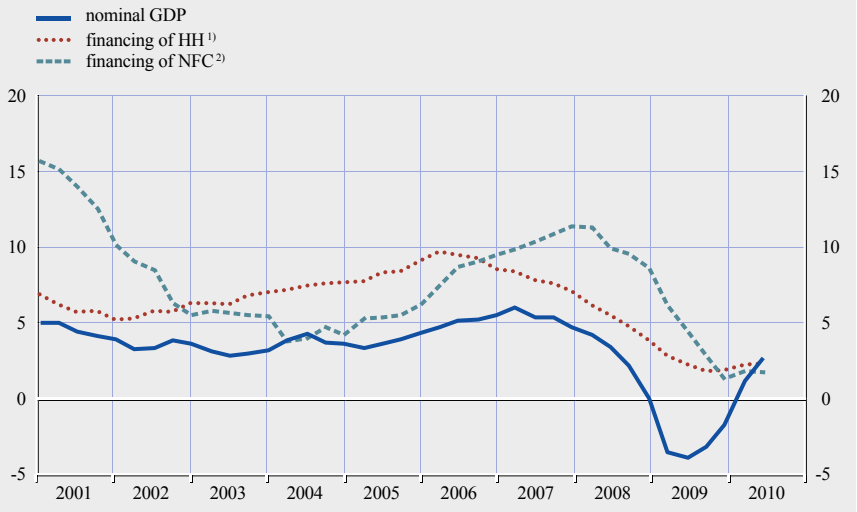
BY LORENZO BINI SMAGHI, MEMBER OF THE EXECUTIVE BOARD OF THE ECB

Before opening the floor for general discussion, let me respond to some of the concerns raised by Flandreau, James and Holtfrerich about the ECB's policies in the current crisis.

Flandreau is concerned that central banks have taken on too much risk. He emphasises that the expansion of the eligible collateral in the current crisis contrasts with historical experiences. One should, however, point out that the complexity and inter-connectedness of modern financial systems also contrast with historical experiences. Effective intervention in such markets requires extraordinary measures, involving an expansion of the eligible collateral. These extraordinary measures enabled decisive actions to avoid a major financial meltdown, like those in the past. Most importantly, the ECB's non-standard measures have been effective in preventing a credit crunch in the euro area. This is illustrated in Chart 1a. This plot shows that the financing of both households and non-financial corporations has been positive in the euro area throughout the crisis. By the way, this stands in contrast to the US data (shown in Chart 1b), where financing was negative during last year.

Chart 1a Financing of households and non-financial corporations in the euro area

(annual percentage changes; nsa)



Sources: ECB and Eurostat.

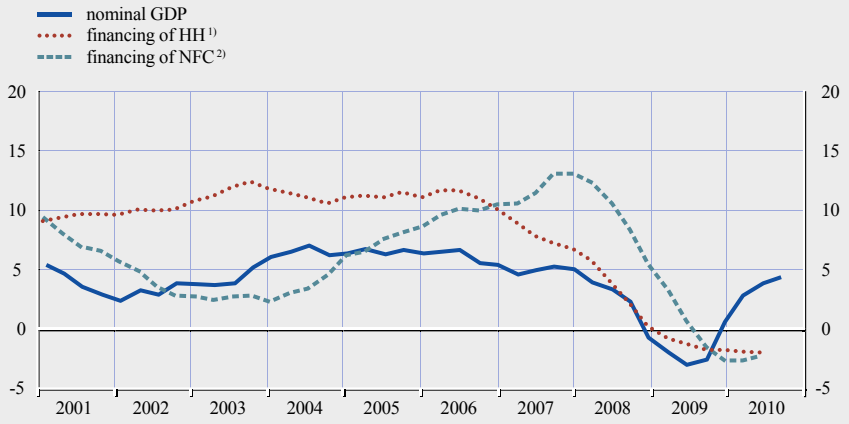
Note: The annual growth rate refers to the total value of transactions during the year in relation to the outstanding stock a year before. Latest observation: 2010 Q2.

1) Includes loans.

2) Includes loans, debt securities and liabilities for direct pension commitments of employers (i.e. not including other payables).

Chart 1b Financing of households and non-financial corporations in the United States

(annual percentage changes; nsa)



Sources: Board of Governors of the Federal Reserve System.

Note: The annual growth rate refers to the total value of transactions during the year in relation to the outstanding stock a year before. Latest observations: 2010 Q2; for nominal GDP: 2010 Q3.

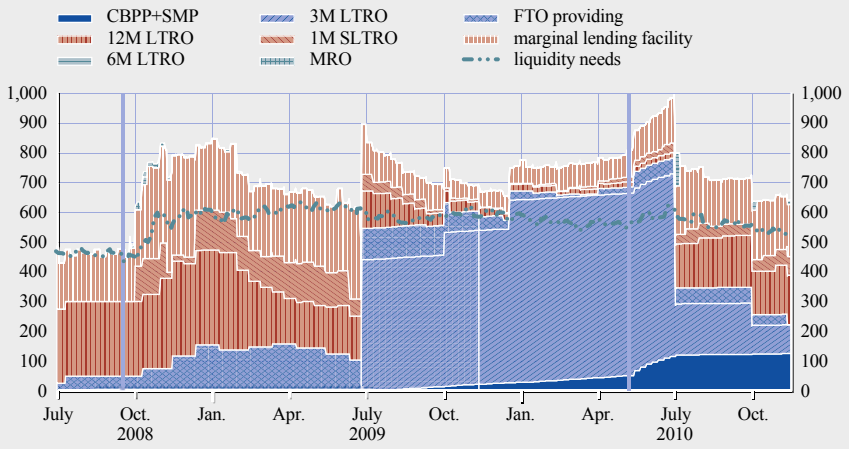
1) Includes credit market instruments (i.e. loans not including other payables) and debt securities issued by non-profit organisations.

2) Includes loans, debt securities and liabilities for direct pension commitments of employers (i.e. not including other payables).

Moreover, contrary to Flandreau's claims, the ECB's non-standard measures are temporary in nature. Chart 2 shows that, recently, the ECB's liquidity operations actually diminished. In fact, given that in the ECB's monetary policy operations framework the non-standard measures rely on repos and not on outright asset purchases, this unwinding is endogenous.

Chart 2 ECB's liquidity operations

(EUR billions)



Source: ECB.

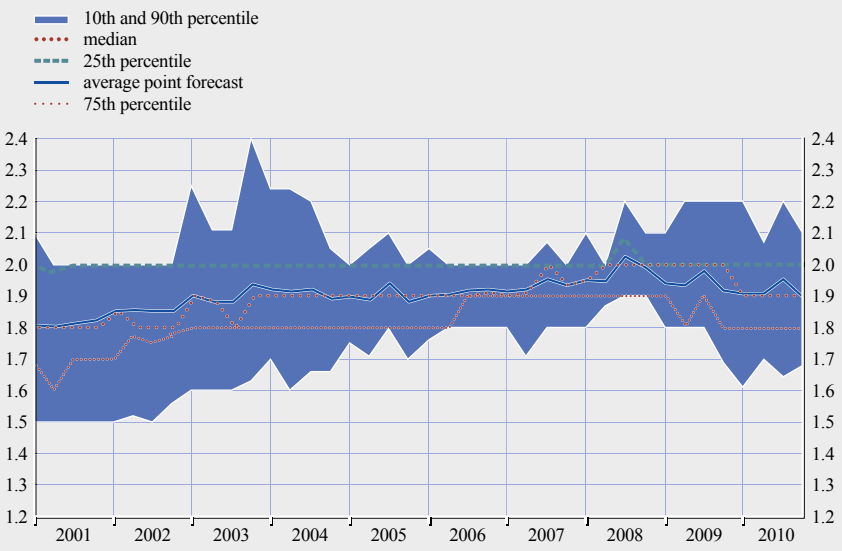
Note: EUR billions.

James and Holtfrerich worry that non-standard monetary policies put central bank independence and credibility at risk. The ECB's independence is enshrined in the EU Treaties and has, together with the ECB's track record of keeping inflation close to, but below 2% over the medium term, contributed to the ECB's high degree of credibility for maintaining price stability. One indicator of the ECB's credibility is a measure of euro area inflation expectations. As shown in Chart 3, five-years-ahead inflation expectations have been stable and centred around 2%, the ECB's declared objective, all through the crisis. The only exception is the blip in the second quarter of 2008.

The ECB's credibility permitted it to take prompt action in the most dramatic moments, such as the Bear Stearns collapse in March 2008, the Lehman Brothers collapse in September 2008 and the Greek sovereign debt crisis in May 2010. The seriousness and the scope of the May 2010 episode are often underestimated. Charts 4 and 5 present evidence that this was one of the most dramatic episodes in the crisis. Chart 4 shows the time series of a systemic risk indicator derived from bank credit default swap spreads. We can see that euro area systemic risks in May 2010 were even higher than in September 2008. The global importance of the May 2010 episode is further illustrated by another measure of systemic risk in Chart 5. This Chart shows the average pair-wise realised correlations between S&P 500 stocks. In May 2010 these correlations were close to 1 and clearly higher than in September 2008.

Chart 3 Medium-term inflation expectations

(ECB's survey of professional forecasters; 5 years ahead)



Sources: Eurostat, ECB.
Note: HICP annual percentage change.

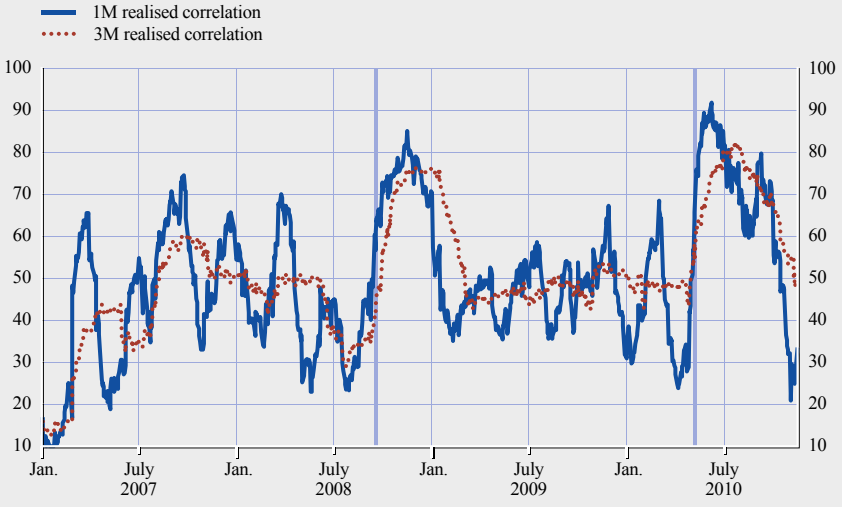
Chart 4 Indicator of systemic risk

(percentages; derived form bank CDS spreads)

Source: Bloomberg, ECB calculations.

Chart 5 Correlation between US equities

(percentages)



Source: Citi Group.

Note: Average pair-wise realized correlation between S&P 500 stocks.

Overall, I would therefore conclude that the empirical evidence shows that the ECB's policies have been effective and commensurate with the circumstances.

GENERAL DISCUSSION

Referring to Flandreau's presentation, **Charles Goodhart** (London School of Economics) pointed out a difference between today's bank supervision and that of the 19th century. To a 19th-century central bank, being a competitor, the door to a commercial bank was always closed, and the central bank knew nothing about commercial banks' internal operations. What they did know about was the quality of the securities they bought. Is the lesson today that central banks should investigate the business of commercial banks? Since mortgage credits are such big business today, should central banks monitor the loan-to-value and loan-to-income ratios for these credits?

Goodhart disagreed with James' account of the political attacks on the Bank of England. The measures that the Bank of England took to restructure the cotton and steel industries received virtually no political criticism. They were actually praised for providing support to the industrial heart of the UK. Reasons for which the Bank of England was criticised were its support for the re-adoption of the gold standard in 1925 at a rate against gold that was far too high, and the fact that it subsequently kept interest rates high. The accusation was that the high interest rates were crucifying industry for the benefit of the City. So, the Bank of England was praised for supporting industry and strongly criticised for perceived deflationary exchange rate and interest rate policies.

William White (OECD) called for a historical perspective on how monetary policy affects inflation expectations, as well as other types of expectations. He recalled the debate on bimetallism in the United States, which failed to trigger higher inflation expectations, but which did trigger a collapse of business confidence.

James agreed that Lancashire cotton reconstruction was not particularly controversial. The most important cause for controversy was not the discussion of the choice of exchange rate in 1925, however. The Bank of England came under attack because it was supposedly part of a "bankers' ramp" that was pushing through a specific political programme, namely the cutting of the "dole" (unemployment benefit).

Most importantly, central bank interventions in particular sectors of the economy are a problem precisely because they are widely approved and trigger demand for further actions of the same kind. For example, the Lancashire cotton reconstruction triggered demand for Bank of England interventions in steel and other industries as well. We hear similar voices today: "if the Federal Reserve can bail out financial services, why would it not bail out other sectors of the economy?"

Regarding inflation expectations, there is enormous confusion in related political and media discussions. A good example is the Bild Zeitung headline from 2009 "Jetzt kommt die Inflation" ("Now inflation is coming"). At the time James bought 20 copies to show his US colleagues the level of discussion in

prominent areas of the German media. But fears of inflation also exist in the United States, although this seems to be irrational, since what actually happened recently was a major temporary relative price shock. House prices fell while food prices increased. But people were using their houses as savings banks in order to finance their consumption. So when they saw house prices, i.e. their assets, falling, and food prices rising, they perceived inflation. The lesson is that inflation perceptions can be very different from the actual inflation risks in the longer term. For central banks this is a tricky communication issue, as income and wealth effects interfere with inflation perceptions.

Holtfrerich returned to the question on historical inflation expectations. The US Coinage Act of 1873 ("the crime of 1873") that stopped the coinage of silver was followed by two decades of deflation, which was, in his view, anticipated. During the 1890s, the abundant supply of gold from South Africa and Canada – in tandem with the introduction of the cyanide process of refining gold – triggered inflation expectations. Broad money creation by the developing financial system in the United States reduced the need for banknotes and coin, and also created inflation expectations.

Flandreau referred back to the comment by Bini Smaghi that ECB policies helped avoid a meltdown. He voiced a concern that the ECB, by providing liquidity and buying time for the troubled banks and governments, is helping to delay a resolution of structural problems and weakening the incentives for resolving them.

Flandreau agreed with Goodhart that, as competitors of commercial banks, 19th-century central banks had no access to certain information. But on the other hand they were gathering a significant amount of information by being involved in the market on a day-to-day basis. For example, Bank of England correspondence with Barings in 1890 shows that they were aware in advance of Barings' problems. Barings had to be rescued in the end, which also shows that the too-big-to-fail problem is not a privilege of present times.

Regarding White's question on inflation expectations, Flandreau referred to Garber (1986) and Calomiris (1993), who construct 19th-century inflation expectations reflecting the probability of monetary regime changes. For instance, during Bryan's election campaigns (1896 and 1990), the market considered the switch to the silver standard to be a significant probability. The associated inflation expectations were reflected in higher interest rates.

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Jean-Claude Trichet and Alexandre Lamfalussy

DINNER ADDRESS

DINNER ADDRESS

BY ALEXANDRE LAMFALUSSY

On 30 June 1997, at the farewell ceremony on the occasion of the change of presidency of the European Monetary Institute (EMI), I made a speech in which I said, not literally but in substance: "Don't overburden monetary policy with tasks it cannot accomplish", by which I meant, "keep it targeting and achieving price stability and let other policies, and policy-makers, bear the responsibility for failing to achieve, or being proud of having achieved, other respectable policy objectives".

In the first part of my remarks this evening, I propose to look back and set this recommendation in its historical context. This is the relatively easy part of my remarks. In the second part, I shall stick my neck out and meditate (I apologise to Jean-Claude for borrowing his patented expression) on whether today I would still make such a recommendation.

When I made this recommendation, only 18 months before 1 January 1999, which was the last possible date for the single monetary policy to start operating. There were still doubts, especially across the Channel and the Atlantic, whether this was going to happen, but the view of the markets and of all those familiar with the progress of the preparatory work was shifting towards cautious optimism. The most important events to shape this view were the crucial informal autumn meeting of the Ecofin Council in Valencia and the formal European Council meeting in Madrid in December 1995, which agreed on the main ingredients of the changeover to the single currency.

While a lot still remained to be done in those 18 months, in terms of institution-building the groundwork was almost completed. I have often been asked: why did the forebodings prove unfounded? I must confess that until the Madrid meeting I had my own share of forebodings. In fact, while the road leading to the beginning of Stage Three was on occasion somewhat bumpy, there were no major conflicts of the kind that could have fatally jeopardised the implementation of the single currency: neither between the EMI Council and the national governments, nor among the governments themselves, nor inside the EMI, nor between any of these bodies and the European Commission – despite the fact that there were many vested interests against the introduction of the single currency. A lot of things could have gone wrong in the process of institution-building. How come they did not go wrong?

My favourite explanation is that we were well served by the exceptional convergence of several facts and influences. Let me list some of them – without going into longish explanations:

(i) The initiators of the project were the governments themselves – and at the highest level: the Heads of State or Government – who had a vested interest in a successful implementation process.

(ii) These political leaders were shrewd enough to entrust the central bankers with a major role in the preparation of the Maastricht Treaty (Jacques Delors deserves a special mention in this respect).

(iii) The Maastricht Treaty set out a roadmap in great detail, described reasonably clearly the division of labour between the European Council, the European Commission and the central bankers of the EMI and of the European Central Bank (ECB) and, most importantly, set 1 January 1999 as the final date for the beginning of Stage Three. This time constraint, as Wim Duisenberg and I had the privilege to learn, turned out to be a barbarian, but most effective instrument for finding, in time, constructive compromises in matters which were not regulated by the Maastricht Treaty (such as the changeover scenario).

(iv) In terms of the internal management of the EMI, an institution which had to be speedily built up from the small secretariat of the Committee of Governors into a fully operational enterprise, the EMI Council granted me almost complete authority (which was particularly helpful for staff recruitment and allowed the number of staff to jump from 15 to close to three hundred by the time I was leaving).

External circumstances also played a helpful role. Perhaps the most important external circumstance was the fact that after the stagflation experience of the 1970s, Keynesian demand management went out of fashion and anti-inflationary monetary policy began acquiring, or regaining, professional (and political) respectability. This led to a sharp decline in inflation rates well before the Economic and Monetary Union (EMU) initiative. Average EU inflation declined successively from a horrifying peak of 14% in 1974 to 10% during the period 1980-84 and then to 4% during the years 1985-89. Even more significantly, there was a marked downward convergence of inflation rates. The standard deviation of CPI inflation, which was a very high 6% during the late 1970s, fell to 2% by 1995. This goes a long way towards explaining the relatively serene atmosphere prevailing in the Ecofin meetings I attended.

To all this, we have to add the fact that the regained respect for both inflation-fighting and the inflation-fighting capability of monetary policy has been accompanied by a gradual, but general move towards granting policy-making independence to central banks – and this, too, began well before Maastricht. It is of course true that the Federal Republic of Germany played a major role in shaping the definition of the ECB's independence – which in fact was defined in stricter terms than that of the Deutsche Bundesbank, although no more strictly than what had become the German practice over time – but these requests fell on receptive ears in the case of most Member States. The time was ripe for moving collectively in this direction.

With these favourable developments in mind, what prompted me to make my recommendation? Well, quite simply, my deep concern about the inherent weakness of the "E" leg of EMU – and by weakness I mean the prospective highly probable incapability of the intergovernmental decision-making process

to deliver the "right" kind of fiscal (as well as other, non-fiscal) policies. Admittedly, I had to acknowledge that the uncontrolled growth of debt levels (general government gross debt, which in 1991 stood at 56% of GDP, reached 73.5% by 1996) would have prompted governments to take action in any case – but this action received additional, and welcome, help from the constraint of the convergence criteria, which emerged at the right time. I nevertheless sensed a sharp contrast between the likely capability of the future ECB to deliver price stability and the built-in risk that an intergovernmental process would not be able to deliver the right kind of policies.

But beyond this broad problem, we were beginning to perceive EMI-specific reasons for concern. Both in the 1996 Convergence Report published by the EMI and in the EMI's 1996 Annual Report you may find numerous examples of concern being expressed about a number of developments: the slowness of the pace of reduction of fiscal deficits; the recourse to one-off measures; the temptation to raise taxes rather than reducing expenditure; and, most importantly, the little attention paid to the sustainability of deficit-reduction measures. Moreover, the Convergence Report contained a detailed analysis of a development which received, at that time, far less attention than today: the growing fiscal burden of state pensions.

Now let me turn to the second part of my remarks – would I make the same recommendation today? Well, yes and no, or no and yes. Let me spell out the reason for this cryptic answer.

Our current experience has confirmed something that was (or should have been) expected: that whether they like it or not, central banks are in the front line when it comes to keeping crises under control. They have the resources, and their traditional banking operations plus their oversight responsibilities in payment and settlement systems give them a proximity to the money and financial markets which finance ministers or supervisors not connected with central banks do not possess.

What is new in the current experience is that central banks have had to carry out their liquidity-boosting operations in an environment where liquidity shortages turned rather quickly into solvency problems of frightening dimensions – problems for which there has been no precedent since the 1930s. Nor has there been any precedent for the speed of contagion at the global level. The result has been an increasing variety of "non-standard" central banking interventions, ranging from the lengthening maturity of liquidity support to quantitative easing of all shapes and sizes. In a number of instances, this has led not only to the spectacular expansion of the balance sheets of central banks, but also to a change in the composition of their assets, which implied the acquisition of risky assets. As a result, central banks have started navigating in uncharted waters, in terms of both operational techniques and their relations with governments.

Looking ahead, it is difficult not to ask whether these problems are going to fade away once we have the current crisis behind us. I regret to say that I doubt it. I have three major reasons for my doubts.

First, because our globalised, competitive and highly innovative financial markets have an unlimited capacity to cause financial disturbances of a size and nature that could lead to systemic meltdown. I note with preoccupation the speed with which new, complex and bizarre innovations appear whenever the financial stress starts to ease. Hopefully, the severity of the current crisis will not be promptly forgotten by all market participants. But how long will the moderation last?

Second, while acknowledging that the numerous reform processes, if properly implemented, will enhance our prevention capability, I have to note that precious little is being done in the crucial field of structural reforms. Mergers and acquisitions are leading to concentration, and increasing the size of banks that qualify as systemically important. The widespread belief that such banks will always be bailed out has two devastating consequences: it encourages reckless risk-taking by such institutions, and it provides them with an unfair competitive edge over the rest of the financial industry by ensuring cheaper financial resources for them. To avoid this unappealing moral hazard trap, it has to be made clear that no financial firms, and especially banks, should count on being protected from failure. But no such statement will appear credible unless ways and means are found to ensure that the absence of a bail-out option has no systemically disruptive consequences. Trying to find, and agree "globally" on, such crisis resolution processes should rank very high on the political agenda. This does not seem to be the case.

Finally, despite the encouraging statements made by the G20, it is questionable whether we have the ability to deal with those macroeconomic imbalances which played an instrumental role in the crisis and therefore are likely to continue to nurture a "crisis-friendly" environment. I refer, of course, to the savings/investment imbalances and their capacity to contribute powerfully to the creation of excess liquidity.

It is for these reasons (and for some others as well) that I would expect systemic fragility to remain a source of concern for years to come. If so, central banks should not regard their macro-prudential duty as being less important than their mandate to preserve price stability. But nor do I believe that their duty to prevent a systemic meltdown should lead them to forget their mandate to preserve price stability. Price stability is just as much a public good as the stability of the financial system, and vice versa. Does this amount to squaring the circle? I do not think so, but I do not deny that situations may arise where decisions have to be taken which pose a risk to one of these objectives – a risk which is difficult to measure and therefore can lead to conflicting assessments. To minimise such risks, techniques have to be found to preserve the capability of central banks to reabsorb the excess liquidity created by "non-standard" liquidity-boosting interventions: this is feasible, but may on occasion be quite a challenge.

Does this put central banking independence at risk? Yes, it does. The risk arises from the obvious fact that having to comply with two distinct mandates pushes central banks into a much more complex world. The modalities of their independence in their monetary policy function may be debatable, but once agreed, the content of independence can be reasonably well defined. In the case

of macro-prudential independence, this is much more difficult. Once the initial liquidity problem appears to be turning into a solvency problem, and especially when the latter implies the risk of a systemic meltdown, central banks have to operate hand in hand with their governments. But "hand in hand" can mean very different things – hence my plea for a reasonably well-defined operational framework. For a central bank, the macro-prudential mandate requires a type of relationship with, and therefore a type of independence from, the government that is different in substance from the one governing monetary policy. The rules of the game on both sides have to be spelled out.

The complexity of the current situation, and the likelihood that it will remain complex, mean that you have to navigate in uncharted waters. There is no way of "opting out" of this complex world. Wishing that we could go back to the professional and intellectual comfort of the pre-crisis years is a pipe dream.

A short remark by way of conclusion. A potential conflict between the two mandates is most likely to arise in the various stages of managing an open, or almost open, crisis. If you want to avoid this happening, you should put the emphasis on crisis prevention and, in particular, on working out crisis resolution processes that would make it possible to let financial institutions fail without triggering a systemic crisis. I realise that such reforms are difficult to design and even more difficult to implement, but this is the price you have to pay for financial stability and for a somewhat quieter life for central banks.

Well, this is where the text I drafted ahead of this dinner comes to an end. Having re-read it after today's fascinating discussions, I feel that my remarks should be completed by trying to answer the following question: will the ECB be able to respond with efficiency to the challenges of this complex new world? Looking over the ECB's past performance, five facts stand out which to my mind warrant quite some confidence that it will:

i) It has fulfilled its core mandate by ensuring price stability over the past 11 years – and this has happened despite the fact that a number of member countries were relative newcomers to the club of those countries which had a long period of price stability behind them.

ii) It has displayed a capacity to adjust to new circumstances. I refer here to the gradual changes in its "two pillar" monetary policy strategy.

iii) It has displayed an unquestionable capacity to take swift decisions, of which the prime example was the Eurosystem's massive intervention on 9 August 2007. I still vividly remember that a certain newspaper described the ECB as a sleepy organisation, whose oversized Governing Council, operating on the basis of consensus, would be unable to reach prompt decisions in the event of a crisis.

iv) It has displayed imagination and inventiveness: anybody who doubts this should take the trouble to note the steady changes in the Bank's monetary policy tool-box.

v) Finally, it has managed to preserve its independence.

Let me now conclude by expressing the hope that the ECB will play an active role in the work of the newly created European Systemic Risk Board – an institution which must become the key macro-prudential player in the new European financial regulatory and supervisory architecture.

Jürgen Stark

KEYNOTE SPEECH

IN SEARCH OF A ROBUST MONETARY POLICY FRAMEWORK

BY JÜRGEN STARK, MEMBER OF THE EXECUTIVE BOARD OF THE ECB

I am very pleased[1] to open the second day of the ECB Central Banking Conference. We witnessed very interesting presentations and discussions yesterday, and today's programme promises to be no less stimulating.

In my remarks I would like to offer some reflections on what I consider to be the desirable features of a robust monetary policy framework. Only three years ago, it was widely believed that this issue had been settled once and for all. At that time, several studies outlined the then prevailing consensus view on monetary policy.[2]

This view emphasised, among other things:

- central bank independence;
- price stability as the primary objective of central banks; and
- the importance of transparent communication for the solid anchoring of long-term inflation expectations.

But the consensus also emphasised four elements to which the ECB has never subscribed, namely:

- the targeting of inflation at a relatively short and fixed horizon;
- the assignment of a primary role to monetary policy in the management of aggregate demand in the short term;
- the systematic disregard of money and credit indicators in the conduct of monetary policy; and
- the asymmetric reaction to asset price bubbles as opposed to busts; the latter often referred to as the "cleaning-up strategy" in the context of the "Jackson Hole consensus".

This framework has been severely tested during the financial crisis and perhaps, to some extent, damaged. Moreover, the crisis has exposed the fact that, on some

1 I am grateful for support and comments by Claus Brand, Francesco Drudi, Philippine Cour-Thimann, Dieter Gerdesmeier, Christophe Kamps, Wolfgang Schill, Wolfgang Modery, Philippe Moutot, Huw Pill and Massimo Rostagno.

2 See e.g. Goodfriend (2007), Mishkin (2007) and Woodford (2008).

crucial questions, the consensus view, as expressed in these studies, is in need of revision.

Certainly, some aspects of the framework will, in my view, *have* to survive the crisis. The first aspect is central bank independence and, at least in the EU context, the prohibition of government debt monetisation. The second aspect is the centrality of price stability for monetary policy. And the third aspect is the importance of transparent communication. The crisis has not at all discredited these three principles. Together they have formed, and I believe will continue to form, the basis for central banks' credibility and efficiency in contributing to the economic welfare of nations.

International convergence on these principles has, however, been a slow process. After the collapse of the Bretton Woods system there was a long period of confusion created by the loss of a nominal anchor, which, during the system's good times, had been provided by the US commitment to peg its currency to the price of gold. In the 1970s even some central bankers were sceptical that monetary policy alone could control inflation.[3] Failed attempts to fine-tune the economy and the associated stop-and-go policies resulted in stagflation in a vast portion of the industrialised world. Drawing lessons from this experience, and inspired by monetarist views that had successfully influenced monetary policy in Germany and Switzerland, central banks in the 1980s gained confidence in their ability to bring inflation down to levels consistent with price stability at a modest cost to the economy at large.

The 1990s were characterised by the development of monetary policy frameworks capable of perpetuating the achieved degree of price stability. In my view, two major initiatives stand out: first, the development of inflation targeting. Inflation targeting developed in many countries when other strategies failed to bring about the desired level of price and macroeconomic stability. Some countries turned to inflation targeting because the instability of money demand in the face of ongoing financial innovation appeared to render the application of textbook-type versions of monetary targeting unappealing. Even so, inflation targeting was heavily influenced by the monetarist view that monetary policy can control inflation.

The second development was the establishment of the ECB, with its two-pillar monetary policy strategy. Inflation targeting and the ECB's strategy share important features: the insistence on central bank independence, the priority assigned to the price stability objective, and the importance of transparent communication. These three principles are fundamental to sound monetary policy.

3 See Burns (1979). As Chairman of the Federal Reserve, Burns had long lamented the difficulty for a central bank to control inflation.

Nevertheless, for various reasons, the ECB does not view itself as an inflation-targeting central bank, at least not in the way inflation targeting is commonly described. One reason relates to our definition of price stability and our specification of the policy horizon. Another reason relates to the special role our monetary policy strategy assigns to money and credit. Both aspects differ markedly from textbook inflation targeting. But I should also add that the ECB's monetary pillar builds on the tradition developed by the most successful central banks prior to the introduction of the euro – a tradition which precedes the advent of inflation targeting, in some cases by decades.

Let me adopt a stylised incarnation of a flexible inflation-targeting regime, a description which, nonetheless, follows closely early expositions in the literature. Inflation targeting has evolved, as we all know, both in theoretical work and in the practice of the inflation-targeting central banks. However, it might still be useful to identify elements in the regime – as it was originally conceived – which have influenced the conduct of monetary policy in the years immediately prior to the crisis more profoundly than was perhaps ideal.

I will concentrate on two specific features, the implied short-termism in terms of excessive focus on aggregate demand management, on the one hand, and the systematic disregard of monetary phenomena, on the other, which in my view are essential ingredients for understanding the genesis of the crisis.

A key lesson from the current crisis is that, going forward, any monetary policy framework that lays claim to being "robust" will have to satisfy the following two requirements – beyond the uncontroversial principles I mentioned earlier: first, the monetary policy strategy needs to be geared towards the medium term to resist the fine-tuning temptation; and second, the strategy needs to assign a prominent role to developments in money and credit which – as the crisis has shown convincingly – provide reliable signals of risks to long-term price stability, financial stability and overall macroeconomic stability.

In my view, these two requirements are natural complements. The key role of money, both before and during the crisis, has been to maintain a focus on developments in nominal trends at lower frequencies.

THE CASE FOR MONETARY POLICY STRATEGIES ORIENTED TOWARDS THE MEDIUM TERM

In this context let me elaborate the case for monetary policy strategies oriented towards the medium term. You may ask "but isn't this exactly what central banks around the world have been pursuing for the past two decades?" Well, perhaps or perhaps not. Five years ago, at the Jackson Hole conference, for example, former Fed Vice Chairman Alan Blinder described US monetary policy since the late 1980s in terms of the "resurrection of fine-tuning".[4] Moreover, flexible inflation targeting, with its added focus on output stabilisation beyond inflation stabilisation is at risk of succumbing to the temptation of fine-tuning.

4 See Blinder and Reis (2005).

An element of the so-called "Jackson Hole consensus" was that monetary policy should play a key role in the management of aggregate demand in the short term, whereas fiscal policy was viewed as an inappropriate instrument, mainly because of decision and implementation lags embedded in the policy process. I would argue that we should not overestimate the potency of either policy. Before the crisis there was a common misperception that monetary policy could focus more on demand management because inflation was durably under control. Proponents of this view found apparent vindication in the phenomenon of the "great moderation" observed in the 20 years before the crisis. However, there were clear warnings that the short-term orientation could have negative side effects in the medium to long term.[5] As we now know, the side effects manifested themselves in a spectacular build-up of monetary and financial imbalances. The sudden unwinding of these imbalances marked the beginning of the current crisis. Although monetary policy frameworks oriented more towards the medium term could probably not have completely prevented the current crisis, I am convinced that they would have helped to make it less disruptive.

The then dominant theoretical framework suggested otherwise. The New Keynesian model generated policy prescriptions which assigned the central bank the task of stabilising inflation and output developments at short horizons and in quite precise terms.

These prescriptions have shaped the inflation-targeting policy advice to a non-negligible extent. Let me emphasise, though, that many inflation-targeting central banks retain a considerable degree of flexibility when putting this advice into practice – although in a very different way from the meaning the term "flexibility" has received in theoretical work. I will return to this point shortly.

Simplifying, the inflation-targeting policy advice can be articulated in three main precepts:

- First, look at inflation forecasts and output gap forecasts as summary statistics of the state of the economy.

- Second, rely on your best model of the economy, even if it does not integrate or just assigns a trivial role to a host of variables, particularly money and credit, which are assumed to adjust to the state of the economy.

- Third, follow the best policy implied by the model and set the policy instrument so that inflation forecasts – whatever the nature of the shocks that might have caused them – are stabilised, and output volatility is minimised, at a pre-set horizon.

Now, it is easy to imagine economic conditions in which these prescriptions induce destabilising behaviour on the side of monetary policy, which is the exact opposite of what monetary policy should do.

5 See e.g. Rajan (2005).

Limiting the information set to inflation forecasts and output gap forecasts can be highly misleading. One of the reasons for this has been known for a long time: output gaps cannot be observed in real time. An imperfectly understood concept – which, in addition, is statistically very imprecisely measured and subject to frequent revisions – is not a safe indicator to choose as a guide for policy. Indeed, the great policy failures of the 1970s have been traced to policy-makers' exaggerated real-time measures of economic slack.[6]

Another reason which argues against limiting the policy-makers' information set is that the same inflation forecast can result from very different combinations of economic shocks. In other words, inflation forecasts are *not* summary statistics of the state of the economy: you have to look at the underlying shocks in order to interpret inflation. This is far less appreciated, but it is one of the economic foundations of the ECB's monetary policy strategy. A fundamental principle of our strategy is that different underlying shocks – although potentially leading to the same inflation forecast – can have vastly different implications for policy. Failing to recognise that a prudent policy stance is always conditional on the shocks that hit the economy, and that accordingly the policy-relevant horizon varies with those shocks, would not comply with the requirements of a medium-term orientation and, in addition, would be extremely hazardous.

Let me give you an example. Think of a benign disinflation caused by positive supply-side shocks. Positive supply-side shocks tend to produce lower inflation and high output growth at the same time. The attempt to stabilise inflation at a certain horizon – and thus resist disinflation – can, in those circumstances, introduce pro-cyclicality in monetary policy. A central bank that is instructed to stabilise inflation at a pre-set horizon in those circumstances can well end up providing too much accommodation, precisely at a time when output and incomes are growing robustly and asset markets are most prone to exuberance. Think of the protracted period of productivity growth and negative price surprises associated with technological innovation and globalisation that we saw over the second half of the 1990s. If you combine that scenario with systematic resistance to disinflation, and systematic neglect of monetary phenomena, you can lay the ground for financial instability down the road.

As I said, central banks describing themselves as inflation targeters have realised that, in practice, one needs to go beyond the standard inflation-targeting policy advice emanating from the New-Keynesian framework.

Referring back to my example, my feeling is that the central bank community is increasingly sharing the view that – in the face of positive supply-side shocks – one should accept in the short run inflation somewhat lower than the inflation objective so as to avoid the risks involved in potentially large deviations from target at longer horizons.[7]

6 See Orphanides (2002).
7 See e.g. King (2004), p. 15.

This view is perfectly consistent with the ECB's view of the medium term, also in the sense of not trying to manage aggregate demand. It points to the advantages of limiting the central bank's mandate to the maintenance of price stability over the medium term without any reference to aggregate demand management. However, it immediately raises the question of how to enshrine this view into a monetary policy strategy. For inflation-targeting central banks, embedding this view appears to be achieved by extending the forecast horizon and by applying judgement. In contrast, the ECB's monetary analysis can be seen as a formalisation of the view that the policy horizon should be commensurate with the nature and size of shocks, rather than being determined by a particular set of inflation forecasts.

This leads me to my second topic, the case for correcting the systematic disregard of monetary phenomena in the consensus framework.

THE CASE FOR CORRECTING THE SYSTEMATIC DISREGARD OF MONETARY PHENOMENA

As I have stressed before, in my view, monetary policy should avoid any kind of short-termism. The necessary medium-term orientation of monetary policy calls for the use of tools and indicators that have a comparative advantage over such a horizon. At the same time, it is an undisputed fact in academic and central banking circles that prolonged periods of high inflation are associated with high money growth. On both theoretical and empirical grounds, the ultimately monetary nature of inflation cannot be challenged. While other factors can influence price developments at shorter horizons, this does not call into question the underlying long-term relationship between money and prices.[8] Furthermore, the empirical evidence clearly points to monetary trends *leading* inflationary trends, thus giving support for a monetary analysis in a forward-looking monetary policy. The analysis of monetary aggregates allows the ECB to identify the longer-term and more persistent trends in inflation. This is the main reason for the monetary pillar in our monetary policy framework.

The monetary pillar should not be confused with a "financial stability pillar". Monetary analysis is not conducted with the principal goal of detecting financial imbalances. It ultimately rests on the quantity-theoretic notion of there being a reliable link between money and price developments. Exploring the link between money and asset prices should be seen as a complementary way of better understanding the role of money.

A number of recent studies have demonstrated, in a quite impressive way, that monetary developments – especially when seen in conjunction with credit developments – can also alert policy-makers to unwarranted financial developments and imbalances. Needless to say, the financial crisis we have experienced has, in my view, clearly demonstrated the need for policy-makers to have such reliable early warning signals at their disposal.

8 See Lucas (1972, 1996) or McCandless and Weber (1995).

While some parts of the academic literature have long held the view that identifying a bubble in real time is an impossible task, the academic literature on early warning indicator models has made significant progress over the past ten years. Research carried out within the BIS and the ECB have illustrated that – among other variables, such as price-earnings ratios or price-dividend ratios – simple deviations of money and credit aggregates from a trend that exceed a given threshold are among the few early indicators for (potentially costly) boom and bust periods.[9] And one key property that strikes me as being of particular interest for policy-makers is the fact that these warning signals emerge well before the alarm bells of standard conjunctural analysis start ringing.

The financial crisis and its subsequent shockwaves have also led to recommendations for greater importance to be placed on an approach of "leaning against the wind". According to this approach, monetary policy should be conducted in a "symmetric" manner over the financial cycle. More precisely, monetary policy should be more accommodative in times of falling asset prices, but less accommodative during a financial market boom. For instance, the central bank should conduct a slightly tighter monetary policy than warranted by its price stability objective, when the build-up of a potentially detrimental asset price boom has been identified. In so doing, the central bank would better ensure price stability over extended horizons and – at the same time – contain the future growth of the bubble. Such an approach can be compared to "buying insurance" against the risk of a harmful asset boom/bust cycle, with its potential costs in terms of macroeconomic and financial stability.

Traditionally, however, there has been a great deal of scepticism about "leaning against the wind" for at least four reasons.[10] First, it has been argued that it is not evident that asset price boom/bust cycles are necessarily a bad thing for real long-term growth in all countries. The benefits from the realisation of additional investment projects could, on average, outweigh the costs incurred during the bust phases.

Second, as I have already mentioned, it is considered very difficult to identify an asset price bubble in real time. In particular, a tight policy response to asset price increases may end up destabilising the economy unnecessarily if the asset price valuation is driven by fundamentals.

Third, it has been claimed that the policy interest rate is "too blunt a tool" to contain potential bubbles. Raising policy rates will depress the prices of many assets – including those not booming – as well as the real economy and consumer prices.

Furthermore, in times of market euphoria, the policy rate might have to be raised quite significantly in order to have a measurable effect on booming asset prices. When taken seriously, these considerations lead to doubts about the effectiveness and efficiency of an active "leaning against the wind" approach.

9 For a number of illustrative examples see, for instance, ECB (2010a).
10 For a more detailed discussion, see Papademos and Stark (2010), especially Chapter 6.

A fourth argument basically refers to cost-benefit considerations. In essence, the argument postulates that the costs of "cleaning up afterwards" (namely by loosening the monetary policy stance after the bust) are smaller than the "collateral damage" of a leaning against the wind approach pursued during the boom. These considerations describe the so-called "cleaning-up strategy" I mentioned earlier.

In essence, these arguments all reflect valid concerns and cannot be easily dismissed. More recently, however, a number of arguments have given reason for a tempering of the concerns I have just expressed and have lent support to a "leaning against the wind" approach to asset price bubbles.

First of all, with regard to the welfare implications of "leaning against the wind", the analysis of the costs of boom/bust cycles in asset prices in developed economies has been deepened and refined. Existing theoretical models use fairly specific assumptions to allow for bubbles in general equilibrium, and tend to neglect important aspects which make bubbles costly in the real world. Admittedly, not all boom/bust cycles are detrimental and have significant real effects. This is also one of the reasons why the mechanical targeting of asset prices is not a sensible option for monetary policy. However, the experience of the recent financial crisis – which has been accompanied by sharp declines in global economic activity and increasing unemployment in advanced economies – is a vivid reminder that there are boom/bust cycles which have the potential to trigger systemic crises and thus constitute a serious threat to world economic growth.

Furthermore, as regards the scepticism on the effectiveness of monetary policy in containing asset price bubbles, recent research has detected some additional monetary policy transmission channels that, in essence, relate to the risk-taking behaviour of banks, the signalling effects of monetary policy and the breaking of herding behaviour. Taken together, the results then point towards the fact that each of these channels can reasonably be expected to amplify the impact of monetary policy during boom periods. For instance, the "risk-taking" channel suggests that banks' attitudes towards risk are strongly correlated with the monetary policy stance. In the presence of very considerable intra-financial sector leverage, even relatively modest increases in policy rates can lead to significant changes in credit conditions and market dynamics, to the extent that they alter financial institutions' risk tolerance. Similarly, mechanisms that operate through the signalling effects of monetary policy or the role potentially played by central banks in discouraging herding behaviour by investors can result in policy rate changes exerting more pronounced effects on asset prices than was typically thought to be the case in the past.

Regarding the appropriate policy reaction to the build-up of financial imbalances, there seems to be broad agreement that monetary policy would hardly be the first best line of defence against, for example, systemic risk associated with asset markets, let alone asset price bubbles detected in specific market segments. This task would rather fall to regulatory and supervisory policies. But if bubble-like behaviour becomes more widespread and reflected in imbalances in money and credit developments, it becomes a concern for monetary policy too.

If the past is of any guidance for the future, monetary policy needs to support regulatory and supervisory policies on two accounts. First, by making sure that the very short-term, risk-free price of credit – which the central bank controls – does not become a pro-cyclical source of volatility. And second, by intervening in a timely manner, both before asset price booms develop and when the bust of a bubble impacts the economy. Indeed, regulatory and supervisory policies lag behind innovation-driven financial market developments, and sometimes they tend to be implemented too cautiously or too slowly. In this context, it is worth keeping in mind that asset prices by no means constitute the end point of the monetary policy transmission process. There are a variety of mechanisms – among them wealth and confidence effects – through which higher asset prices have an impact on business cycle developments and may eventually result in higher consumer prices.

As the financial crisis illustrates, the macroeconomic costs of financial instability and the challenges that it poses for the maintenance of price stability provide support to the case for a flexible and cautious strategy encompassing the need, in some well chosen circumstances, to influence financial markets. But how can such a policy be made operational? And if it can, can it really be implemented in practice? The answer to these questions very much depends on the monetary policy framework specifically adopted by a central bank. In this respect, the ECB's monetary policy strategy embodies elements that – in my view – provide a suitable and robust framework for an occasional, but appropriate "leaning against the wind" approach.

The ECB's Governing Council has defined its aim of keeping inflation rates below, but close to, 2% over the medium term. The medium-term anchoring of inflation expectations allows the conduct of a less accommodative monetary policy during a period of buoyant financial markets, even in an environment of relatively subdued inflationary pressures. While this will result in lower inflation over shorter horizons, one could expect it to be more effective in maintaining price stability over longer horizons by helping to prevent the emergence of possible deflationary risks after the bursting of the bubble.

Taken together, I tend to regard the ECB's monetary policy strategy as being particularly well equipped to deal with risks to price stability across different time horizons, insofar as they arise from imbalances in money and credit.

It is fair to say that there have been times when the ECB's monetary policy strategy has not been well understood in some academic circles. In my view, there is only one way of addressing these concerns in a constructive way: the ECB needs to foster the public's understanding of its monetary policy strategy and, thereby, especially the robustness of monetary analysis.

In spring 2007 the Governing Council endorsed the pursuit of an agenda to enhance the ECB's monetary analysis. Having faced excessive money growth, we then perceived serious challenges. We have made significant progress on our agenda. The results look promising and they will hopefully stimulate the debate further. To this end we have published a book on "Enhancing Monetary

Analysis". Of course, the book should not be seen as the final word. While it has interesting answers to offer regarding some questions, other questions and challenges have arisen during the process of compiling the material. But I am confident that the new generation of tools presented in the book and the results of the subsequent debate will help us to prevent a crisis of the magnitude seen in the recent past in future decades.

CONCLUSION

Let me conclude by summarising what are – in my view – the main features of a robust monetary policy framework.

- First, there is broad agreement that central bank independence, price stability and transparent communication will remain key features of effective and credible monetary policy-making.

- Second, in the case of the ECB, a quantitative definition of price stability, a medium-term orientation and a broad analytical framework, with money and credit playing an important role, have been key elements in the conduct of monetary policy. The crisis seems to be paving the way for solidifying support for the medium-term orientation and for the role of money and credit in a central bank's analysis.

- Third, in relation to this, the crisis seems to point towards a need for a symmetric approach in central banks' reaction to asset price bubbles and busts. Traditionally, the proposal of "leaning against the wind" has faced a considerable degree of scepticism. Recent results, however, call for a fair reassessment that does more justice to the advantages of such an approach.

I am confident that these features of a robust monetary policy framework will guide us in the future. At the same time, I am convinced that central bankers have a responsibility to ensure that their monetary policy frameworks create the proper incentives for the banking community to assume its responsibilities and take the appropriate decisions in a timely manner to shape a healthy banking sector at the service of the real economy.

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SESSION 3

PANEL
WHAT SHORTCOMINGS IN MACROECONOMIC AND FINANCE THEORY HAS THE FINANCIAL CRISIS REVEALED, AND HOW SHOULD THEY BE ADDRESSED?

PANEL STATEMENT

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THE ENDOGENOUS DYNAMICS OF MARKETS: PRICE IMPACT AND FEEDBACK LOOPS

1 INTRODUCTION

Why do asset prices move so frequently and why is the volatility so high? Why do prices move at all? This is obviously a fundamental question in theoretical economics and quantitative finance that encompasses other, related issues: what is the information reflected by prices, and to what extent do market prices reflect the underlying economic reality? Do we understand the origin of crises and crashes? In this paper, we review the evidence that the erratic dynamics of markets are to a large extent of endogenous origin, i.e. determined by the trading activity itself and not due to the rational processing of exogenous news. In order to understand why and how prices move, the joint fluctuations of order flow and liquidity – and the way these impact prices – become the key ingredients. Impact is necessary for private information to be reflected in prices, but, by the same token, random fluctuations in order flow necessarily contribute to the volatility of markets. Our thesis is that the latter contribution is in fact dominant, resulting in a decoupling between prices and fundamental values, at least on short-to-medium time scales. We argue that markets operate in a regime of vanishing revealed liquidity, but large latent liquidity, which would explain their hyper-sensitivity to fluctuations. We discuss several unstable feedback loops that should be relevant to account for excess volatility and market crises.

1.1 EFFICIENT MARKETS

The neo-classical paradigm answers that question as follows: prices change because new information about the fundamental value of the asset becomes available. If the information is instantly and perfectly digested by markets, then prices should reflect faithfully these fundamental values and only move because of exogenous unpredictable news. This is the Efficient Market story, which assumes that informed rational agents would arbitrage away any error or small mispricing, and nudge the price back to its "true" value. This is very much a Platonian view of the world, where markets merely reveal fundamental values *without influencing them* – the volatility is an unbiased measure of the flow of news, and is not related to the trading activity per se. Crashes, in particular, can only be *exogenous*, but cannot be induced by market dynamics itself.

Is this picture fundamentally correct to explain why prices move and to account for the observed value of the volatility? Judging from the literature, it looks as if a majority of academics still believe that this story is at least a reasonable

starting point. The idea of rational agents and efficient markets has shaped the mind-set of decision-makers and regulators for decades and has permeated a variety of spheres, from international monetary policy to derivative markets or sociology. Scores of financial mathematics papers are deeply rooted in the idea that options markets are efficient. In the aftermath of the crisis, a number of scholars and pundits have expressed concern about this whole intellectual construct, in particular about the intrinsic stability of markets (see, among the most provocative ones, Soros (2008), Akerlof and Shiller (2009), Farmer and Geanakoplos (2008), Marsili (2008), and in the context of financial markets, Taleb (2007) and Derman and Wilmott (2008)) – bearing in mind that Keynes (1936) had anticipated a lot of these "new" ideas).

There are many reasons to believe that markets are very far from efficient in the above traditional sense. To start with, the very concept of a "fundamental value" that can be computed, at least as a matter of principle, with arbitrary accuracy with all information known at time t, appears to be deeply flawed. The number of factors affecting the fundamental value of a company (or of a currency, etc.) is so large, and the influence of unknown-unknowns so predominant, that there should be, at the very least, an irreducible error margin. All valuation models or predictive tools used by traders and market participants (e.g. using economic ratios, earning forecasts) or based on statistical analyses that detect trends or mean-reversion, are extremely noisy (statistical methods can only rely on a rather short history) and often even biased. For example, financial experts are known to be on the whole over-optimistic, and rather imprecise at forecasting the next earning of a company (see, for example, Guedj and Bouchaud (2005) and references therein). News is often ambiguous and not easy to interpret, and real information can be buried underneath terabytes of irrelevant data. This is why there is no way to check directly that market prices indeed reveal fundamental values (if this could be achieved, we would not need markets in the first place!).

If we accept the idea of an intrinsically noisy fundamental value with some band within which the price can almost freely wander (because nobody can know better), the immediate question is: how large is this irreducible uncertainty? Is it very small, say 10^{-4} in relative terms, or quite a bit larger, say 50% – as suggested by Black (1986), who defined an efficient market as a market giving the correct price to within a factor 2? If Black is right (which we tend to believe) and the uncertainty in the fundamental value is large, then Keynes' famous beauty contest is a better narrative of what is going on in financial markets, at least in the short term. It is less the exogenous dynamics (news-driven) of the fundamental value than the endogenous dynamics of supply and demand that should be the main focus of research.

Another reason why markets cannot be efficient is the limited intelligence of us humans (even if, quite strangely, many academics have a hard time coming to terms with this[1]). We do make mistakes and have regrets, and we

1 A lot could be said – and, to some extent, has been – about the religious roots and the political implications of the rational agent concept.

do make suboptimal decisions. In fact, even perfectly rational agents that have to process information in a finite amount of time, are likely to make errors or go for suboptimal solutions. A good illustration of this is provided by chess: pressed by time, even chess masters do make errors and lose against Deep Blue. Many optimisation problems are indeed very complex, in the sense that the best algorithm to solve them requires a time that grows exponentially as a function of the size of the problem (for example, the size of a portfolio that one wishes to optimise, see Galluccio et al. (1998)). Humans just cannot be expected to be any good at such tasks without developing intuitive or heuristic rules – the most common one being: *just do what your neighbour is doing, he might know better*. Another one is: *look for patterns, they might repeat* (on this one, see Arthur (1995) and Wyart and Bouchaud (2007)).

1.2 MARKET IMPACT

This in fact leads us to a crucial issue, that of market impact, which is the main theme of this paper. It is both rather intuitive and empirically demonstrated that "buy trades" are followed by a rise of the price, and "sell trades" by a price decline. A simple way to try to guess what others are doing is to observe price variations, which may reflect the impact of their trades, and therefore their intentions (Kyle (1985)). The interpretation of the price-impact phenomenon is, however, potentially controversial. In the Efficient Market picture, impact is nearly tautological, since informed agents successfully forecast short-term price movements and trade to remove arbitrage opportunities. This trivially results in correlations between trades and price changes, but these correlations cannot be exploited by copycats. In this story, however, uninformed trades should have no price impact (except maybe on short time scales); otherwise silly trades would, in the long run, drive prices arbitrarily far from fundamental values.

A more plausible story is the following: if Black's idea is correct and the uncertainty in the fundamental value is large, then the amount of information contained in any given trade is necessarily small.[2] Furthermore, modern electronic markets are anonymous, which makes it impossible to distinguish potentially informed trades from non-informed trades. Hence, all trades are equivalent and they must (statistically) equally impact prices.

The mechanism by which the market reacts to trade by shifting the price is precisely the above copycat heuristic rule, applied at a tick-by-tick level. Since all agents are pretty much in the dark, but believe (or fear) that some trades might contain useful information, prices must statistically move in the direction of the trades. As reviewed below, high-frequency data allow one to make much more precise statements about the amplitude and time-dependence of this impact. But the consequence of such a scenario is that even silly trades do impact prices and contribute to volatility – a mechanism for instabilities, bubbles and crashes, even without any "news" or other fundamental cause for such events.

2 Empirically, the standard deviation of market impact is found to be very large compared to its mean, confirming that the quantity of information per trade must indeed be small.

We therefore have to decide between two opposite pictures for the dynamics of price: *exogenous*, news-driven, or *endogenous*, impact-driven. Of course, reality should lie somewhere in the middle. In the next sections, we will review several empirical findings that suggest that endogenous dynamics are in fact dominant in financial markets.

2 EXOGENOUS OR ENDOGENOUS DYNAMICS?

Is news the main determinant of volatility? Were this true, and in the absence of "noise traders", the price should essentially be constant between news, and move suddenly around the release time of the news. Noise traders should merely add high-frequency, mean-reverting price changes between news, that do not contribute to the long-term volatility of the price.

There are, however, various pieces of evidence suggesting that this picture is fundamentally incorrect. First, high-frequency time series do not look at all like long plateaus dressed by high-frequency noise. On liquid assets, there is very little sign of high-frequency mean-reversion that one could attribute to noise traders – in other words, the high-frequency volatility is very close to its long-term asymptotic value (see, for example, Bouchaud et al. (2004)).[3] Volatility is furthermore well-known to be much too high to be explained by changes in fundamentals (Shiller (2000)), and most large price swings seem to be unrelated to relevant news releases. This was the conclusion reached by Cutler, Poterba and Summers (1989) in a seminal study of large daily price changes (see also Fair (2002) for a more recent discussion with identical conclusions).

2.1 NEWS AND NO-NEWS JUMPS

We have recently confirmed in detail this conclusion, now on high-frequency data, using different news feeds synchronised with price time series. We have looked for simultaneous occurrences of price "jumps" and intra-day news releases on a given company (Joulin et al. (2008)).[4] This requires one to define jumps in a consistent, albeit slightly arbitrary fashion. We chose to compare the absolute size $|r(t)|$ of a one-minute bin return to a short-term (120 minutes) flat moving average of the same quantity, $\sigma(t)$, in order to factor in local modulations of the average volatility. An s-jump is then defined such that $|r(t)| > s\sigma(t)$. The number of s-jumps as a function of s is found to decay as $\approx s^{-4}$, consistent with previous work on the distribution of high-frequency returns (Plerou et al. (1999), Gopikrishnan et al. (1999) and Gabaix et al. (2006)). We note once again that this distribution is very broad, meaning that the number of extreme events is in fact quite large. For example, for the already rather high value $s = 4$ we find seven to eight jumps per stock per day! A threshold of $s = 8$ decreases this

3 Here we talk about the volatility of the mid-point, not of the traded price, that shows a large, trivial bid-ask bounce.

4 Overnight news and overnight jumps are not included in the study. "Big" company news are usually issued overnight. But this makes the existence of intraday jumps all the more puzzling!

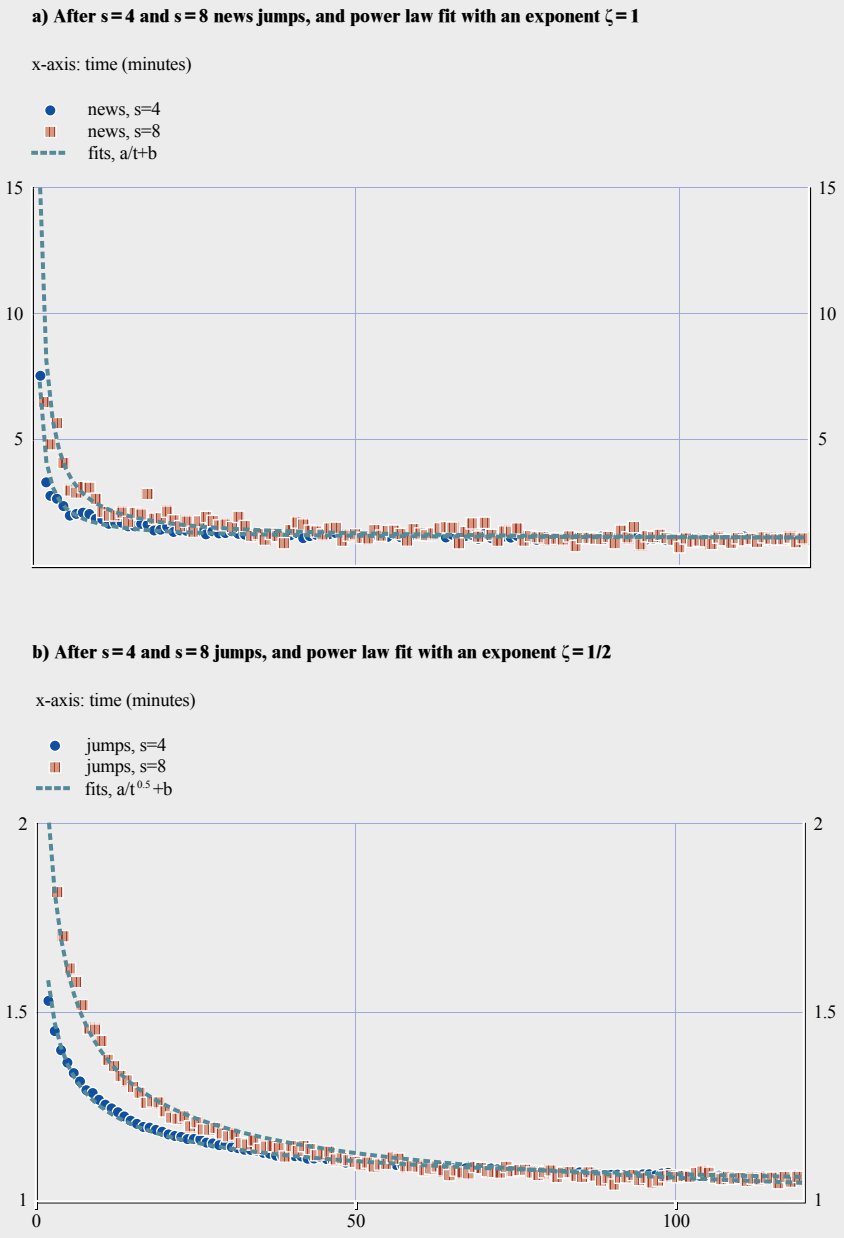
number by a factor ≈ 10, amounting to one jump every day and a half per stock. In the same period, we find on average one news item every three days for each stock. These numbers already suggest that a very large proportion of shocks cannot be attributed to idiosyncratic news (i.e. a news item containing the ticker of a given stock). This conclusion still holds when one includes (possibly also endogenous) collective market or sector jumps in the definition of news. The number of jumps explained by these "macro" events only increases by 20%, but leaves most jumps unexplained (see Joulin et al. (2008) for more details). One may also argue that these jumps are due to the arrival of private information. But this cannot be, since an investor really possessing superior information will *avoid* disturbing the market by trading too quickly, in order not to give away his advantage. As illustrated by Kyle's model (1985), an insider should better trade incrementally and discretely. We will discuss below strong empirical evidence that trading indeed occurs incrementally.

More quantitatively, there are striking statistical differences between jumps induced by news, and jumps with no news, that clearly demonstrate that the two types of event result from genuinely distinct mechanisms. One difference resides in the distribution of jump sizes: the cumulative distribution of jumps with news has again a power law tail $s^{-\mu}$, but with an exponent $\mu \approx 2.7$, different from the value $\mu = 4$ mentioned above for jumps without news. Interestingly, if we extrapolate these distributions deep in the tail (and far beyond the observable regime), the news-induced jumps eventually become more probable than the no-news jumps, but only for $s \approx 60$!

A second difference is the way in which the volatility relaxes after a jump. In both cases, we find (see Chart 1) that the relaxation of the excess-volatility follows a power-law in time $\sigma(t) - \sigma(\infty) \propto t^{-\zeta}$ (as also reported in Lillo and Mantegna (2003) and Zawadowski et al. (2006)). This behaviour is the counterpart of the "Omori law" for earthquake aftershocks. The exponent of the decay is, however, markedly different in the two cases: for news jumps, we find $\zeta \approx 1$, whereas for no-news jumps one has $\zeta \approx 1/2$, with, in both cases, little dependence on the value of the threshold s. The difference between endogenous and exogenous volatility relaxation has also been noted in Sornette et al. (2003), but on a very restricted set of news events. Although counter-intuitive at first, the volatility after a no-news jump relaxes more slowly than after a news. This could be due to the fact that a jump without any clear explanation makes traders anxious for a longer time than if a well-identified event caused the jump. The slow, non-exponential relaxation after a no-news jump is very interesting per se, and already suggests that the market is, in some sense, critical.

So, yes, some news do make prices jump, sometimes a lot, but the jump frequency is much larger than the news frequency, meaning that most intraday jumps appear to be endogenous, induced by the speculative dynamics itself that may spontaneously cause liquidity micro-crises. In fact, a decomposition of the volatility (made more precise in Section 4.1 below) into an impact component and a news component confirms this conclusion: most of the volatility seems to arise from trading itself, through the very impact of trades on prices.

Chart I Relaxation of the volatility



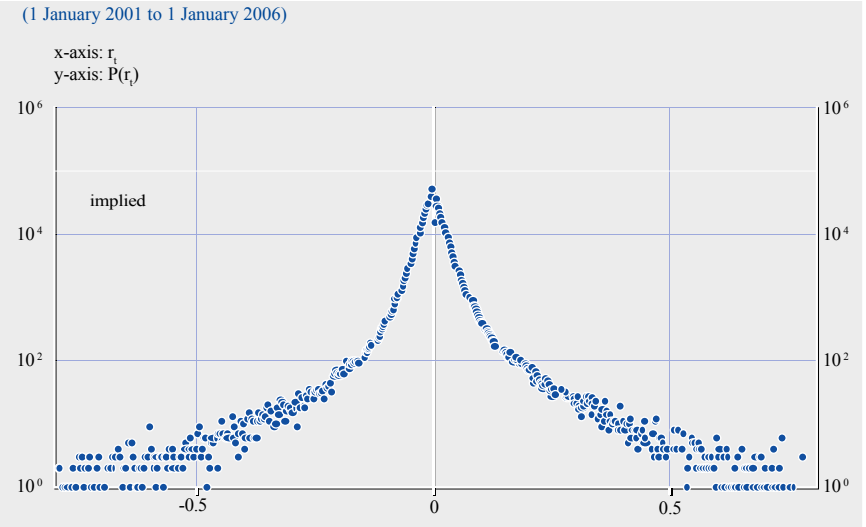
Source: From Joulin et al. (2006).

2.2 UNIVERSALLY INTERMITTENT DYNAMICS

Another striking observation that could be naturally accounted for if price movements do result from the endogenous dynamics of a complex system is the *universality* of many empirical stylised facts, such as the Pareto tail of the distribution of returns, or the intermittent, long-memory nature of the volatility. These features are observed across the board, on all traded liquid assets, and are quantitatively very similar. We show for example in Chart 2 the distribution of the relative daily changes of the 60-day implied volatility corresponding to the S&P100 stocks from 1 January 2001 to 1 January 2006 (Biely (2006)). There is no reason whatsoever to expect that the statistics of implied volatility returns should resemble that of price returns. The implied volatility represents the market consensus on the expected volatility of the stocks for the 60 days to come. But as Chart 2 illustrates, the distribution of implied volatility returns has the very same shape as that of any other traded asset, whatever its nature. In particular, the positive and negative tails of the distribution decay here as $|r|^{-4}$ – very much as the tails of the daily price returns of stocks. The Pareto exponent is always found to be in the same ballpark for any liquid asset (e.g. stocks, currencies, commodities, volatilities). This suggests again that these tails are not generated by strong exogenous shocks, but rather by the trading activity itself, more or less independently of the nature of the traded asset.

The activity and volatility of markets have a power-law correlation in time, reflecting their intermittent nature (see Chart 3): quiescent periods are intertwined with bursts of activity, on all time scales. Interestingly, many "complex" physical systems display very similar intermittent dynamics (Bouchaud (2009)):

Chart 2 Semi-log plot of the probability distribution of the daily returns r of the 60-day implied volatility corresponding to the S&P100 stocks

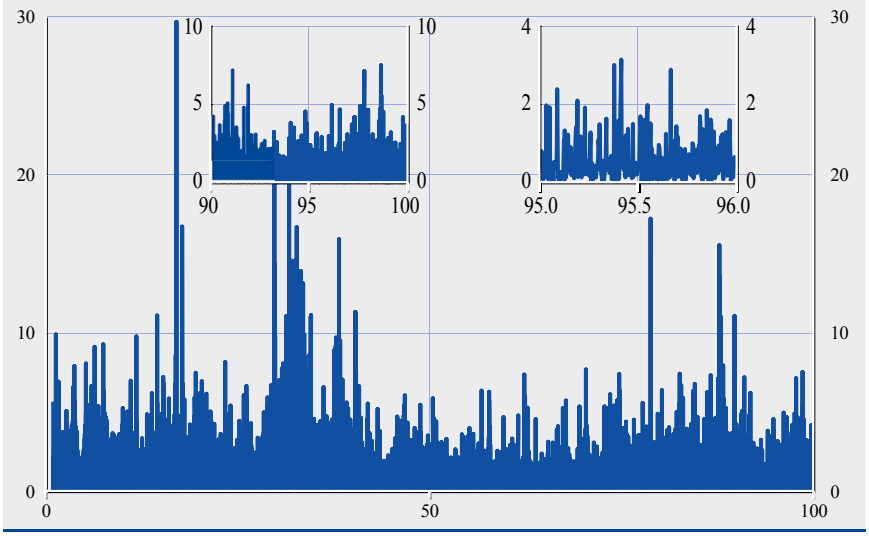


Note: The positive and negative tails of the distribution decay as $|r|^{-4}$, much as the distribution of the underlying stock returns.

earthquakes, solar eruptions, velocity fluctuations in turbulent flows (Frisch (1997)), avalanche dynamics in random magnets under a slowly varying external field (Sethna et al. (2001)), teetering progression of cracks in a slowly strained disordered material, etc. (Le Doussal et al. (2010), see also Krawiecki et al. (2002) and Cabrera and Milton (2002) for related papers). The crucial point about all these examples is that, while the exogenous driving force is regular and steady, the resulting endogenous dynamics are complex and jittery. These systems find a temporary equilibrium where activity is low, before reaching a tipping point where avalanches develop, until a new quasi-equilibrium is found – sometimes close to the previous one, sometimes very far. In financial markets, the flow of "real" news is of course needed to stir activity, but the scenario we favour is similar: it is the *response* of the market that creates turbulence, and not necessarily the cause, barring of course exceptional events that do sometimes severely disrupt markets (for example, Lehman's bankruptcy). As explained above, these events are, however, much too rare to explain why prices jump so frequently.

In all of the above physical examples, the non-trivial nature of the dynamics comes from collective effects: individual components have a relatively simple behaviour, but interactions lead to new, emergent phenomena. Since this intermittent behaviour appears to be generic for physical systems with both heterogeneities and interaction, it is tempting to think that the dynamics of financial markets, and more generally of economic systems, do reflect the same underlying mechanisms. We will come back to these ideas in the conclusion.

Chart 3 Absolute value of the daily price returns for the Dow Jones index over a century (1900-2000) and zoom on different scales (1990-2000 and 1995)



Source:
Notes: The volatility can remain high for a few years (like in the early 1930's) or for a few days. This volatility clustering can also be observed on high frequency (intra-day) data.

3 ARE MARKETS IN "EQUILIBRIUM"?

Recent access to UHF, tick-by-tick data allows one to investigate the microscopics of order flow and price formation. As we will explain below, the analysis of these data sets calls for a substantial revision of the traditional view of the Walrasian *tâtonnement* process, that in theory should allow prices to quickly settle to their equilibrium values.

3.1 TRADES ARE LONG-RANGED CORRELATED!

Each transaction can be given a sign $\varepsilon = \pm 1$ according to whether the trade took place at the ask, and was triggered by a buy market order, or at the bid, corresponding to a sell market order. Market orders cross the half-spread and are usually interpreted as resulting from agents possessing superior information that urge them to trade rapidly, at the expense of less-informed traders who place limit orders. Whether or not this interpretation is correct, it is an empirical fact that such market orders impact prices, in the sense that there is some clear correlation between the sign of a trade and the following price change. The impact function is a quantitative measure of this, and is defined as:

$$R(l) = \langle (p_{n+l} - p_n) \cdot \varepsilon_n \rangle_n \tag{1}$$

where p_n is the mid-point price immediately preceding the nth trade, and the average is taken over all trades, independently of their volume.

The efficient market story posits that each trade is motivated by a new piece of information, which quickly moves the price towards its new value. Since, by definition, the direction of the news is unpredictable, the resulting string of signs ε_n should have very short-range correlations in time. The surprising empirical result discovered by Bouchaud (2004) and Lillo and Farmer (2004) (see Bouchaud et al. (2009) for a review) is that the autocorrelation of the sign of trades is in fact very *long-range correlated*, over several days or maybe even months. The sign correlation function decays extremely slowly, as a power law:

$$C(l) \equiv \langle \varepsilon_{n+l} \cdot \varepsilon_n \rangle_n \propto l^{-\gamma}, \tag{2}$$

where the exponent γ is found to be around 0.5 for stocks and around 0.8 for futures. The fact that these binary strings have long memory (in the sense that $\gamma < 1$) turns out to have important technical consequences, discussed below. The long-memory nature of the sign process means that the order flow is highly predictable. Conditional on observing a buy trade now, one can predict with a rate of success a few percent above ½ that the sign of the 10,000th trade from now (corresponding to a few days of trading) will be again positive!

3.2 SCANT LIQUIDITY AND TRADE FRAGMENTATION

Where does such a persistent correlation come from? A crucial point is that even "highly liquid" markets are in fact not that liquid. Take for example a US large cap stock. Trading is extremely frequent: tens of thousands of trades per

day, adding up to a daily volume of roughly 0.1% of total market capitalisation. However, the volume of buy or sell limit orders typically available in the order book *at a given instant of time* is quite small: only of the order of 1% of the traded daily volume, i.e. 10^{-5} of the market cap for stocks. Of course, this number has an intra-day pattern and fluctuates in time, and it can reach much smaller values during liquidity crises.

The fact that the outstanding liquidity is so small has an immediate consequence: trades must be fragmented. It is not uncommon for investment funds to want to buy large fractions of a company, often several percent. If trading occurs through the continuous double auction market, the numbers above suggest that to buy 1% of a company requires at least the order of 1,000 individual trades. It is clear that these trades have to be diluted over several days, since otherwise the market would be completely destabilised, leading to unacceptable costs for an aggressive buyer. Thus, if an investment fund has some information about the future price of a stock, it cannot use it immediately, and has to trade into the market incrementally in order to avoid paying its own impact (Kyle (1985)). This fragmentation of orders clearly leads to long-range correlations in the sign of trades (see Bouchaud et al. (2009) and Wyart et al. (2008) for a more thorough discussion of the empirical evidence for this fragmentation interpretation, rather than a copy-cat mechanism, at least on long time scales). Trade fragmentation is a direct evidence that most investors are, to some degree, insensitive to price changes. Once the decision to buy has been made, the trade is completed even if the price moves up and down, at least within some bounds on the order of a few days or a few weeks of volatility. This is in line with the idea that the inherent uncertainty on the price is rather large.

3.3 MARKETS SLOWLY DIGEST NEW INFORMATION

From a conceptual point of view, the most important conclusion of this qualitative discussion is that prices are typically not in equilibrium, in the traditional Marshall sense. That is, the true price is very different than it would be if supply and demand were equal – as measured by the honest intent of the participants, as opposed to what they actually expose. As emphasised above, because of "stealth trading", the volume of individual trades is much smaller than the total demand or supply at the origin of the trades. This means that most of the putative information is necessarily latent, withheld by participants because of the small liquidity of the market. Information can only slowly be incorporated into prices (see Lyons (2001) for similar ideas). Markets are hide-and-seek games between "icebergs" of unobservable buyers and sellers that have to funnel through a very small liquidity drain. Prices cannot be instantaneously in equilibrium. At best, the notion of equilibrium prices can only make sense when coarse-grained over a long time scale, but then the flow of news, and the change of prices themselves, may alter the intention of buyers and sellers.

But why is liquidity, as measured by the number of standing limit orders, so meagre? Because "informed" traders that would use limit orders are reluctant to place large orders that would reveal their information. Liquidity providers who eke out a profit from the spread are also reluctant to place large limit orders that

put them at risk of being "picked-off" by an informed trader. Buyers and sellers face a paradoxical situation: both want to have their trading done as quickly as possible, but both try not to show their hands and reveal their intentions. As a result, markets operate in a regime of vanishing *revealed liquidity*, but large *latent liquidity*.

The long-range nature of the sign correlation however leads to a beautiful paradox. As we emphasised above, the sign of the order flow is highly predictable. Furthermore, each trade impacts the price in the direction of the trade. Why is it, then, that prices can remain statistically efficient in the sense that there is hardly any predictability in the sign of price changes? The resolution of this paradox requires a more detailed description of the impact of each trade and, in particular, the time dependence of this impact. This is what we address in the next section.

4 IMPACT AND RESILIENCE

We qualitatively discussed the origin of price impact in the introduction. Even at this microlevel, one is faced with the exogenous vs. endogenous debate about the origin of price changes. In the efficient market picture, as emphasised by Hasbrouck (2007), "orders do not *impact* prices. It is more accurate to say that orders *forecast* prices." However, if the market collectively believes that even a small fraction of trades contain true information, the price will, on average, be revised upwards after a buy and downwards after a sell. But while impact is a necessary mechanism for information to be reflected by prices, its very existence means that "information revelation" could merely be a self-fulfilling prophecy, which would occur even if the fraction of informed trades is in fact zero.

4.1 SOME EMPIRICAL FACTS ABOUT IMPACT

In any case, using high-frequency data, one can measure impact accurately. The average change of the mid-point between two successive transactions, conditioned to a buy trade or after a sell trade are found to be equal to within error bars:

$$E[p_{n+1} - p_n | \varepsilon_n = +1] \approx -E[p_{n+1} - p_n | \varepsilon_n = -1] = R(l = 1), \tag{3}$$

where we have used equation (1) for the definition of the *instantaneous impact*. Note that, in the definition above, we average over all trades, independently of their volume. It is well known that the dependence of impact on volume is very weak: it is more the trade itself, rather than its volume, that affects the price (Jones et al. (1996), Bouchaud et al. (2009)). This is often interpreted in terms of discretionary trading: large market orders are only submitted when there is a large prevailing volume at the best quote, a conditioning that mitigates the impact of these large orders.

One important empirical result is that the impact $R(\ell = 1)$ is proportional to the bid-ask spread S: $R(\ell = 1) \approx 0.3S$. This proportionality holds both for a

given stock over time, as the spread fluctuates, and across an ensemble of stocks with different average spreads. This law means that the market instantaneously updates the valuation of the asset almost to the last traded price (in which case one would find $R(\ell = 1) \approx S/2$).

What happens on longer time scales? A plot of $R(\ell)$ vs. ℓ reveals that the impact first grows with time by a factor two or so in the first 100 to 1,000 trades, before saturating or maybe even reverting back (Bouchaud et al. (2004)). However, the interpretation of this increase is not immediate since we know that the signs of trades are correlated: many trades in the same direction as the first trade will occur. From this point of view, it is even surprising that $R(\ell)$ does not grow more than a factor of two. This is related to the paradox mentioned above.

Another remarkable empirical finding is that the volatility per trade σ_1 is found to be proportional to the instantaneous impact, and therefore to the spread. In fact, one can regress the volatility per trade as a function of the impact, as:

$$\sigma_1^2 = AR_1^2 + J^2, \tag{4}$$

where $R_1 = R(\ell = 1)$ and $J^2$is the contribution of news-induced jumps, that should happen with very little trading. One then finds that the second contribution is very small compared with the first (see Wyart et al. (2008)). The relation between σ_1 and S is again true both for a single stock over time and across different stocks. A very simplified picture accounting for this finding is that the spread defines a "grid" over which the price moves with a random direction at every trade. Of course, the problem with this interpretation is that the long-ranged nature of the sign correlations should lead to super-diffusion, i.e. persistent trends in the price – we are back to the same paradox.

4.2 A SUBTLE DYNAMICAL EQUILIBRIUM

Let us assume that the price at trade time t can be decomposed as a sum over past impacts, in the following way:

$$p_t = p_{-\infty} + \sum_{t'=-\infty}^{t-1} G(t-t')\varepsilon_{t'} S_{t'} V_{t'}^{\psi} \tag{5}$$

where S_t is the spread at time t and Vt the volume of the trade at that instant. The exponent Ψ is found to be quite small (see Bouchaud et al. (2009) for a detailed discussion): as noted above, it is well documented that the response to the volume of a single trade is strongly concave. The most important quantity in the above equation is the function $G(\ell)$, that "propagates" the impact of the trade executed at time t' up to time t. In other words, G can be interpreted as the impact of a single trade, in contrast to R, which sums up the impact of correlated trades. Within the above model, the relation between the two quantities reads:

$$R(\ell) = K\Big[G(\ell) + \sum_{0<n<\ell} G(\ell - n)C(n) + \sum_{n>0} [G(\ell + n) - G(n)]C(n)\Big], \tag{6}$$

where K is a certain constant, and C is the correlation of the signs of the trades (see Bouchaud et al. (2004)). If impact was permanent, i.e. $G(\ell) = G_0$, the

long-range nature of the correlation of trades would lead to an ever growing $R(\ell)$, as $\ell^{1-\gamma}$ for $\gamma < 1$, i.e. for a long memory process. Whenever $\gamma > 1$, $R(\ell >> 1)$ saturates to a constant. This underlies the significance of the fact that empirically γ is found to be less than unity.

If, on the other hand, $G(\ell)$ decays as $\ell^{-\beta}$ with β exactly tuned to $(1 - \gamma)/2$, then the transient nature of the impact of single trades precisely offsets the long-range correlation of the sign of trades. This choice of β leads to both a saturating $R(\ell)$ and a diffusive price, for which returns are uncorrelated (Bouchaud et al. (2004)). The solution of our paradox is therefore that the market is resilient: after the immediate reaction to a trade, the impact slowly mean-reverts back to zero (but in the meantime, of course, new trades occur). Equation (6) above in fact allows one to determine the unknown function $G(\ell)$ from the empirical determination of $R(\ell)$ and $C(\ell)$, through matrix inversion (see Bouchaud et al. (2004) and Eisler et al. (2009)). One indeed sees that $G(\ell)$ decays as $\ell^{-\beta}$ for large ℓ.

The above model can be reformulated in terms of a surprise in the order flow. Since the order flow is highly correlated, the past history of trades allows one to make a prediction of the sign of the next trade, that we call $\hat{\varepsilon}_t$. Within a linear filter framework, this prediction can be expressed in terms of past realised signs:

$$\hat{\varepsilon}_t = \sum_{t'=-\infty}^{t-1} B(t-t')\, \varepsilon_{t'}, \tag{7}$$

where $B(\ell)$ are coefficients. If we forget the fluctuations of the product SV^{ψ}, it is easy to show that the above transient impact model can be exactly rewritten in terms of a permanent response to the surprise in the order flow, defined as $\varepsilon_t - \hat{\varepsilon}_t$:

$$p_t = p_{-\infty} + G(1) \sum_{t'=-\infty}^{t-1} [\varepsilon_{t'} - \hat{\varepsilon}_t], \tag{8}$$

provided that the following identification is made: $G(1)B(\ell) = G(\ell+1) - G(\ell)$ (see Gerig (2007) and Bouchaud et al. (2009)). If $B(\ell)$ corresponds to the best linear filter adapted to the long-ranged correlation in the εs, one easily recovers that $G(\ell)$ indeed decays as $\ell^{-\beta}$ with $\beta = (1-\gamma)/2$.

The above interpretation in terms of surprise is interesting because it provides a microscopic mechanism for the decay of the impact of single trades. Let us rephrase the above result in more intuitive terms. Call $\hat{\varepsilon}_t$ the probability that a buy follows a buy. The unconditional impact of a buy is $G(1)$ (see equation (8)). From the same equation, a second buy immediately following the first has a reduced impact, $G^+(1) < G(1)$, since now $\varepsilon = 2p_+ - 1 > 0$. A sell immediately following a buy, on the other hand, has an enhanced impact equal to $G^-(1) > G(1)$. If we want the next trade to lead to an unpredictable price change, its conditional average impact must be zero: $p_+ G^+(1) - (1-p_+)G^-(1) \equiv 0$, which indeed leads to $G^-(1) = \frac{p_+}{1-p_+} G^+(1) > G^+(1)$ when $p_+ > \frac{1}{2}$ (Gerig (2007)). This is the "asymmetric liquidity" effect explained in Lillo and Farmer (2004), Farmer et al. (2006) and Gerig (2007). This mechanism is expected to be present in general: because of the

positive correlation in order flow, the impact of a buy following a buy should be less than the impact of a sell following a sell – otherwise trends would build up.

Now, what are the mechanisms responsible for this asymmetric liquidity, and how can they fail (in which case markets cease to be efficient, and jumps appear)? One scenario is "stimulated refill": buy market orders trigger an opposing flow of sell limit orders, and vice versa (Bouchaud (2004)). This rising wall of limit orders decreases the probability of further upward moves of the price, which is equivalent to saying that $G^{+}(1) < G^{-}(1)$. This dynamical feedback between market orders and limit orders is therefore fundamental for the stability of markets and for enforcing efficiency. It can be tested directly on empirical data; for example Weber and Rosenow (2005) have found strong evidence for an increased limit order flow compensating market orders (see also Eisler et al. (2009) for similar results).

This stabilisation mechanism can be thought of as a dynamical version of the supply-demand equilibrium, in the following sense: incipient up-trends quickly dwindle because, as the ask moves up, market order buy pressure goes down while the limit order sell pressure increases (see also Handa et al. (1998)). Conversely, liquidity-induced mean-reversion – that keeps the price low – attracts more buyers, which, in turn, is an incentive for liquidity-providers to raise their price. Such a balance between liquidity-taking and liquidity-providing is at the origin of the subtle compensation between correlation and impact explained above. In fact, the relation between volatility and spread noted above is a direct manifestation of the very same competition between market orders and limit orders (Wyart et al. (2008)). Limit orders are only profitable if the spread is larger than the volatility, whereas market orders are profitable in the opposite case. A small spread attracts market orders, whereas a large spread attracts limit orders. In orderly market conditions, an equilibrium is reached, enforcing $\sigma_1 = cS$, where c is a numerical constant (Wyart et al. (2008)). But this tight relation can also lead to an instability: a local increase of volatility leads to an opening of the spread, itself feeding back on volatility. This mechanism might be at the heart of the frequent liquidity micro-crises observed in markets, and the associated no-news jumps reported above. The relation between volatility and spread means that there is a kind of "soft-mode": the market can operate at any value of the volatility, provided the spread is adapted (and vice versa). The absence of a restoring force pinning the volatility to a well-defined value is probably responsible for the observed long-memory property, and the slow relaxation of the volatility after a jump (see Chart 2).

4.3 THE PROBLEM WITH IMPACT

In conclusion, although "price impact" seems to convey the idea of a forceful and intuitive mechanism, the story behind it might not be that simple. Empirical studies show that the correlation between signed order flow and price changes is indeed strong, but the impact of trades is neither linear in volume nor permanent, as assumed in several models. Impact is rather found to be strongly concave in volume and transient (or history-dependent), the latter property being a necessary consequence of the long-memory nature of the order flow.

Coming back to Hasbrouck's comment, do trades *impact* prices or do they *forecast* future price changes? Since trading on modern electronic markets is anonymous, there cannot be any obvious difference between "informed" trades and "uninformed" trades. Hence, the impact of any trade must statistically be the same, whether informed or not informed. Impact is necessary for private information to be reflected in prices, but, by the same token, random fluctuations in order flow must necessarily contribute to the volatility of markets. As argued all along this paper, our belief is that the latter contribution is significant, if not dominant.

5 SUMMARY AND PERSPECTIVES

Let us reiterate the main points of this paper, which aimed at describing why and how asset prices move and identifying the building blocks of any quantitative model that claims to reproduce the dynamics of markets.

5.1 MARKETS ARE CLOSE TO A CRITICAL POINT

We have first made a strong case that the dynamics of markets is mostly endogenous, and determined by the trading activity itself. The arguments for this are:

- News play a minor role in market volatility; most jumps appear to be unrelated to news, but seem to appear spontaneously as a result of the market activity itself;

- The stylised facts of price statistics (fat-tails in the distribution of returns, long-memory of the volatility) are, to a large extent, universal and independent of the particular nature of the traded asset, and very reminiscent of endogenous noise in other complex systems (e.g. turbulence, Barkhausen noise, earthquakes, fractures). In all these examples, the intermittent, avalanche nature of the dynamics is an emergent property, unrelated to the exogenous drive, which is slow and regular.

In search of a purely endogenous interpretation of these effects, it is natural to investigate to high-frequency, micro-structure ingredients that generate price changes. We have discussed the remarkable long-range correlations in order flow that has far-reaching consequences and forces us to revise many preconceived ideas about equilibrium. First of all, these correlations reflect the fact that even "liquid" markets are in fact very illiquid, in the sense that the total volume in the order book available for an immediate transaction is extremely small (10^{-5} of the market capitalisation for stocks). The immediate consequence is that the trades of medium-to-large institutions can only be executed incrementally, explaining the observed correlation in the order flow. By the same token, the information motivating these trades (if any) cannot be instantaneously reflected by prices. Prices cannot be in equilibrium, but randomly evolve as the icebergs of latent supply and demand progressively reveal themselves (and possibly evolve with time). This feature is an unavoidable consequence of the fact that sellers and

buyers must hide their intentions, while liquidity-providers only post small volumes in fear of adverse selection.

The observation that markets operate in a regime of vanishing revealed liquidity, but large latent liquidity is crucial to understand their hyper-sensitivity to fluctuations, potentially leading to instabilities. Liquidity is necessarily a dynamical phenomenon that reacts to order flow in such a way as to dampen the trending effects and keep price returns unpredictable, through the subtle "tug-of-war" equilibrium mentioned above. Such a dynamical equilibrium can, however, easily break down. For example, an upward fluctuation in buy order flow might trigger a momentary panic, with the opposing side failing to respond immediately. Similarly, the strong structural link between spread and volatility can ignite a positive feedback loop, whereby increased spreads generate increased volatility, which itself causes liquidity-providers to cancel their orders and widen the spread. Natural fluctuations in the order flow therefore lead, in some cases, to a momentary lapse of liquidity, explaining the frequent occurrence of price jumps without news. An extreme incarnation of this feedback loop probably took place during the "flash crash" of 6 May 2010. We believe that the formal limit of zero liquidity is a critical point (Bak (1996)), which would naturally explain the analogy between the dynamics of markets and that of other complex systems, in particular the universal tails and the intermittent bursts of activity. We are, however, lacking a precise model that would allow one to formalise these ideas (see Challet et al. (2005) and Mike (2008) for work in that direction).

In summary, the picture of markets we advocate is such that the lion's share of high-frequency dynamics is due to fluctuations in order flow. News and information about fundamental values only play the role of "stirring" the system, i.e. slowly changing the large latent supply and demand, except on relatively rare occasions where these events do indeed lead to violent shocks. Most of the market activity comes from the slow execution of these large latent orders, which cascades into high-frequency fluctuations under the action of the use of liquidity-providers and liquidity-takers, who compete to exploit all statistical regularities.

The end-product of this activity is a white noise signal. Prices are, in a first approximation, statistically efficient in the sense that there is little predictability left in the time series. But this does not necessarily mean that these prices reflect in any way some true underlying information about assets. We believe, as Keynes and Black did, that the uncertainty in fundamental values is so large that there is no force to anchor the price against random high-frequency perturbations. It is quite remarkable indeed that the high-frequency value of the volatility approximately coincides with the volatility on the scale of weeks, showing that there is very little mean-reverting effects to rein the high-frequency tremor of markets. Only when prices reach values that are – say – a factor 2 away from their "fundamental value" will mean-reverting effects progressively come into play. In the context of stocks, this only happens on the scale of months to years (see de Bondt and Thaler (1985) and the discussion in Wyart & Bouchaud (2007)). From this point of view, as emphasised by Lyons (2001), "micro-structure implications may be long-lived" and "are relevant to macroeconomics".

5.2 LOOKING FORWARD

Having said all this, the theoretical situation is still rather disappointing. There is, at this stage, no convincing framework to account for these effects, in the sense of converting the above qualitative ideas into a quantitative model that would, for example, predict the shape of the tails of the return distribution, or the long-range memory of volatility after a suitable coarse-graining in time. Most available models to date (e.g. agent-based models (Lux and Marchesi (2000), Giardina and Bouchaud (2003), Goldstone and Janssen (2005)), Minority Games (Challet et al. (2005)), herding models (Cont and Bouchaud (2000)), Langevin approaches (Bouchaud and Cont (1998))) postulate a linear (in volume) and permanent impact as in the Kyle model (Kyle (1985)), whereas, as we have shown, impact is both non-linear and transient. It may well be that the assumption of a linear, permanent impact is justified after some coarse-graining in time, say on a daily scale, but this is actually part of the programme that needs to be achieved.

In the meantime, several strong messages emerge from the above remarks, that are particularly topical after the 2008 crisis:[5]

- Even liquid markets are not really liquid, and therefore have no reason to be efficient. One should stop taking market prices at face value, especially in many OTC markets where "liquidity" is deceptive. Quants should quit the obsession of exact calibration on market prices, in particular when the models are absurdly remote from reality. One of the worst examples, in the author's opinion, is the use of local volatility models (Dupire (1994)), that are by construction able to fit any volatility surface – so calibration will always work, and this is unfortunately why the approach is so popular. But sing this framework to price more exotic derivatives using plain vanilla instruments can lead to disaster, even if plain vanilla markets were efficient – because the underlying reality has nothing to do with a local volatility process. The situation is obviously even worse if markets are not efficient. Errors are propagated and amplified in a non-linear way, and the price and hedge of illiquid instruments can be totally nonsensical. There are many examples in the quantitative finance literature of erroneous models that can be easily calibrated, and that are therefore used and abused by financial engineers. The use of such models contributes to propagate systemic risk, specially as they become standard practice.

- Collective effects mediated by imitation or contagion pervade markets and lead to instabilities. Prosperity relies heavily on trust, which is an immaterial common good that has no inertia and can dissipate overnight (Anand et al. (2009)). The mechanisms that foster or destroy trust are intrinsically (or even tautologically) collective. The most efficient mechanism for contagion is through the dynamics of the price and of the order flow, which is public, common information. Since it is impossible to be immediately sure that a silly trade is indeed silly, its impact on the price

5 There are obviously many other aspects that we leave aside. The destabilising use of leverage is one of them (see Thurner et al. (2008) for a recent interesting paper).

can trigger an instability, as was likely the case during the flash crash of 6 May 2010. Being influenced by the behaviour of others seems to be one of the most common human traits that persists across history. We are always worried that others may be smarter, or may have more information than we do. This imitation propensity is well known to lead to dramatic effects (see, for example, Keynes (1936), Granovetter (1978), Brock and Durlauf (2001), Galam (2008), Curty and Marsili (2006), Michard and Bouchaud (2005), Borghesi and Bouchaud (2007), Gordon et al. (2009) and references therein), and must be one of the ingredients leading to crises and crashes (Akerlof and Shiller (2009)). The importance of hysteresis, in that respect, cannot be overemphasised – see Michard and Bouchaud (2005), Gordon et al. (2009), Bouchaud (2009) and Cross et al. (2009).

There are many other contagion mechanisms – we just mentioned the use of similar pricing and risk models. More generally, common strategies lead to common positions (see, for example, the quant crunch of August 2007 (Khandani and Lo (2009)), and so does the widespread diffusion of similar "toxic" products (e.g. CDOs). Benchmarking performance to the average of a peer group promotes copy-cat behaviour. The cross-liability network between financial institutions or between companies can also be instrumental in wreaking havoc (see, for example, Battiston et al. (2009), Neu and Kühn (2004) and Choi and Douady (2009)).

- Another important idea is that agents in financial markets are strongly heterogeneous. Physical systems where individual elements are both heterogeneous and strongly interacting are well known to be inherently fragile to small perturbations. These systems generically evolve in an intermittent way, with a succession of rather stable epochs punctuated by rapid, unpredictable changes – again, even when the exogenous drive is smooth and steady. Within this metaphor of markets, competition and complexity could be the essential cause of their endogenous instability.

  The main problem with the current theories is that they are based on the idea that we can replace an ensemble of heterogeneous and interacting agents by a unique representative one, in other words that the micro- and macro-behaviour should coincide (Kirman (1992)). Within this framework, crises are expected to require a major external shock, whereas in reality small local disturbances can trigger large systemic effects (the US sub-prime market represented in itself only a minor fraction of the global credit market, but still stoked a global crisis).

- Finally, there are a number of explicit destabilising feedback loops that regulators should investigate and abate. Some are a direct consequence of the faith in the efficiency of markets, such as the "mark-to-market" accounting rule, which relies on the idea that market prices are fair and unbiased. Such a pro-cyclical practice applied on credit derivatives has contributed to impair the balance sheet of many financial institutions in 2008, and amplified the mayhem. In our opinion, again, the "fair price" idea does not make sense without at least the notion of an intrinsic uncertainty

and a liquidity discount based on a pessimistic estimate of the impact cost during a fire-sale. Other feedback loops are created by the use of financial derivatives (see Marsili (2008) and Brock et al. (2009)) and/or, as alluded to above, by quantitative models themselves – a vivid example is the crash of 1987 that was a direct consequence of the unwarranted trust in Black-Scholes' perfect replication theory.

There are also nasty feedback loops lurking in the high frequency, micro-structure side. We have mentioned several times in this paper the spread → volatility → spread loop that is probably at the origin of most "spontaneous" liquidity crises (such as the one of 6 May 2010, but also all the daily jumps that we discussed but that rarely make the news). It would be interesting to investigate mechanisms that help averting those. For example, dynamic make/take fees that depend on market conditions and on the distance between the placed order and the last traded price could endogenise stabilising feedback loops. This is clearly an issue around which academic research and regulation merge, which makes modelling high-frequency so exciting.

Whether or not the above ingredients can be mixed with agent-based models to provide a truly quantitative theory of economic and financial crises remains of course, at this stage, a fascinating open problem.

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PANEL STATEMENT

WHAT SHORTCOMINGS IN MACROECONOMIC THEORY AND MODELLING HAVE BEEN REVEALED BY THE FINANCIAL CRISIS AND HOW SHOULD THEY BE ADDRESSED IN THE FUTURE?

BY MARTIN EICHENBAUM, NORTHWESTERN UNIVERSITY AND NBER

This panel session is a wonderful opportunity to think about the lessons for researchers that have emerged from the recent economic crisis. I will organise my comments around three points. First, the key modelling and policy issues associated with the recent crisis were crystallised thirty years ago in two papers: Kareken and Wallace (1978) and Diamond and Dybvig (1983). So whatever else may be true about the shortcomings of modern macroeconomic theory, the notion that it has little to say about the crisis is just wrong. Second, there are both good and bad reasons why mainstream pre-2008 dynamic stochastic general equilibrium (DSGE) models did not place much emphasis on financial market frictions. Third, significant further progress in understanding key financial market puzzles will involve making progress in modelling heterogeneity in beliefs and persistent disagreement between agents.

Macroeconomists have long thought about financial crises. As Sargent (2010) argues, it is useful to centre these thoughts around the models in Diamond and Dybvig (1983) and Kareken and Wallace (1978). The key policy question addressed in those papers is: "what do government lender-of-last-resort and deposit insurance programmes do to stop or promote financial market crises?"

Sargent (2010) calls these models polar, because in Diamond and Dybvig's model (the DD model) deposit insurance programmes have purely beneficial effects, whereas in Kareken and Wallace's model (the KW model) the same programmes have purely negative effects. These differences reflect the different causes of financial market instability in the two models. In the DD model, instability of financial markets arises from a temporal mismatch between financial intermediaries' assets and liabilities. In the KW model, instability arises from mispriced government deposit insurance and the implied distortions in banks' portfolios.

Consider first the DD analysis. In this model banks perform the function of maturity and liquidity transformation, which improves social efficiency. Banks' activities enable depositors to make long-term investments even though they hold liabilities that are short-term in duration. Through these activities banks facilitate risk-sharing among people with uncertain future liquidity needs.

A potential problem with the arrangement is that for long-term investments to come to fruition and for the premature liquidation of banks' long-term investments to be avoided, enough patient depositors must leave their funds in banks. Without deposit insurance, even patient depositors may want to withdraw their funds early, causing banks to prematurely liquidate long-term investments.

In particular, bank runs can be triggered by patient depositors' private incentives to withdraw early if they think that other patient investors are choosing to withdraw their deposits early. Formally, there exist multiple Nash equilibria, some good and some bad in terms of welfare. The equilibria in which bank runs do not occur correspond to good social outcomes, while the equilibria in which runs do occur correspond to bad social outcomes.

The good news is that in the DD model there is a "simple" solution to bank runs: government-supplied deposit insurance. Even better news is that publicly provided insurance is virtually without cost to the government because in equilibrium there aren't any bank runs.

There is nothing special about commercial banks, either in the DD analysis or in reality. The DD analysis applies to *any* institution that is in the business of liquidity and maturity transformation. Just substitute the phrase rollover risk for bank-run risk and go from there. In 2008, there were all sorts of institutions that were really banks in the DD sense but which did not have access to explicit deposit insurance. These entities, otherwise known as the shadow banking system, were the key players in the recent crisis.

Sargent (2010) points out that we can use the DD framework to provide a sympathetic interpretation of policy-makers' response to the financial crisis. Policy-makers looked out their windows in the early autumn of 2008 and saw DD bank runs all over the place. From this perspective, the correct response was to stop the runs at the earliest stage possible by convincing creditors that their short-term loans and deposits were effectively insured. Accordingly, policy-makers in the United States and Europe provided new short-term loans that markets weren't willing to supply and effectively guaranteed the assets of shadow banks' creditors. In this way, policy saved fundamentally good institutions and minimised the damage to the economy from the outbreak of bank runs. As in the DD model, the icing on the cake was that the "rescue" could be accomplished at little or no eventual cost to the taxpayers.

The KW framework provides a competing and darker vision of recent events. Instability of banks in the KW model arises from mispriced government deposit insurance and the implied distortions in banks' portfolios. To make this point in as stark a manner as possible, KW suppose there are complete markets and that some people want to hold risk-free deposits. Without deposit insurance, depositors who want risk-free deposits must hold them in banks that hold risk-free portfolios. Naturally such banks emerge in equilibrium. But suppose that there is deposit insurance that is either free or is priced too cheaply. Then it is privately optimal for banks to become as risky and as large as possible. With positive probability, banks will fail and taxpayers will have to compensate banks' depositors.

The critical policy lesson is that if the government sets up deposit insurance and doesn't regulate bank portfolios, then it is setting the stage for a financial crisis. Similarly, if the government deregulates financial institutions, it must first reform deposit insurance to prevent sewing the seeds of a crisis. The US policy-makers

of the 1970s chose to not heed KW's advice. The resulting harvest yielded the Savings and Loan crisis of the 1980s.

The lesson for our time is clear. Any institution that knows it is too big or too complex to fail has an incentive to take on high degrees of risk. Claiming that these institutions won't be bailed out isn't credible because it is not time-consistent. After the fact it is just too costly to let the shadow banking system collapse and induce a huge recession. Straightforward KW logic shows that such institutions have to be regulated.

So here we have a darker view of the recent crisis. The United States deregulated financial markets in the 1970s and 1980s. Policy-makers failed to effectively regulate financial firms and did not credibly commit to letting shadow bank creditors suffer heavy losses. These firms took highly leveraged, risky positions, helping to ignite a huge run-up in housing prices. Once real estate markets peaked, many important players in the shadow banking system became insolvent. Policy-makers caved in to the time-consistency problem and effectively bailed out their creditors. So the class of 2008 policy-makers had to pay for the sins of their predecessors, who failed in their regulatory duties.

In sum we have two competing visions of the origin of the recent crisis and the appropriate policy response. The KW analysis instructs policy-makers to be very cautious about lender-of-last-resort facilities and very sensitive to the risk-taking activities of banks. The DD analysis prescribes that policy-makers should be sensitive to the possibility of runs on the financial system and the need for mechanisms to stop runs.

No doubt there is some truth to both visions. In real time policy-makers had to place their bets on which of the visions was more important. It's clear that during the crisis they put their chips on the DD analysis. At the same time they promised to pursue financial regulation in the future. Many of us are waiting for a meaningful delivery on that promise.

Looking forward, macroeconomists face two key tasks. First, we need to assess the quantitative importance of the risks stressed in the DD and KW visions. Second, we need to help design institutional reforms for minimising both sets of risks while allowing the financial system to perform its socially beneficial functions.

Now that the word quantitative has been mentioned, it seems fair to ask: "where were the DSGE models during the 2008 crisis and its immediate aftermath?"

Few DSGE models placed financial market frictions at the centre of their analyses prior to the crisis. Important exceptions to this pattern can be found in models by Bernanke, Gertler and Gilchrist (1999) and Christiano, Motto and Rostagno (2009). But, while useful, these models have risk residing directly in real returns at the level of goods-producing firms. Our recent problems originated in the financial system, not so much in the riskiness of production itself.

Since the crisis, there has been a burst of good work incorporating financial market frictions into DSGE models. But there are still very few DSGE models in which shocks originate from within the financial system, rather than the production sector. Moreover, all of the DSGE models that I'm familiar with rely on exogenous shocks to an entity's net worth. Such models can certainly be used to assess how policy should respond to shocks. But we need richer models that let us assess the efficacy of alternative regulations that make "shocks" less likely and less intense.

We've certainly known for a long time that financial frictions could act as important propagation mechanisms to shocks. So why didn't DSGE modellers place more emphasis on those frictions? In practice we have to work with simplified models. So we have to make choices about which frictions to emphasise. One good reason not to have emphasised financial frictions in DSGE models is that until the recent episode, post-war recessions in the United States and western Europe did not seem closely tied to disturbances in financial markets. True, there was the Savings and Loan crisis. But it was a localised affair that did not develop into anything like the "Great Recession". Similarly, the stock market meltdown in the late 1980s only had minor effects on aggregate economic activity. So, guided by the post-war data from the United States and western Europe, modellers emphasised other non-financial-market frictions when considering economic fluctuations.

There was also a bad reason why DSGE modellers did not emphasise financial market frictions: we focused too narrowly on post-war US and western European data. Even if we leave pre-war history aside, the post-war era has been marked by numerous currency crises. Many of these crises, especially in the post-1980 period, amounted to twin banking/currency crises. Moreover, many of the policy debates, especially those surrounding the collapse of fixed exchange rate regimes in South-East Asia, closely paralleled the DD and KW debate.

The crisis countries in South-East Asia were not running large deficits or suffering from any standard problems that would lead to an exchange rate crisis. So-called "second-generation" models explain these currency crisis episodes as self-fulfilling expectation crises that were essentially DD bank runs (see Burnside, Eichenbaum and Rebelo (2008) for a review of alternative currency crisis models). In contrast, "third-generation" models emphasise the importance of implicit or explicit government guarantees to banks' foreign creditors under fixed exchange rate regimes. Burnside, Eichenbaum and Rebelo (2001a, 2004) argue that, in the presence of such guarantees, it is optimal for banks to expose themselves to exchange rate risk and declare bankruptcy if a devaluation occurs. But a devaluation transforms potential government liabilities into actual liabilities. So government guarantees create the possibility of self-fulfilling currency crises.

As in the KW model, fundamentals, in the form of government guarantees, determine whether a twin banking/currency crisis will occur. But, as in the DD model, the precise timing of the crisis is a multiple equilibrium phenomenon.

So third-generation currency crisis models build on key features of the two polar models of financial instability.

Now, all models have to take *some* institutional frameworks as given. While flaws in our institutions can have intense effects, these effects occur at irregular, infrequent intervals. We can be blindsided if we focus on relatively short time series from broadly similar countries. The time series are not sufficiently informative to easily detect low-frequency fault lines in our institutions. Economic history and data from countries less similar to our own can be highly informative in helping to detect those fault lines.

I leave it to the economic historians to chastise macroeconomists for ignoring their work. I will chastise mainstream macroeconomists for not paying more attention to the post-war experiences of emerging markets. The currency crises of the late 1990s should have been the canary in the coal mine of financial deregulation. They weren't, and we paid a heavy price.

Does this failure imply that there is an alternative to DSGE models? Of course not. Central banks work on a decision cycle of a few months. Quantitative models are crucial for organising discussions of the state of the economy and quantifying the likely effects of alternative policy actions. For these purposes, there are simply no coherent alternatives to estimated DSGE models.

Exactly which features should we embed in future DSGE models? Future clever theorists will come up with clever theories highlighting all sorts of possibilities. Some of these possibilities may even contain a grain of truth. But we need some way of assessing their quantitative importance for aggregate economic activity. The *only* way to do this is to incorporate the proposed frictions into DSGE models.

The trick will be to estimate and evaluate evolving DSGE models using cross-country evidence, and not rely solely on time series methods using data over short periods for similar countries. How to do this in a systematic way poses an interesting challenge. I suspect that Bayesian approaches will be particularly useful in this regard.

From a broader perspective, macroeconomists face an even larger challenge. Researchers and policy-makers obviously have long-lasting, persistent disagreements about fundamental issues. Thirty years on and we're *still* debating the relative merits of the KW and DD models. This disagreement is not just a matter of academic interest. When the policy-makers of the ECB convene to discuss the ongoing sovereign debt crises, differences of opinion will revolve around different answers to the following types of questions:

Are Ireland, Greece, Portugal and Spain's debt problems primarily contagion phenomena or are we just seeing fundamentals work their way out?

How important is the moral hazard problem of "bailing out" a fellow Member State?

What is an analogue of "regulation" in a monetary union of sovereign states?

Clearly differences of opinion matter and are persistent. While it is easy to generate disagreement on fundamental matters in a conference of economists or policy-makers, it is remarkably hard to generate persistent disagreements between the agents in our models. I don't think we'll have convincing theories of asset prices and financial markets until we have convincing models of disagreement.

Nobody disagrees about the odds of drawing four aces from a deck of cards. But there is substantial scope for belief heterogeneity when historical evidence is at best a weak guide. For many questions this situation is the one we face. The data just aren't there to provide compelling evidence about the effects of low-frequency changes in fundamentals such as regulations, the incentive effects of a monetary union on member country deficits, or the effects of changes in productivity growth rates on asset prices. Under these circumstances, heterogeneity in beliefs can evolve over prolonged periods of time with important consequences for market outcomes. See for example Burnside, Eichenbaum and Rebelo (2011) who analyse booms and busts in housing prices in models where agents have persistent disagreements about housing fundamentals.

Confronting the existence of persistent disagreements can push us outside the formal rational expectations framework, but in such a way that the richness or weakness of historical data remains informative. This research strategy is in its infancy but is highly promising. See Hansen (2007) and Sargent (2008) for a review of the literature.

Let me conclude with the following observation for policy-makers. Many of you were truly shocked to discover that staff models didn't account for some key features of the crisis. And you were certainly frustrated that the science of macroeconomics hasn't quite caught up with the art of macroeconomics. Before venting your frustration on the staff, remember the sage advice of the noted American decision theorist Don Rumsfeld: the art of policy-making involves constantly being on the alert for the unknown unknowns that we don't know we don't know.

In a crisis, the staff can help. State-of-the-art models can help. Even 75-year-old books providing general theories of employment, interest and money can help. But a wise policymaker in the throes of a crisis will never focus on only one feather in his quill. And he will never be surprised to be surprised.

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PANEL STATEMENT

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ENDOGENOUS LEVERAGE AND DEFAULT

I INTRODUCTION

In my view the fundamental missing ingredients in quantifiable macro models used by the Federal Reserve and the ECB are endogenous default and endogenous lending terms distinct from the interest rate. The models do not recognise that changes in the perception of potential defaults can radically alter lending conditions and therefore economic activity. This failure has prevented policy-makers from recognising asset bubbles, from understanding the source of debt crashes and from accurately gauging the severity and duration of their aftermath. It led to policy errors in ignoring the dangerous build-up of debt before this last crisis and to further policy errors after the crisis in not acting to restructure unpayable debts. In short, it has led to a faulty understanding of the nature of the debtor-creditor relationship and its impact on the macroeconomy.

For a long time now, maybe since Irving Fisher, we have come to believe that managing interest rates is the way to regulate lending and borrowing in the macroeconomy. Whenever anything goes wrong, people say "change the interest rate". Similarly, we have developed a phobia about forgiving debt. My view is that neither of these prejudices can be unambiguously derived from a proper general equilibrium model with endogenous default and lending. Collateral rates or leverage can be more important to economic activity and prices than interest rates, and more important to manage. And the only expeditious way out of a severe leverage cycle crash is to move quickly in writing down debts. The fact that we do not presently know how to compute the optimal leverage ratios, or the optimal amount of debt forgiveness, is not an argument against taking such actions, but rather further proof that we have been developing the wrong models.

The nature of promises and debt has been a preoccupation of philosophers for thousands of years. Keeping promises was Plato's first proposed definition of justice in the Republic (it was shown not to be always just). Nietzsche, in the "Genealogy of Morals", says the emergence of Conscience came from the repeated punishing of people who failed to honour their debts and the subsequent internalisation of that punishment. (Thus "schuld" is the root of the German word for debt and also for one version of Conscience.) The subtlest literary analysis of keeping promises can be found in Shakespeare's "Merchant of Venice".

The plot of the "Merchant of Venice" centres around the contract negotiated by Antonio to borrow money from Shylock to finance his friend Bassanio's courtship of the beautiful and rich Portia. In the central scene in the play, Antonio and

Shylock argue over the rate of interest on the loan. But Shakespeare understood the primary importance of collateral. How many of you can remember the interest rate Shylock charged Antonio and Bassanio? Yet, all of you remember the collateral agreed on in the contract – the pound of flesh. Obviously, Shakespeare thought the collateral was more important. When all the boats apparently sink and Antonio is unable to repay the loan, the Court alters the collateral, saying it should be a pound of flesh, but not a drop of blood.

The theme of borrowing and default is repeated several times in the play with the story of the rings. Portia and her assistant lend Bassanio and his assistant their rings in exchange for the promise that they will never be taken off their fingers. Shylock has earlier made it clear that he would never break his promise about the ring his wife Leah gave him. Yet when faced with an urgent need, Bassanio and his assistant do give up their rings, and they expect forgiveness. "To do a great right, do a little wrong" is Bassanio's philosophy. Or as Portia describes forgiveness of debts, "The quality of mercy is not strain'd, ...It blesseth him that gives and him that takes."

Following Shakespeare's lead, I discuss models of collateral and debt forgiveness (or punishment for default). In the next section I argue for the necessity of collateral and leverage in macro models. I point out that, at present, leverage is absent from those models, even if lip service is paid to it now. I illustrate my view by describing the kinds of effects I have obtained in my models of leverage that cannot be reproduced by the more carefully calibrated macro models that guide central bank action. Next, I show that only by taking collateral seriously can one properly assess the effect on asset prices of new derivatives like credit default swaps. Finally, I talk about the optimal punishment for default and the current deplorable conditions of debt overhang that much of the world finds itself in.

2 LEVERAGE AND ASSET PRICING

Just as with Shakespeare's Court, I believe today that the regulatory authority ought to be managing collateral rates in addition to interest rates. I have worked on the leverage cycle, as I call it, for over ten years – not quite as long as Shakespeare and with somewhat less attention than Shakespeare received. My oldest published papers on the subject are "Promises, Promises" in 1997, about collateral general equilibrium, "Liquidity Default and Crashes" in 2003, about the leverage cycle, and "Leverage Cycles and the Anxious Economy" in 2008 with Ana Fostel, about the spread of leverage cycles across markets. In those papers I showed that when leverage is high, asset prices tend to rise, and when leverage declines, asset prices fall, sometimes in a violent crash.

There have been other early papers on collateral. In fact, Ben Bernanke was one of the pioneers in emphasising collateral. However, he did not really write very much about leverage or changes in leverage. Instead he emphasised that when collateral goes down in value, the amount that can be borrowed goes down (as would be the case with a constant loan-to-value lending rule). What I emphasised is that the loan-to-value can change dramatically and it is the rapid

change in loan-to-value that is a crucial source of crashes. And as I shall argue, loan-to-value is a variable that can be regulated.

The modern calibrated macro models that pay any attention to collateral, such as those presented by Christiano at the American Federal Reserve meetings in Jackson Hole last August (Christiano et al. (2010)) and by Smets at this ECB conference in Frankfurt (Fahr et al. (2010)), derive from the foundational work of Bernanke, Gertler and Gilchrist, and Kiyotaki and Moore. In that foundational work, leverage is barely mentioned and changes in leverage play no significant role. In Kiyotaki and Moore, for example, leverage actually rises after a bad shock, dampening any crisis. In the papers of Christiano and Smets, leverage is duly noted, though it is not clearly distinguished from credit, but again it does not play a central role. Both those models suggest the possibility of calibrating what happened in the current crisis. In the Smets paper, mysterious shocks started the crisis. No effort is made to identify what the shocks are or what they correspond to in reality; their existence is inferred from the fact that we had a crisis. Not even their properties are identified. In the leverage story I told in 2003 (and which is also told in Brunnermeier and Pedersen (2009)), it is crucial that the shocks are not only negative, but that they increase in volatility, as they did in reality. Moreover, I identify the first shocks as increases in mortgage delinquencies. In the Smets paper, there is no reason why his shocks should cause leverage to decrease rather than increase. In Christiano, the shocks are explicitly identified as changes in future productivity. But again there is no reason why such shocks should lower leverage. It is quite clear that in these models, leverage is not needed and changes in leverage do not play a vital role.

The foundational work of Bernanke, Gertler and Gilchrist, Kiyotaki and Moore, and Holmstrom and Tirole is about credit cycles, not leverage cycles. In those papers, a drop in asset values or the wealth of entrepreneurs makes it more difficult to borrow, which in turn hampers productivity, which then lowers asset values, making it harder to borrow and so on. Their story is about levels of credit, not ratios. It could be told as if the ratio of loans to asset values were constant. The leverage cycle differs from the credit cycle insofar as it is about ratios of credit to asset values. In my view it is these ratios which played the crucial dynamic role.

What I mean by leverage is loan-to-value on *new* loans. If the loan-to-value is 80%, USD 20 down gets you a USD 100 house. The leverage is five because your cash downpayment of USD 20 has been multiplied by five in the USD 100 value of the asset. Loan-to-value and leverage describe the same thing. But let me emphasise it is on new loans. Debt-to-equity is essentially loan-to-value on old loans. Debt-to-equity is also an important ratio, but different from what I mean by leverage. And the two ratios often go in different directions. Historically, debt-to-equity typically increases for two or three years after a crisis and then starts a long slow decline stretching over years. But leverage on new loans drops abruptly *before* a crash. It is a cause, not a lagging result. How well things are going in the economy usually depends more on the leverage on new loans, not on what is happening to old loans, which often goes in the opposite direction. Of course, as we shall see, the duration of a crisis depends critically on the debt overhang, that is on the loan-to-value on old loans.

The point of my equilibrium theory of leverage is that supply and demand determine not just the interest rate, but leverage as well. Supply equals demand for a loan is apparently just one equation, which gives rise to a puzzle. How can one equation determine two variables: interest and leverage? That is part of the reason why leverage has received so little attention in economics. It is just awkward for economic theory. That is why, as an economic theorist, I began to think about the subject. I wanted an equilibrium theory of what influences leverage and what role leverage plays in the economy.

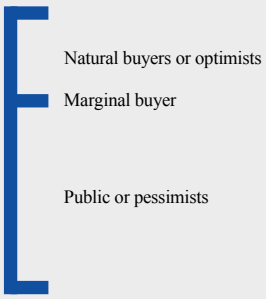
In my theory, supply and demand do determine both the interest rate and leverage. (The trick is that there is more than one supply equals demand equation, but I do not have time to discuss that here). What ends up influencing the interest rate in equilibrium is impatience; what influences leverage in equilibrium is volatility in the short run and, in the long run, innovation (because the economy is always looking for innovative ways to stretch scarce collateral).

Why are people now saying leverage is important? Every trader knows, if you are leveraged five to one and the asset goes up or down 1%, your wealth goes up or down 5%. You are more sensitive to changes. And the second thing they say is that since collateralised loans often turn out to be no recourse loans, people can walk away from their debts. "If we had only had limited leverage, these banks would not have lost so much money when prices started to go down. And homeowners would not be walking away from their homes."

Of course, I believe those two things are very important and they play a crucial role in my theory. But there was a third aspect of leverage in my theory which I think is far more important. The real significance of leverage is that it allows fewer people to buy more assets and therefore raises the price of assets. Leverage causes bubbles.

In the leverage cycle, periods of high leverage produce higher asset prices, while periods of low leverage produce lower asset prices, provided there is no short selling. In Chart 1 below, you can see why that is. Imagine a continuum of people from top to bottom, who have different views about the value of assets. The people at the top think the assets are worth a lot. The people at the bottom do

Chart 1 Marginal buyer theory of price



not think they are worth very much. This heterogeneity is of crucial importance. Whatever the price is, there are going to be people at the top who think the price is cheap and they will be the buyers. The people lower down are going to think the price is too much and they will be sellers. The guy who thinks the price is just right, his valuation is equal to the price. You might say his valuation is determining the price.

When leverage goes up, the people at the top can borrow more. Fewer of them are required to hold all the assets, so the marginal buyer goes up and the price rises, not because there is any fundamental change in the economy, but because the marginal buyer is someone who has a higher opinion of the value of the asset. More leverage causes higher asset prices because it changes the marginal buyer. Most of modern finance basically assumes this heterogeneity away. I am not aware of a single finance or macro textbook that mentions endogenous leverage and its effect on asset pricing.

There are many reasons why, in reality, agents have heterogeneous valuations of assets. For example, there are real differences in risk tolerance – risk-averse people value the assets less, even with the same information. There are also real differences in how people can use assets for production. There are also differences in utility from owning assets, like living in a house, for example. And some people maybe are just more optimistic about the assets than others.

3 THE LEVERAGE CYCLE IN THEORY

Over the leverage cycle, leverage gradually rises, as I said earlier, because of technological innovation stretching the available collateral and because volatility is low. After a big, bad shock that increases volatility, leverage abruptly plummets. The fall in asset prices can be much bigger than anybody thinks is justified by the news alone because it is coupled with a crash in leverage and the bankruptcy of the most optimistic buyers. There is too much leverage in normal times and therefore too-high asset prices, and too little leverage in bad times and therefore too-low asset prices.

Leverage cycle crashes always happen in exactly the same way. First, there is a period in which leverage becomes very high and the assets are concentrated in the hands of the natural buyers (optimists for short) who have borrowed large sums of money to get them, setting the stage for the crisis. Then there is bad news that causes asset prices to fall because every investor values the assets less. This price fall forces the leveraged natural buyers or optimists to sell assets to meet their margin calls, thus realising their losses. In Chart 2 below, I assume they all go bankrupt. Their departure causes asset prices to fall more because the assets fall into less optimistic hands. If the bad news is “scary”, then lenders demand more collateral. This means that the remaining less ebullient optimists each buy less, requiring more of them to hold all the assets. The new marginal buyer must be much further down the continuum and so much more pessimistic, and prices drop even further, reflecting the opinion of the lower marginal buyer.

Chart 2 Leverage cycle theory of crashes

Now what is "scary bad news"? It is not just bad news, but it is the kind that creates more uncertainty, more volatility. You are at an airport and they say the plane is going to be ten minutes late. That is bad, but ten minutes is really nothing. However, once you hear it is ten minutes late, you think, "My gosh, maybe it is going to be an hour late." That could be really bad.

It is the *uncertainty* the news creates that is critical, not how bad it is. Another example is subprime delinquencies going from 2% to 5% in January 2007. 5% is not catastrophic. However, once it has reached 5% and broken the old pattern, investors think maybe it will go to 30% or 40%. That is what causes people to get nervous. When the lenders get nervous, they ask for more collateral and they force deleveraging. That is the beginning of the crisis.

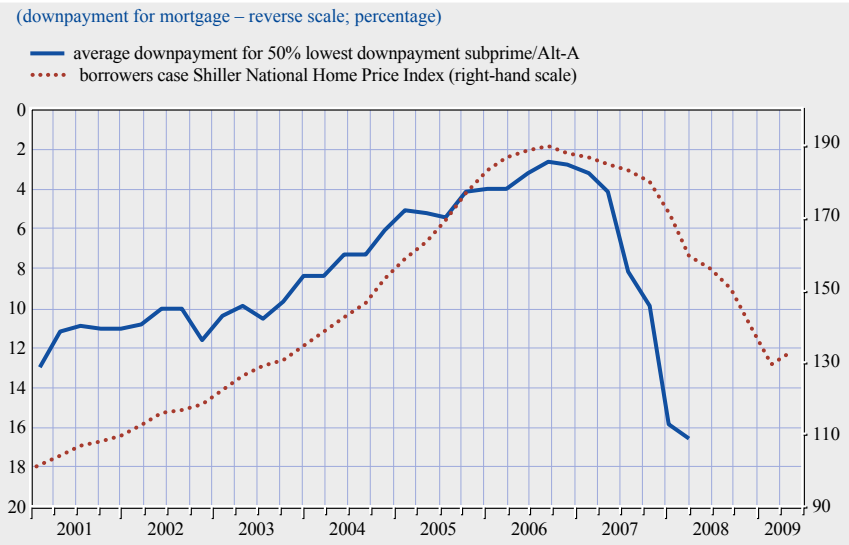
The leverage cycle would occur even with completely rational agents; it gets much worse with irrationality. For example, if, in the boom, irrational lenders thought prices could only go up, leverage would get absurdly high, or if, as bad times approached, panicked investors sold everything, prices would fall much faster.

4 LEVERAGE CYCLES IN HISTORY

I believe our financial history is full of recurring leverage cycles, during which leverage gradually builds up, creating a huge asset bubble, and then leverage and asset prices suddenly come crashing down. That is what happened in the Tulip mania of 1637 in Holland, in the great Florida land boom and bust just before the Great Depression, in the 1980s land bubble in Japan, in the Asian crisis of 1998 and in the subprime crisis of 2007-09. Of course, the data on historical collateral rates is spotty and needs assembling. There is a lot more work that could be done about this. We need to develop macro models that could calibrate the waste in the overbuilding that inevitably takes place in the ebullient stage when asset prices are too high and, even more importantly, that could calibrate the loss from the crisis stage and its aftermath.

The current crisis, I believe, is a clear example of a leverage cycle crash after a long leverage boom. And for this we do have some data. In Chart 3 below,

Chart 3 Housing leverage cycle: margins offered (downpayments required) and housing



Notes: Observe that the downpayment axis has been reversed, because lower downpayment requirements are correlated with higher home prices. For every Alt-A or subprime first loan originated from the first quarter of 2000 to the first quarter of 2008, the downpayment percentage was calculated as appraised value (or sale price if available) minus total mortgage debt, divided by appraised value. For each quarter, the downpayment percentages were ranked from highest to lowest, and the average of the bottom half of the list is shown in the chart. This number is an indicator of the downpayment required: clearly, many homeowners put down more than they had to, and that is why the top half is dropped from the average. A 13% downpayment in the first quarter of 2000 corresponds to leverage of about 7.7, and a 2.7% downpayment in the second quarter of 2006 corresponds to leverage of about 37. Subprime/Alt-issuance stopped in the first quarter of 2008.

the dotted line is Shiller's famous housing index. In 2000, it was at 100 on the right-hand scale. By the second quarter of 2006, it hits 190, a 90% increase in six years. Then it goes down by 30% or so from there. Shiller famously said that it was irrational exuberance driving prices up. And, when the narrative changed because people decided things could not go up forever, they started telling bad stories, so everyone got depressed and the prices went down.

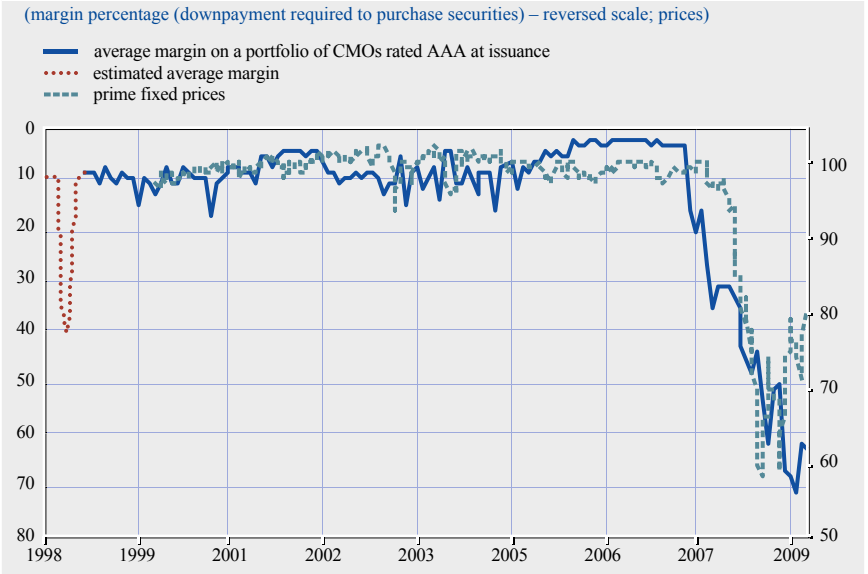
I believe the housing boom and bust was more a matter of leverage than of irrational exuberance. The solid line above gives the average loan-to-value for securitised subprime and Alt-A loans among the top 50% leveraged homeowners. The left vertical axis measures loan-to-value from 0% at the bottom to 100% at the top, or equivalently, the downpayment measured from 0% at the top to 100% at the bottom. You can see that the average downpayment goes from 14% (that is 86% loan-to-value) in 2000 to 2.7% in the second quarter of 2006. In exactly the same quarter that leverage hits its maximum – the second quarter of 2006 – so do home prices. It is not irrational exuberance, I say, but leverage that caused housing prices to go up and then go down.

In Chart 4, you see the analogous leverage-price diagram for prime mortgage-backed security bond prices. Measured along the right vertical axis, the prices in the dashed curve stay close to 100 until the beginning of 2008 when they start to

fall, eventually declining all the way to 70. Leverage is measured as in Chart 3 on the left vertical axis, and is given by the solid blue curve. These repo downpayments (margins) are data the Federal Reserve should be keeping, but apparently the Federal Reserve did not closely monitor repo margins before the crisis. The hedge fund Ellington Capital Management that I work with gave me the history of margins they were offered, averaged over a large portfolio of prime mortgages. You see that downpayments were at 10% in 1998, then in the 1998 leverage cycle crisis they jumped to 40%, then went back to 10% very quickly when the crisis subsided. Margins eventually went down to 5% in 2006 – so 20-to-1 leverage. Then in 2007 leverage began to collapse, and afterwards you see prices and leverage collapsing together. Leverage on these AAA bonds, measured properly as loan-to-value on new loans, starts to collapse before prices and is part of the reason for the collapse of prices. The deleveraging comes before the fact, not two years after the fact. Of course, much of the deleveraging in the diagram (and in other time series of security prices) comes simultaneously with the fall in prices. Falling prices make rational lenders demand more collateral, which in turn lowers prices, making lenders ask for still more collateral and so on.

What caused prices and leverage to go down? What was the scary bad news? To listen to the conventional accounts, the crisis began with housing prices

Chart 4 Securities leverage cycle: margins offered and AAA securities prices



Notes: The chart represents the average margin required by dealers on a hypothetical portfolio of bonds subject to certain adjustments noted below. Observe that the margin % axis has been reversed, since lower margins are correlated with higher prices.

The portfolio evolved over time and changes in average margin reflect changes in composition as well as changes in margins of particular securities. In the period following August 2008, a substantial part of the increase in margins is due to bonds that could no longer be used as collateral after being downgraded, or for other reasons, and hence count as 100% margin.

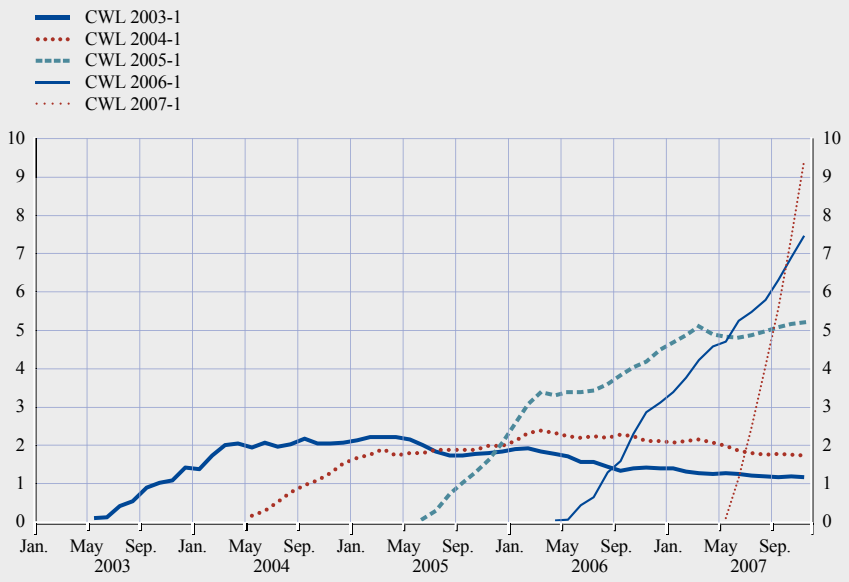
suddenly plummeting, completely unexpectedly, out of the blue. In Chart 3, you see housing went down slowly. It is a nice slow curve. It goes up, it stops going up, and then it comes down slowly. That housing prices stopped going up is not really a surprise from the leverage cycle vantage point. Downpayments cannot go below 0%, so as housing downpayments approach their minimum, one would expect housing prices to stop increasing. What is surprising is how fast leverage comes down just after the second quarter of 2006. What happened? What was the scary bad news?

The scary bad news was that delinquencies on subprime loans started going up in 2006 and by the beginning of 2007 it was clear a dangerous trend was materialising. In Chart 5 we see that historical delinquencies as a percentage of original balances for Countrywide deals asymptote at 2%. But in January 2007 the delinquencies on 2005 and 2006 loans were already approaching 5%.

The result was that the subprime BBB ABX index collapsed in January and Feburary of 2007, as we see in Chart 6.

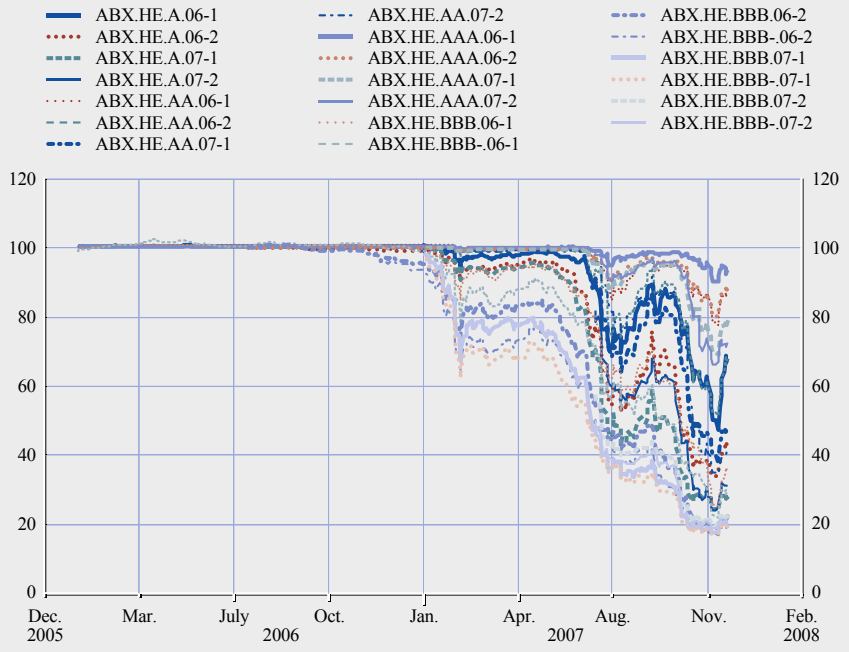
Chart 5 Delinquencies as a percentage of original balances

(countrywide loans (CWL) more than 90 days delinquent divided by the original loans; percentage)



Note: The result was that the subprime BBB ABX index collapsed in January and Feburary of 2007, as we see in Chart 6.

Chart 6 BBB subprime mortgage bonds prices crash before big drop in housing



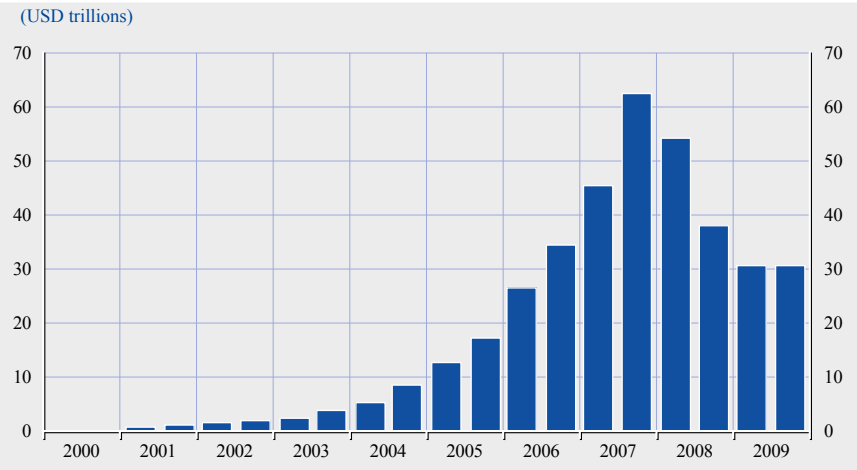
Note: Series codes: ABX.HE – index of subprime mortgage bonds; rating (A, AA, AAA, BBB or BBB-); year and semester in which the loans were pooled to back the bond (e.g. 06-1 means the first half of 2006).

It may seem surprising that an increase in delinquencies from 2% to 5% could cause such a drop in the subprime security index. I argued earlier this should not be surprising because of a sharp decline in leverage on subprime securities as nervous lenders ask for more collateral. I do not have the data on subprime security collateral, but I have the next best thing. As buyers of subprime securities get more nervous, one would expect them to prefer pools with subprime loans that have bigger downpayments. And that is just what we see in Chart 3. Leverage on subprime loans collapses just after January 2007. And I believe that is what led to the housing price collapse.

5 THE LEVERAGE CYCLE AND DERIVATIVES

The role of derivatives in the financial crisis has not been well understood. In my opinion the introduction of credit default swaps (CDSs) played a vital role in the subprime crash. Before their introduction, a pessimist could not leverage his views. CDSs did not become standardised for mortgages until the end of 2005. Only then could you easily leverage your position as a pessimist. All those guys at the bottom of the continuum in Chart 1, who earlier just had to stand by and shake their heads at the high subprime prices, could thereafter weigh in with money behind their opinion. This was bound to push the marginal buyer lower and to have a big effect on asset prices. Chart 7 shows the dramatic increase in CDSs in general (data is not available for mortgage CDSs in particular).

Chart 7 Volume of credit default swaps



Source: "ISDA market survey: historical data."

But this raises an interesting puzzle. The growth of derivatives, for example, as tranches in the collateralised mortgage obligation market or as separate bonds in subprime securitisations, long predated the spectacular expansion of the CDS market. In this prior stage, the growth in derivatives seemed to raise asset prices. Indeed, one of the major reasons the government sponsored securitisation and encouraged tranching was because it was believed to raise the underlying mortgage price, thereby making it cheaper for homeowners to borrow money to buy homes. But why should the creation of a derivative inside a mortgage securitisation increase the value of the mortgage, whereas the creation of a similar derivative like a CDS outside the tranche reduces the value of the mortgage?

The answer that Ana Fostel and I gave in a recent paper is that the collateralised mortgage obligation tranches obviously make the underlying mortgage more valuable relative to cash because the mortgage pay-offs can be divided in ways that appeal to heterogeneous investors. The mortgage acts as collateral for the tranches (and in fact is literally called collateral in the deal). On the other hand, when trading a CDS one has to put up cash as collateral to guarantee the payment. In effect, the CDS tranches the cash, making the cash more valuable relative to the mortgage.

6 MANAGING THE LEVERAGE CYCLE

Let me conclude my discussion of the 2000-10 leverage cycle by briefly mentioning four reasons why this last leverage cycle was worse than its predecessor cycles. First, leverage reached levels never seen before in previous cycles. There are a variety of reasons for this, including the great and long moderation in volatility. Another is the aforementioned securitisation and tranching. Yet another is that the government effectively guaranteed the debt of Fannie and Freddie, and perhaps even implicitly for the big banks, letting them all leverage with

no market discipline. Still another reason is that the banks hid their leverage from regulators who might have turned a blind eye to them anyway. Lastly, low rates might have encouraged more leverage from investors searching for yield. The second reason this last leverage cycle was so bad is that it was really a double leverage cycle – in securities on the repo market and on homes in the mortgage market. These cycles fed off each other and, as we saw, as security prices fell and leverage collapsed there, leverage then went down in the housing mortgage market. Third, CDSs played a huge role and had been absent from previous cycles. CDSs helped optimists leverage at the end of the boom, making them more vulnerable, but most importantly, it provided an opportunity for pessimists to leverage and so made the crash much faster than it would have been without them. Lastly, because leverage got so high and then prices fell so far, a huge number of people and businesses ended up underwater, including 14 million homeowners. This debt overhang is playing a big role in our current malaise.

What should be done about the leverage cycle? Something to prevent it from getting too high, and then something to get out of the acute crisis once there is a crash, and, lastly, something to shorten the costly aftermath.

To prevent leverage from building up, we have to monitor it by collecting not only debt-to-equity ratios on a large variety of institutions, but also loan-to-value leverage data on all kinds of securities and assets. We have to put derivatives like CDSs on an exchange or something similar. I do not have time now to explain it, but CDSs are just another way of leveraging. So you have to monitor the leverage of derivatives just like you would monitor the leverage of asset purchases. During normal times, loan-to-value leverage should be regulated. The Federal Reserve or another body that is given the authority should simply say, "You cannot loan at 2% down on houses. You cannot make repo loans with 0.5% down. You cannot write CDS insurance unless your initial margin is comparable to the margin on buying the security. And if you want to buy CDS insurance, you also have to put comparable margins down."

Allow me to mention four of the six reasons I have given elsewhere why monitoring and regulating leverage should be based at least partly on loan-to-value ratios on new loans (asset-based leverage) for all borrowers and lenders, rather than solely according to debt-equity ratios of entire institutions (investor leverage). First, leverage in the system can move away from regulated institutions. Second, limiting the overall leverage of an institution can sometimes incentivise it to choose riskier investments that are leveraged less. Third, as we have seen, investor leverage and asset leverage often move in opposite directions. Fourth, it is harder to lie about asset-based leverage because separate reports will be obtained from both the borrower and the lender.

If, despite efforts to curtail leverage, the crisis begins anyway, the only way to get out is to reverse the three standard causes of leverage cycle crises: reduce the uncertainty, re-leverage the system (to moderate levels), and inject optimistic capital to make up for the lost demand from the suddenly bankrupt or insolvent optimists. In the acute stage of the crisis we always see the same thing. There are a huge number of people who have gone bankrupt, but a much bigger group that

are teetering on the edge of bankruptcy. Partly because of counterparty worries, a number of markets freeze up and liquidity disappears. Regulatory controls may suddenly be triggered. So there is a new kind of uncertainty, quite distinct from the volatile shock that triggered the crisis. The government must step in to quell this uncertainty and to keep markets transparent.

During the crisis and its aftermath, what looks like a demand problem – no one is borrowing at the going low interest rate – is really a collateral problem. Lenders are asking for so much collateral that investors cannot borrow because they do not have the collateral. What the Federal Reserve has to do is to go around the banks and lend directly on less collateral, not at lower interest rates. In fact, that is one of the things the Federal Reserve and the Treasury did (in the TALF and PPIP programmes) that helped get the United States out of the depths of the crisis. It could have been done on a much broader scale. But the bravery to do something that had never been done before played a critical role in helping avoid a worse catastrophe.

Let me close this section by challenging the false separation between interest and collateral that has been maintained by some monetary authorities. It has been suggested that the Federal Reserve or the ECB should deal exclusively with interest in normal times, perhaps managing collateral in crises as "non-standard" policies. Of course, it has now been recognised that leverage must be systemically curtailed. But the idea is that in normal times the central bank worries about interest, while collateral management is left to the macro-prudential regulator. This reminds me of the old Soviet separation: one bureau was put in charge of prices, another in charge of quantities. A crisis is a window into the soul of the economy, like Plato's republic was the soul writ large. If non-standard policies saved the economy during the crisis, they surely should play a role in normal times.

7 THE AFTERMATH: GETTING OUT FROM UNDERWATER

After a major crisis has stabilised, the most important uncertainty becomes who else will go bankrupt and how will they behave while they are underwater? The depth and length of the crisis and its aftermath depends on how much leverage there was to begin with and on how effective government policy is in reducing value-destroying bankruptcies and debt overhang.

Debt overhang causes terrible deadweight losses. Once a homeowner is far enough underwater, he is not going to spend money to fix his house in order to raise its value when he knows he will probably lose it eventually anyway. Even if he wanted to fix his house, nobody would lend him the money to finance the repairs anyway. The underwater homeowner might continue to make his mortgage payments if he feels it would be more expensive to move and rent another house and live with a diminished credit rating, or if he thinks there is a chance his house might eventually recover enough value to be worth more than the debt. However, once he becomes far enough underwater it becomes too expensive *not* to default.

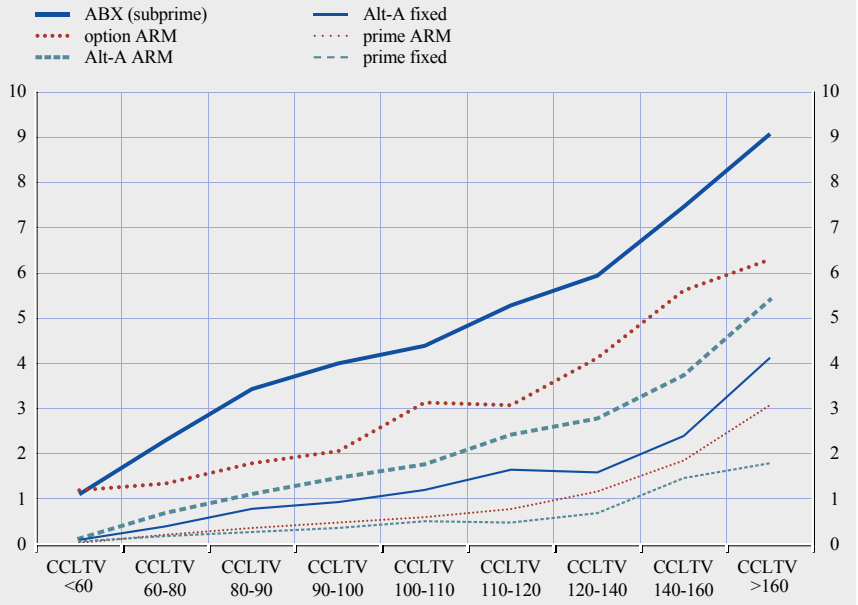
A major reason many homeowners have stopped paying in this crisis is that they are underwater. Chart 8 indicates that homeowners with current loan-to-values well below 100% rarely default, whereas subprime borrowers with loan-to-value at 160% were defaulting at the rate of 8% per month in 2009. Default rates are steeply monotonic in how far underwater the homeowner is.

Throwing a homeowner out of the house for defaulting also incurs huge costs. On average, subprime lenders recover less than 25% of their loan from foreclosing. It takes 18 months to 3 years nowadays to throw somebody out of his house, during which time the mortgage is not paid, taxes are not paid, the house is not fixed, the house is often vandalised and realtor expenses are incurred.

By writing down principal on subprime loans so that the homeowners are above water, lenders and borrowers can both gain. For example, the lender can expect less than USD 40 back on a USD 160 loan if the house has a market value of USD 100 at the time of the default. If the lender cut the principal to USD 80, the homeowner would probably pay. If not, he would fix up the house and sell it. Either way the lender would get USD 80 instead of USD 40. The biggest policy mistake of the Obama administration in the current crisis was entrusting

Chart 8 Loan-to-value ratios and default frequency

(net monthly flow from less than 60 days to over 60 days delinquency; percentages)



Note: Net monthly flow (excluding mods) from less than 60 days to over 60 days delinquency, six-month average as of January 2009, 06-2 indices. CCLTV – current combined loan-to-value.

mortgage modifications to the servicers and the banks. The servicers do not own the mortgages and thus do not have the same incentives as the bondholders or the homeowners to write down principal. On the contrary, their incentives lie in not writing down principal. And the big bank lenders are afraid of taking an immediate loss on their books, even though they will incur a bigger loss down the road by foreclosing. I wrote about this over two years ago in two op-eds with Susan Koniak in the *New York Times*, predicting a foreclosure fiasco if the government did not act.

The same logic can be applied to the many underwater businesses in America today. What appears to be a lack of demand for investment may instead be an inability to borrow either because of debt hangover (as Myers pointed out in 1977) or because lenders now require too much collateral. Macro models that do not capture such effects cannot possibly predict the effect of a stimulus or the period of time until normal employment levels are restored. Reducing interest, which – in the conventional historical times used to calibrate the standard macro models – can be relied on to generate more activity, may be completely ineffective in the aftermath of a leverage cycle crash.

What applies to homeowners and businesses applies even more so to sovereign debt. After every leverage cycle crash, the government assumes some private debt and borrows to stimulate the economy. If the government debt was large before the crisis, it can become almost unmanageable after the crisis. In the United States, cities and states are beginning to cut back on vital services like policemen, firemen and teachers because they feel they can no longer increase their debt. When we add on top all the pension and medical obligations many western governments took on before the crisis, it is difficult to honestly maintain that any of them are solvent. This brief discussion is surely not the place to document my claim, but in my opinion many western governments will be obliged to scale down their promises, that is, they will have to find ways to write down their debts or default on them.

One of the standard methods for governments to write down their nominal debt is to inflate it away. A 20% inflation over four years would reduce US government debt by 20% and bring millions of homeowners out from underwater. As the need for debt reduction becomes more acute and as the money supply created by the government to stimulate demand via low interest becomes larger, the private sector will begin to expect inflation. Central bankers will declare that they will not allow inflation to start, presumably for fear that once started it may spiral out of control. However, such protestations will not stop the private sector from hedging by moving money into commodities, which will be where inflation begins. With unemployment high and activity low, central bankers will be reluctant to put on the brakes and the inflation will start to spread. The surest way for inflation to spiral out of control is if the central bankers vow it will never start and it does. Then people will really believe it is out of control.

8 DEFAULT, PUNISHMENT AND FORGIVENESS

It is generally believed that forgiving debt might start a chain reaction of defaults because the lender might then be unable to keep his promises, or that a default in one sector will lead lenders to expect a default in another sector and so kill lending there, or that debt forgiveness will create a moral hazard, encouraging future borrowers to take on too much debt and to strategically default. Most importantly, it is believed that default is immoral, that the defaulter deserves blame and that if one man's debt is forgiven, everyone's should be.

I believe that much of this viewpoint derives from the primitive creation of Conscience described by Nietzsche following centuries of punishment. Collateral is a much more sophisticated guarantor of delivery than punishment. It should spread the stigma of default to the lender. If the collateral falls so far in value that it no longer covers the loan, who is more to blame – the borrower or the lender? If a grocer goes bankrupt because he sells below cost (like the lender who asked for too little collateral), is the buyer to blame for purchasing on such absurd terms?

The Law recognises the difference between deception before the fact and default. A tort case and a contract case are treated differently. It may, in fact, be more blameworthy of governments to claim that all debts will be paid, say by entities they are bailing out or by programmes started many years before during boom times, even after they realise they will not than it was to make those promises in the first place when it was thought they could be paid. As Plato said, it is not always just to keep promises when unexpected or unusual circumstances arise.

My point, of course, is not that ancient philosophers understood default better than modern economists, but that we must change our models to incorporate default and lending terms in order to understand the macroeconomy in ways the ancient philosophers could not dream of doing.

Consider for a moment an example presented in Dubey, Geanakoplos and Shubik (2005). Each investor would like to borrow money because he is almost always much richer in the future, but each has a state in the future in which he will be quite poor. Suppose the government can set ex ante a penalty per dollar of default (say how long one goes to jail, or how long one's credit rating is destroyed). One might also think of the penalty as a pang of Conscience. How high should the penalty be set?

If the penalty is infinite, nobody will default and lenders can be sure to get their money back and so will lend at low interest. If the penalty is set lower, even for some people, then people will start to default, especially in the state they are poor. Lenders will then want a higher interest rate and even the borrowers who do not plan to default (but who cannot be distinguished from the low conscience borrowers by the lender) will face high interest rates. Moreover, the people who default will pay the penalty which is a pure deadweight loss for society. There seem to be several compelling reasons to eliminate default by setting high penalties.

Yet it is Pareto superior to set an intermediate level of penalty, allowing for some defaults, the resulting higher interest rates and the deadweight losses of paying the penalties. An infinite default would force people to repay even in their bad state, which, with diminishing marginal utility, would be extremely painful. Foreseeing this, they would not borrow much, even at low interest rates, and everyone would be worse off. Notice that the optimal default penalty allows agents in bad circumstances to default (in exchange for paying the penalty) not because they cannot repay, for in fact they could, but because it would be so painful to repay.

This story includes almost all the elements of default that are so scary to central bankers: lenders demand higher interest rates, even completely reliable borrowers must pay the higher rates, defaults occur, and the defaults are messy and incur deadweight losses. Yet it is socially optimal to have them!

Moreover, if the government could intervene and declare a situation a crisis ex post and mandate debt forgiveness, then there would be yet another Pareto gain because the messy losses from default would be reduced. Ex ante, the lenders would of course anticipate that they would be forced to forgive debt in some circumstances. But the point is that they would not have been paid in those circumstances with the ex ante optimal default penalty either.

One could ask a further question. Can the market set the default penalties? The answer, as shown in Dubey, Geanakoplos and Shubik, is yes, just like the market sets leverage ratios. In some circumstances, the market will set the correct levels of penalties, in some not. But these penalties will have a profound effect on the levels of aggregate borrowing and lending and therefore on macroeconomic activity.

To the best of my knowledge, these kinds of considerations are completely absent from the calibrated models that guide macroeconomic policy. The ECB needs a macroeconomic model in which the anticipation of some sovereign default raises interest rates and which then works out all the likely direct and indirect effects of an actual default. My guess is that the spectre of such an event makes modellers shrink from doing the labour to create the models.

9 PENSION PLAN DEFAULT

One of the principal sources of default is pension obligations. Firms, cities and states alike seem to promise more for future retirees than they can actually deliver. One important reason for this is the lack of regulatory guidelines. There does not appear to be a consensus on how much money should be required in the trust fund to back those promises, or how it should be invested, or even on how to compute the present value of the pension obligations. Discounting expected benefits at the risk-free rate gives astronomical numbers that would put most pension funds deeply underwater. Discounting at an equity return makes the liabilities seem manageable. I believe the reason for the lack of models and clear guidelines for pension plans is that regulators do not want to think seriously about default.

If they got rigorous about default and wanted to ensure that it never happened, they would need to force pension managers to cut all the risk out of their portfolios. But regulators and managers alike seem to agree that it is sensible to hold a large stake in equities because their expected returns are so much higher. Inevitably, that leads to scenarios where the pension fund defaults. This probability must be quantified and the consequences of default systematically investigated.

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GENERAL DISCUSSION

Sukudhew Singh (Central Bank of Malaysia) asked whether the models used at central banks did not lead to policy myopia, in the sense that what was not in the models became invisible to policy-makers. Second, he expressed concern that it is difficult for economists and policy-makers to change the paradigm they are used to in the face of new facts and circumstances.

Eichenbaum answered that an image of a policy-maker looking only at a single New Keynesian DSGE model is a caricature. Policy institutions use many different models simultaneously. A model is merely a way to quantify a point of view. As for responding to new facts, he agreed with Keynes' recipe: "When the facts change, I change my mind – what do you do, sir?"

Klaus Adam (Mannheim University) referred to the research program of integrating asset pricing and macro models. Many of these models, including the Bernanke-Gertler approach, are incapable of reproducing even the very basic asset pricing facts and have to resort to added exogenous bubble components. What mechanisms can provide endogenous propagation to integrate macro dynamics with asset price dynamics?

Bouchaud replied that in his view a lot of the excess volatility of financial assets comes from endogenous propagation within financial markets.

Geanakoplos pointed out two weaknesses of the Bernanke-Gertler and Kiyotaki-Moore frameworks: they have no feedback between leverage and asset prices and they generate counter-cyclical leverage. Leverage is pro-cyclical in data and it is crucial that models replicate this fact. Economists have not yet tried introducing collateral and leverage in a serious way. The best proof of this fact is that they have not bothered to keep data on leverage.

Eichenbaum pointed out that a heterogeneity of beliefs about uncertain fundamentals generates interesting dynamics. Extreme views may affect aggregates in an interesting way, as in Burnside, Eichenbaum and Rebelo (2011), who present a model in which long calm periods are followed by sudden crises. To generate these effects frictions like those in search models are needed.

Geanakoplos added that Credit Default Swap (CDS) markets are crucial to the economy because they allow pessimists to leverage their bets. Without CDS markets only optimists could leverage.

Angel Ubide (Tudor Investment Corporation) raised the point that focusing on aggregate credit bubbles can lead to the oversight of important disequilibria in individual market segments and securities. This is so because implicit leverage can be very large in individual securities under an adverse scenario, even when aggregate credit growth is not strong, as the super senior tranches of collateralised-debt obligations (CDOs) showed.

Geanakoplos agreed that even though banks now tend to ask for a large amount of collateral, certain parts of the economy are leveraging very quickly. Current government interventions are encouraging leverage in the housing markets. The danger is that while policy-makers are trying to revive the economy after the bust they may fuel a new leverage cycle. He called for writing down the principal on subprime mortgages in order to deleverage the economy. This would benefit both lenders and borrowers, as foreclosures are very costly and inefficient. This policy would be more beneficial than the current policy of subsidising interest rates. In response to a query by **Gertrude Tumpel-Gugerell, Geanakoplos** replied that lenders should bear the cost of the write-down, but effectively they would also win, as otherwise subprime borrowers would default anyway and foreclosures are very costly, with very low recovery rates on defaulted mortgages (below 25%). The problem is, however, that only the loan servicers deal directly with homeowners, and these servicers have no incentives to cut the principal as it would reduce their fees.

John Muellbauer (Oxford University) pointed out that the New Keynesian DSGE model is a US invention that spread around the world. He said it was therefore puzzling but welcome that the Federal Reserve has stuck to its old FRBUS model, in which data are allowed to speak more flexibly and asset prices and credit play a role. In this model it would be straightforward to introduce the innovations Geanakoplos mentioned – which are supported by Muellbauer's own research – because the equations are easy to modify.

In reply **Eichenbaum** said he was under the impression that the Federal Reserve invested a large amount in DSGE models, but that it has "many feathers in its quill". It moved away from FRBUS for good reasons, one of them being that it forecasts poorly out-of-sample. That does not mean it is not useful. But going back to using FRBUS alone would be a step backwards.

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Ben Bernanke and Jean-Claude Trichet

KEYNOTE SPEECH

REBALANCING THE GLOBAL RECOVERY

BY BEN S. BERNANKE, CHAIRMAN OF THE BOARD OF GOVERNORS, US FEDERAL RESERVE SYSTEM

1 INTRODUCTION

The global economy is now well into its second year of recovery from the deep recession triggered by the most devastating financial crisis since the Great Depression. In the most intense phase of the crisis, as a financial conflagration threatened to engulf the global economy, policy-makers in both advanced and emerging market economies found themselves confronting common challenges. Amid this shared sense of urgency, national policy responses were forceful, timely and mutually reinforcing. This policy collaboration was essential in averting a much deeper global economic contraction and providing a foundation for renewed stability and growth.

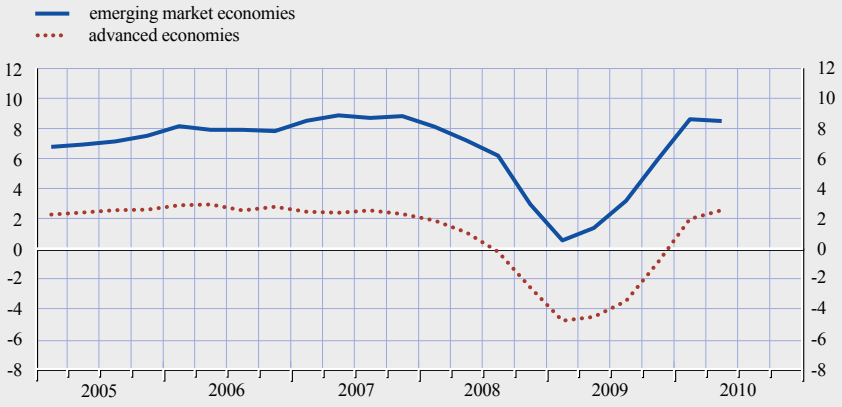
In recent months, however, that sense of common purpose has waned. Tensions among nations over economic policies have emerged and intensified, potentially threatening our ability to find global solutions to global problems. One source of these tensions has been the bifurcated nature of the global economic recovery: some economies have fully recouped their losses while others have lagged behind. But at a deeper level, the tensions arise from the lack of an agreed-upon framework to ensure that national policies take appropriate account of interdependencies across countries and the interests of the international system as a whole. Accordingly, the essential challenge for policy-makers around the world is to work together to achieve a mutually beneficial outcome – namely, a robust global economic expansion that is balanced, sustainable and less prone to crises.

2 THE TWO-SPEED GLOBAL RECOVERY

International policy cooperation is especially difficult now because of the two-speed nature of the global recovery. Specifically, as shown in Chart 1, since the recovery began, economic growth in the emerging market economies (the dashed blue line) has far outstripped growth in the advanced economies (the solid red line). These differences are partially attributable to longer-term differences in growth potential between the two groups of countries, but to a significant extent they also reflect the relatively weak pace of recovery thus far in the advanced economies. This point is illustrated by Chart 2, which shows the levels, as opposed to the growth rates, of real gross domestic product (GDP) for the two groups of countries. Generally speaking, output in the advanced economies has not returned to the levels prevailing before the crisis and real GDP in these economies remains far below the levels implied by pre-crisis trends. In contrast, economic activity in the emerging market economies has not only fully made up the losses induced by the global recession, but is also rapidly approaching its pre-crisis trend. To cite some illustrative numbers, if we were to extend forward from the end of 2007 the

Chart 1 Growth rate of output

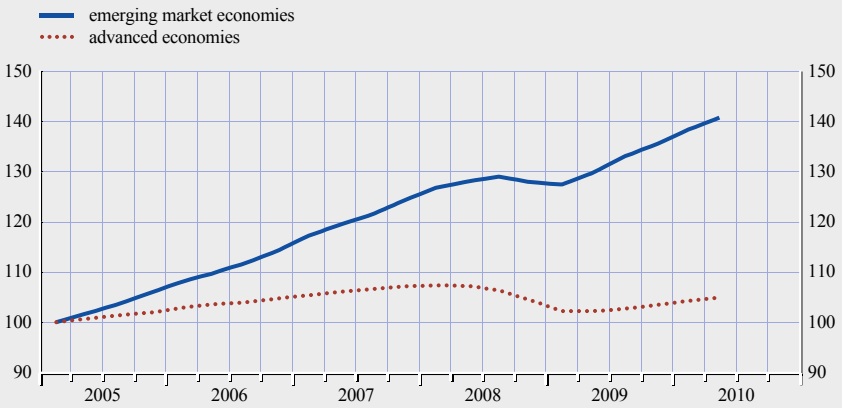
(four-quarter percentage change; quarterly)



Sources: Country sources via Haver; International Monetary Fund and Federal Reserve Board staff calculations.
Notes: Aggregates weighted by shares of gross domestic product valued at purchasing power parity. Advanced economies consist of Australia, Canada, the euro area, Japan, Sweden, Switzerland, the United Kingdom, and the United States. Emerging market economies consist of Argentina, Brazil, Chile, China, Colombia, Hong Kong, India, Indonesia, Israel, Malaysia, Mexico, the Philippines, Russia, Saudi Arabia, Singapore, South Korea, Taiwan, Thailand and Venezuela.

Chart 2 Level of output

(2005:Q1 = 100; quarterly)



Sources: Country sources via Haver, International Monetary Fund and Federal Reserve Board staff calculations.
Notes: Aggregates weighted by shares of gross domestic product valued at purchasing power parity. Advanced economies consist of Australia, Canada, the euro area, Japan, Sweden, Switzerland, the United Kingdom and the United States. Emerging market economies consist of Argentina, Brazil, Chile, China, Colombia, Hong Kong, India, Indonesia, Israel, Malaysia, Mexico, the Philippines, Russia, Saudi Arabia, Singapore, South Korea, Taiwan, Thailand and Venezuela.

Chart 3 US real gross domestic product

Source: Bureau of Economic Analysis.

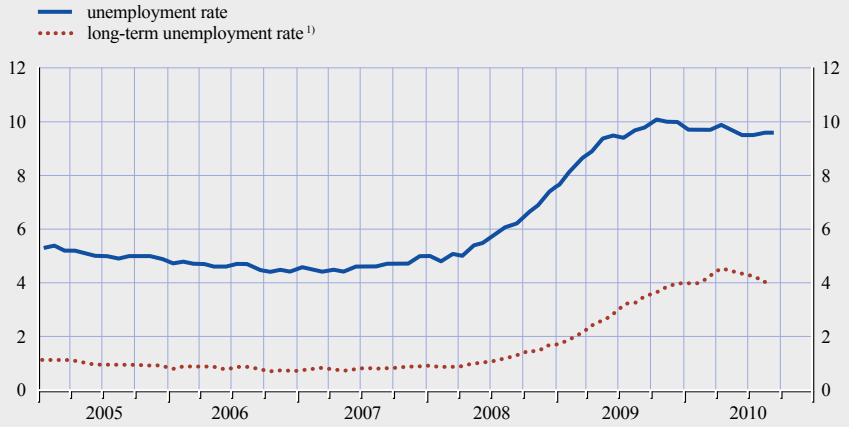
ten-year trends in output for the two groups of countries, we would find that the level of output in the advanced economies is currently about 8% below its longer-term trend, whereas economic activity in the emerging markets is only about 1.5% below the corresponding (but much steeper) trend line for that group of countries. Indeed, for some emerging market economies, the crisis appears to have left little lasting imprint on growth. Notably, since the beginning of 2005, real output has risen more than 70% in China and about 55% in India.

In the United States, the recession officially ended in mid-2009, and – as shown in Chart 3 – real GDP growth was reasonably strong in the fourth quarter of 2009 and the first quarter of this year. However, much of that growth appears to have stemmed from transitory factors, including inventory adjustments and fiscal stimulus. Since the second quarter of this year, GDP growth has moderated to around 2% at an annual rate, less than the Federal Reserve's estimates of US potential growth and insufficient to meaningfully reduce unemployment. And indeed, as Chart 4 shows, the US unemployment rate (the solid black line) has stagnated for about eighteen months near 10% of the labour force, up from about 5% before the crisis; the increase of 5 percentage points in the US unemployment rate is roughly double that seen in the euro area, the United Kingdom, Japan or Canada. Of some 8.4 million US jobs lost between the peak of the expansion and the end of 2009, only about 900,000 have been restored thus far. Of course, the jobs gap is presumably even larger if one takes into account the natural increase in the size of the working age population over the past three years.

Of particular concern is the substantial increase in the share of unemployed workers who have been without work for six months or more (the dashed red line in Chart 4). Long-term unemployment not only imposes extreme hardship on jobless people and their families, but, by eroding these workers' skills and weakening their attachment to the labour force, it may also convert what might otherwise be temporary cyclical unemployment into much more intractable long-term structural unemployment. In addition, persistently high unemployment,

Chart 4 US labour market

(monthly; percentage)



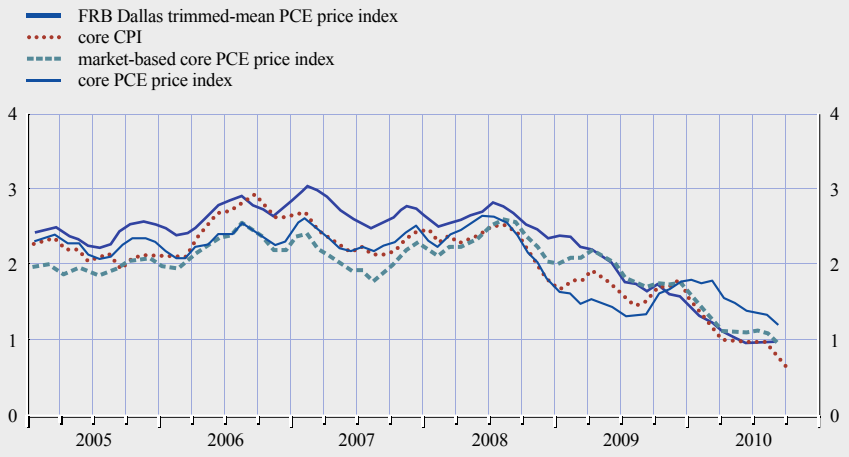
Source: Bureau of Labor Statistics.
1) Unemployed for more than 26 weeks.

through its adverse effects on household income and confidence, could threaten the strength and sustainability of the recovery.

Low rates of resource utilisation in the United States are creating disinflationary pressures. As shown in Chart 5, various measures of underlying inflation have been trending downwards and are currently around 1%, which is below the

Chart 5 US consumer prices

(monthly; 12-month percentage change)



Sources: Bureau of Economic Analysis, Bureau of Labor Statistics and Federal Reserve Bank (FRB) of Dallas.
Note: Core consumer price index (CPI) and core personal consumption expenditures (PCE) price index exclude food and energy.

rate of 2% or a bit less that most Federal Open Market Committee (FOMC) participants judge as being most consistent with the Federal Reserve's policy objectives in the long run.[1] With inflation expectations stable, and with levels of resource slack expected to remain high, inflation trends are expected to be quite subdued for some time.

3 MONETARY POLICY IN THE UNITED STATES

Because the genesis of the financial crisis was in the United States and other advanced economies, the much weaker recovery in those economies compared with that in the emerging markets may not be entirely unexpected (although, given their traditional vulnerability to crises, the resilience of the emerging market economies over the past few years is both notable and encouraging). What is clear is that the different cyclical positions of the advanced and emerging market economies call for different policy settings. Although the details of the outlook vary among jurisdictions, most advanced economies still need accommodative policies to continue to lay the groundwork for a strong, durable recovery. Insufficiently supportive policies in the advanced economies could undermine the recovery not only in those economies, but for the world as a whole. In contrast, emerging market economies increasingly face the challenge of maintaining robust growth while avoiding overheating, which may in some cases involve the measured withdrawal of policy stimulus.

Let me address the case of the United States specifically. As I described, the US unemployment rate is high and, given the slow pace of economic growth, likely to remain so for some time. Indeed, although I expect that growth will pick up and unemployment will decline somewhat next year, we cannot rule out the possibility that unemployment might rise further in the near term, creating added risks for the recovery. Inflation has declined noticeably since the business cycle peak, and further disinflation could hinder the recovery. In particular, with shorter-term nominal interest rates close to zero, declines in actual and expected inflation imply both higher realised and expected real interest rates, creating further drags on growth.[2] In light of the significant risks to the economic recovery, to the health of the labour market and to price stability, the FOMC decided that additional policy support was warranted.

The Federal Reserve's policy target for the federal funds rate has been near zero since December 2008, so another means of providing monetary accommodation has been necessary since that time. Accordingly, the FOMC purchased Treasury and agency-backed securities on a large scale from December 2008 to

1 Chart 5 shows core and trimmed-mean measures to better display the decline in underlying, or trend, inflation. Total inflation measures have been volatile in recent years, but are currently a bit above 1% on a 12-month basis. Projections by FOMC participants have indicated that, under appropriate monetary policies, inflation as measured by the price index for personal consumption expenditures should converge to 2% or a bit less in the long run.

2 Unexpectedly high realisations of real interest rates increase the real burden of household and business debts, relative to what was anticipated when the debt contracts were signed. Higher expected real interest rates deter capital investment and other forms of spending.

March 2010, a policy that appears to have been quite successful in helping to stabilise the economy and support the recovery during that period. Following up on this earlier success, the Committee announced this month that it would purchase additional Treasury securities. In taking that action, the Committee seeks to support the economic recovery, promote a faster pace of job creation and reduce the risk of a further decline in inflation that would prove damaging to the recovery.

Although securities purchases are a different tool for conducting monetary policy from the more familiar approach of managing the overnight interest rate, the goals and transmission mechanisms are very similar. In particular, securities purchases by the central bank affect the economy primarily by lowering interest rates on securities of longer maturities, just as conventional monetary policy, by affecting the expected path of short-term rates, also influences longer-term rates. Lower longer-term rates in turn lead to more accommodative financial conditions, which support household and business spending. As I noted, the evidence suggests that asset purchases can be an effective tool; indeed, financial conditions eased notably in anticipation of the Federal Reserve's policy announcement.

Incidentally, in my view, the use of the term "quantitative easing" to refer to the Federal Reserve's policies is inappropriate. Quantitative easing typically refers to policies that seek to have effects by changing the quantity of bank reserves, a channel which seems relatively weak, at least in the US context. In contrast, securities purchases work by affecting the yields on the acquired securities and, via substitution effects in investors' portfolios, on a wider range of assets.

This policy tool will be used in a manner that is measured and responsive to economic conditions. In particular, the Committee stated that it would review its asset-purchase programme regularly in light of incoming information and would adjust the programme as needed to meet its objectives. Importantly, the Committee remains unwaveringly committed to price stability and does not seek inflation above the level of 2% or a bit less that most FOMC participants see as consistent with the Federal Reserve's mandate. In that regard, it bears emphasising that the Federal Reserve has worked hard to ensure that it will not have any problems exiting from this programme at the appropriate time. The Fed's power to pay interest on banks' reserves held at the Federal Reserve will allow it to manage short-term interest rates effectively and thus to tighten policy when needed, even if bank reserves remain high. Moreover, the Fed has invested considerable effort in developing tools that will allow it to drain or immobilise bank reserves as needed to facilitate the smooth withdrawal of policy accommodation when conditions warrant. If necessary, the Committee could also tighten policy by redeeming or selling securities.

The foreign exchange value of the dollar has fluctuated considerably during the course of the crisis, driven by a range of factors. A significant portion of these fluctuations has reflected changes in investor risk aversion, with the dollar tending to appreciate when risk aversion is high. In particular, much of the decline over the summer in the foreign exchange value of the dollar reflected an unwinding of the increase in the dollar's value in the spring associated with the

European sovereign debt crisis. The dollar's role as a safe haven during periods of market stress stems in no small part from the underlying strength and stability that the US economy has exhibited over the years. Fully aware of the important role that the dollar plays in the international monetary and financial system, the Committee believes that the best way to continue to deliver the strong economic fundamentals that underpin the value of the dollar, as well as to support the global recovery, is through policies that lead to a resumption of robust growth in a context of price stability in the United States.

In sum, on its current economic trajectory the United States runs the risk of seeing millions of workers unemployed or underemployed for many years. As a society, we should find that outcome unacceptable. Monetary policy is working in support of both economic recovery and price stability, but there are limits to what can be achieved by the central bank alone. The Federal Reserve is non-partisan and does not make recommendations regarding specific tax and spending programmes. However, in general terms, a fiscal programme that combines near-term measures to enhance growth with strong, confidence-inducing steps to reduce longer-term structural deficits would be an important complement to the policies of the Federal Reserve.

4 GLOBAL POLICY CHALLENGES AND TENSIONS

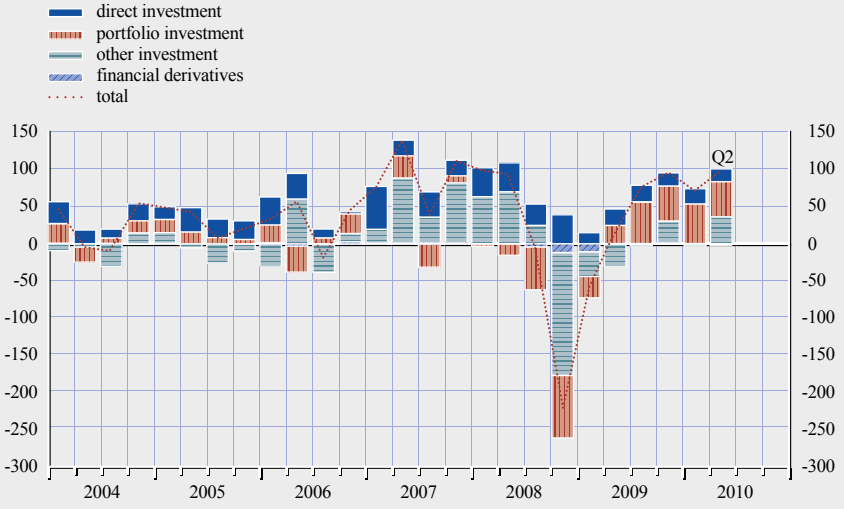
The two-speed nature of the global recovery implies that different policy stances are appropriate for different groups of countries. As I have noted, advanced economies generally need accommodative policies to sustain economic growth. In the emerging market economies, by contrast, strong growth and incipient concerns about inflation have led to somewhat tighter policies.

Unfortunately, the differences in the cyclical positions and policy stances of the advanced and emerging market economies have intensified the challenges for policy-makers around the globe. Notably, in recent months, some officials in emerging market economies and elsewhere have argued that accommodative monetary policies in the advanced economies, especially the United States, have been producing negative spillover effects on their economies. In particular, they are concerned that advanced economy policies are inducing excessive capital inflows to the emerging market economies, inflows that in turn put unwelcome upward pressure on emerging market currencies and threaten to create asset price bubbles. As is evident in Chart 6, net private capital flows to a selection of emerging market economies (based on national balance of payments data) have rebounded from the large outflows experienced during the worst of the crisis. Overall, by this broad measure, such inflows through the second quarter of this year were not any larger than in the year before the crisis, but they were nonetheless substantial. A narrower but timelier measure of demand for emerging market assets – net inflows to equity and bond funds investing in emerging markets, shown in Chart 7 – suggests that inflows of capital to emerging market economies have indeed picked up in recent months.

To a large degree, these capital flows have been driven by perceived return differentials that favour emerging markets, resulting from factors such as

Chart 6 EME net international financial flows excluding changes in reserve assets

(quarterly; USD billions)

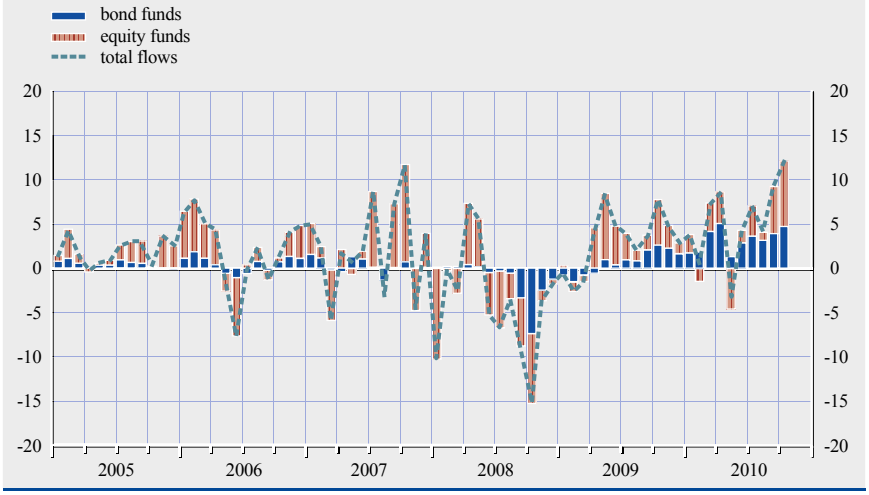


Source: Country sources via Haver.
Note: Emerging market economies (EMEs) consist of Argentina, Brazil, Chile, Czech Republic, Hungary, India, Indonesia, Israel, Malaysia, Mexico, the Philippines, Poland, Russia, Singapore, South Korea, Taiwan, Thailand, Turkey and Ukraine.

stronger expected growth – both in the short term and in the longer run – and higher interest rates, which reflect differences in policy settings as well as other forces. As Charts 6 and 7 show, even before the crisis, fast-growing emerging market economies were attractive destinations for cross-border investment.

Chart 7 Investment flows to EME dedicated funds

(monthly; USD billions)



Source: EPFR Global.
Note: EME stands for emerging market economy.

However, beyond these fundamental factors, an important driver of the rapid capital inflows to some emerging markets is incomplete adjustment of exchange rates in those economies, which leads investors to anticipate additional returns arising from expected exchange rate appreciation.

The exchange rate adjustment is incomplete, in part, because the authorities in some emerging market economies have intervened in foreign exchange markets to prevent or slow the appreciation of their currencies. The degree of intervention is illustrated for selected emerging market economies in Chart 8. The vertical axis of this graph shows the percentage change in the real effective exchange rate in the 12 months up to and including September 2010. The horizontal axis shows the accumulation of foreign exchange reserves as a share of GDP over the same period. The relationship evident in the graph suggests that the economies that have most heavily intervened in foreign exchange markets have succeeded in limiting the appreciation of their currencies. The graph also illustrates that some emerging market economies have intervened at very high levels and others relatively little. Judging from the changes in the real effective exchange rate, the emerging market economies that have largely let market forces determine their exchange rates have seen their competitiveness reduced relative to those emerging market economies that have intervened more aggressively.

It is striking that, amid all the concerns about renewed private capital inflows to the emerging market economies, total capital, on net, is still flowing from relatively labour-abundant emerging market economies to capital-abundant advanced economies. In particular, the current account deficit of the United States implies that it experienced net capital inflows exceeding 3% of GDP in

Chart 8 Exchange rates and reserves

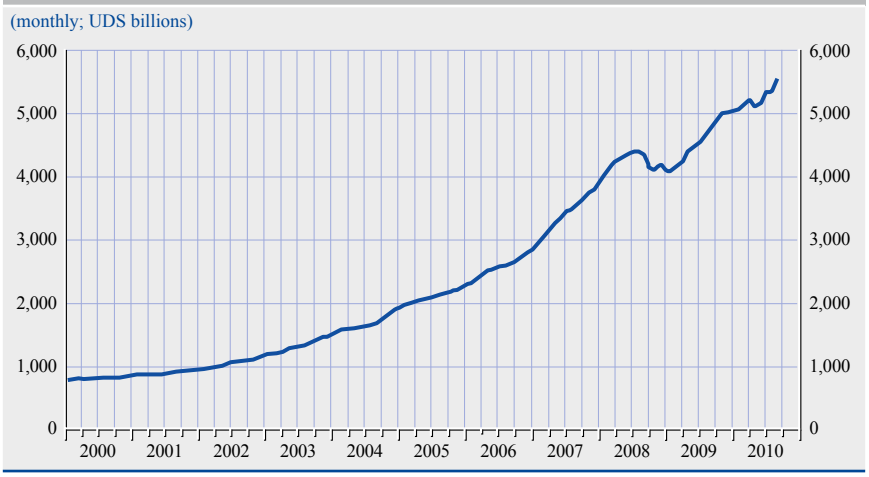
Sources: Bloomberg, country sources via Haver, J.P. Morgan via Haver and Federal Reserve Board staff calculations.
Note: GDP is gross domestic product.
1) From September 2009 until September 2010.

the first half of this year. A key driver of this "uphill" flow of capital is official reserve accumulation in the emerging market economies that exceeds private capital inflows to these economies. The total holdings of foreign exchange reserves by selected major emerging market economies, shown in Chart 9, have risen sharply since the crisis and now surpass USD 5 trillion – about six times their level a decade ago. China holds about half of the total reserves of these selected economies, slightly more than USD 2.6 trillion.

It is instructive to contrast this situation with what would happen in an international system in which exchange rates were allowed to fully reflect market fundamentals. In the current context, advanced economies would pursue accommodative monetary policies as needed to foster recovery and to guard against unwanted disinflation. At the same time, emerging market economies would tighten their own monetary policies to the degree needed to prevent overheating and inflation. The resulting increase in emerging market interest rates relative to those in the advanced economies would naturally lead to increased capital flows from advanced to emerging economies and, consequently, to currency appreciation in emerging market economies. This currency appreciation would in turn tend to reduce net exports and current account surpluses in the emerging markets, thus helping cool these rapidly growing economies while adding to demand in the advanced economies. Moreover, currency appreciation would help shift a greater proportion of domestic output toward satisfying domestic needs in emerging markets. The net result would be more balanced and sustainable global economic growth.

Given these advantages of a system of market-determined exchange rates, why have officials in many emerging markets leaned against appreciation of their currencies toward levels more consistent with market fundamentals?

Chart 9 EME reserves



Sources: Bloomberg, country sources via Haver.
Note: Emerging market economies (EMEs) consist of Brazil, Chile, China, Hong Kong, India, Indonesia, Malaysia, Mexico, the Philippines, Poland, South Korea, Taiwan, Thailand, Turkey, Singapore and Russia.

The principal answer is that currency undervaluation on the part of some countries has been part of a long-term export-led strategy for growth and development. This strategy, which allows a country's producers to operate at a greater scale and to produce a more diverse set of products than domestic demand alone might sustain, has been viewed as promoting economic growth and, more broadly, as making an important contribution to the development of a number of countries. However, increasingly over time, the strategy of currency undervaluation has demonstrated important drawbacks, both for the world system and for the countries using that strategy.

First, as I have described, currency undervaluation inhibits necessary macroeconomic adjustments and creates challenges for policy-makers in both advanced and emerging market economies. Globally, both growth and trade are unbalanced, as reflected in the two-speed recovery and in persistent current account surpluses and deficits. Neither situation is sustainable. Because a strong expansion in the emerging market economies will ultimately depend on a recovery in the more advanced economies, this pattern of two-speed growth might very well be resolved in favour of slow growth for everyone if the recovery in the advanced economies falls short. Likewise, large and persistent imbalances in current accounts represent a growing financial and economic risk.

Second, the current system leads to uneven burdens of adjustment among countries, with those countries that allow substantial flexibility in their exchange rates bearing the greatest burden (for example, in having to make potentially large and rapid adjustments in the scale of export-oriented industries) and those that resist appreciation bearing the least.

Third, countries that maintain undervalued currencies may themselves face important costs at the national level, including a reduced ability to use independent monetary policies to stabilise their economies and the risks associated with excessive or volatile capital inflows. The latter can be managed to some extent with a variety of tools, including various forms of capital controls, but such approaches can be difficult to implement or lead to microeconomic distortions. The high levels of reserves associated with currency undervaluation may also imply significant fiscal costs if the liabilities issued to sterilise reserves bear interest rates that exceed those on the reserve assets themselves. Perhaps most important, the ultimate purpose of economic growth is to deliver higher living standards at home; thus, eventually, the benefits of shifting productive resources to satisfying domestic needs must outweigh the development benefits of continued reliance on export-led growth.

5 IMPROVING THE INTERNATIONAL SYSTEM

The current international monetary system is not working as well as it should. Currency undervaluation by surplus countries is inhibiting needed international adjustment and creating spillover effects that would not exist if exchange rates better reflected market fundamentals. In addition, differences in the degree of

currency flexibility impose unequal burdens of adjustment, penalising countries with relatively flexible exchange rates. What should be done?

The answers differ depending on whether one is talking about the long term or the short term. In the longer term, significantly greater flexibility in exchange rates to reflect market forces would be desirable and achievable. That flexibility would help facilitate global rebalancing and reduce the problems of policy spillovers that emerging market economies are confronting today. The further liberalisation of exchange rate and capital account regimes would be most effective if it were accompanied by complementary financial and structural policies to help achieve better global balance in trade and capital flows. For example, surplus countries could speed adjustment with policies that boost domestic spending, such as strengthening the social safety net, improving retail credit markets to encourage domestic consumption, or other structural reforms. For their part, deficit countries need to do more over time to narrow the gap between investment and national saving. In the United States, putting fiscal policy on a sustainable path is a critical step toward increasing national saving in the longer term. Higher private saving would also help. In addition, resources will need to shift into the production of export and import-competing goods. Some of these shifts in spending and production are already occurring; for example, China is taking steps to boost domestic demand and the US personal saving rate has risen sharply since 2007.

In the near term, a shift of the international regime toward one in which exchange rates respond flexibly to market forces is, unfortunately, probably not practical for all economies. Some emerging market economies do not have the infrastructure to support a fully convertible, internationally traded currency and to allow unrestricted capital flows. Moreover, the internal rebalancing associated with exchange rate appreciation – that is, the shifting of resources and productive capacity from production for external markets to production for the domestic market – takes time.

That said, in the short term, rebalancing economic growth between the advanced and emerging market economies should remain a common objective, as a two-speed global recovery may not be sustainable. Appropriately accommodative policies in the advanced economies help rather than hinder this process. But the rebalancing of growth would also be facilitated if fast-growing countries, especially those with large current account surpluses, would take action to reduce their surpluses, while slow-growing countries, especially those with large current account deficits, take parallel actions to reduce those deficits. Some shift of demand from surplus to deficit countries, which could be compensated for, if necessary, by actions to strengthen domestic demand in the surplus countries, would accomplish two objectives. First, it would be a down payment toward global rebalancing of trade and current accounts, an essential outcome for long-run economic and financial stability. Second, improving the trade balances of slow-growing countries would help them grow more quickly, perhaps reducing the need for accommodative policies in those countries while enhancing the sustainability of the global recovery. Unfortunately, so long as exchange rate adjustment is incomplete and global growth prospects are markedly uneven, the problem of excessively strong capital inflows to emerging markets may persist.

6 CONCLUSION

As currently constituted, the international monetary system has a structural flaw: it lacks a mechanism, market-based or otherwise, to induce needed adjustments by surplus countries, which can result in persistent imbalances. This problem is not new. For example, in the somewhat different context of the gold standard in the period prior to the Great Depression, the United States and France ran large current account surpluses, accompanied by large inflows of gold. However, in defiance of the so-called rules of the game of the international gold standard, neither country allowed the higher gold reserves to feed through to their domestic money supplies and price levels, with the result that the real exchange rate in each country remained persistently undervalued. These policies created deflationary pressures in deficit countries that were losing gold, which helped bring on the Great Depression.[3] The gold standard was meant to ensure economic and financial stability, but failures of international coordination undermined these very goals. Although the parallels are certainly far from perfect, and I am certainly not predicting a new Depression, some of the lessons from that grim period are applicable today.[4] In particular, for large, systemically important countries with persistent current account surpluses, the pursuit of export-led growth cannot ultimately succeed if the implications of that strategy for global growth and stability are not taken into account.

Thus, it would be desirable for the global community, over time, to devise an international monetary system that more consistently aligns the interests of individual countries with the interests of the global economy as a whole. In particular, such a system would provide more effective checks on the tendency for countries to run large and persistent external imbalances, whether surpluses or deficits. Changes to accomplish these goals will take considerable time, effort and coordination to implement. In the meantime, without such a system in place, the countries of the world must recognise their collective responsibility for bringing about the rebalancing required to preserve global economic stability and prosperity. I hope that policy-makers in all countries can work together cooperatively to achieve a stronger, more sustainable and more balanced global economy.

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Henrique Meirelles, Ben Bernanke, Jean-Claude Trichet and Dominique Strauss-Kahn

SESSION 4

POLICY PANEL
EMERGING FROM THE CRISIS – WHERE DO WE STAND?

PANEL STATEMENT

BY JEAN-CLAUDE TRICHET, PRESIDENT OF THE ECB

Let me thank Ben again for his marvellous exposition. I will start by presenting the other two panellists.

We are privileged to have here with us Henrique Meirelles. He needs no introduction, of course, but let me only remind you that he was a private banker. He joined BankBoston in 1974, was appointed President of BankBoston Corporation in 1996, and President of FleetBoston's Corporate and Global Bank in October 1999, following the merger of BankBoston and Fleet Financial Group. Finally, he has been Governor of the Central Bank of Brazil since January 2003, making it almost an eight-year term – I know these eight-year terms very well.

Henrique, you have been instrumental in the fantastic success of the Brazilian economy. I expect that you can help us see things from the perspective of the emerging market economies, taking into account the fact that not all emerging countries are in the same position, which was crystal clear in what we just heard from Ben.

We are also privileged to have here with us Dominique Strauss-Kahn. He has a PhD from the University of Paris. He was a professor of economics at the University of Paris. He was a Member of Parliament in the French National Assembly, of which he also chaired the Finance Commission. He was France's Minister of Industry and International Trade from 1991 to 1993 and their Minister of Economy, Finance and Industry from 1997 to 1999. He left the latter Ministry immediately prior to the introduction of the euro, but he had coordinated all the related preparations. Since November 2007 he has been the tenth Managing Director of the International Monetary Fund (IMF).

Dominique, you have *the* global perspective, not only because of the global reach of the institution you are heading – the IMF – but also because you are so instrumental in the G20.

Ladies and gentlemen, as you see, with this panel we have a unique capacity to look at the current situation from a global perspective. This is crucial, because since 2007 we have been experiencing the first serious stress test of the new entity, i.e. of the fully integrated global financial system and the global economy. This global economy has been created over decades. Two processes accelerated its creation: first, the fall of the Soviet Union, and second, the conversion of the developing countries, as they were called at that time, into the impressive, *emerging market economies*, as they are called now.

I perceive a great unity of purpose between central banks. We are all striving for credible medium to long-term price stability. I note a striking convergence in the definitions of price stability: in a recent speech Ben Bernanke defined price

stability as "inflation of about 2%, or a bit below" (Bernanke (2010)), which is very close to the ECB's definition: "below, but close to, 2%".

Central bankers still hold differing views on a number of very important issues, many of which are under discussion at this conference. One example is whether standard and non-standard measures are viewed as substitutes for, or complements to, each other. In his speech Ben Bernanke presented the view that these tools are substitutes. In contrast, we at the ECB think of them as complements: standard measures are the tools we use to define the monetary policy stance appropriate to delivering price stability. Non-standard measures are the tools that permit this monetary policy stance to be transmitted as correctly as possible to the economy. Thus, non-standard measures are commensurate with financial market anomalies, and they address the shortcomings of the monetary policy transmission channels. In this context I find it interesting that in the speech we just heard, Ben suggested that thanks to the Federal Reserve's new power to pay interest on banks' reserves, its policy stance might be tightened even while bank reserves are still high.

Views on macro-prudential regulation and the monitoring of systemic risks also differ in some aspects between the two sides of the Atlantic, although here too we have a unity of purpose: we are all building institutions that will be able to address the weaknesses exposed by the global stress test that we are experiencing now.

I followed Ben's comments on the dollar exchange rate. To me, his assertions at the Economic Club of New York several months ago constituted a historically very important statement on the part of the Federal Reserve. At the time he said how attentive he was to the fluctuations of the dollar exchange rate, and that the Federal Reserve's "commitment to (its) dual objectives, together with the underlying strengths of the U.S. economy, will help ensure that the dollar is strong and a source of global financial stability." (Bernanke (2009)). We all strongly share the view that a strong dollar that is credible vis-à-vis the other major floating currencies is very important. I also support his message on the current account surplus in economies with exchange rates that are not sufficiently flexible.

Let me conclude with global imbalances. We absolutely need to correct the current global imbalances, and we need to develop an appropriate strategy with which to tackle them in the future. If we fail to fulfil these two goals, we will pave the way for future major crises.

Thank you for your attention, and let me hand over the floor to Dominique Strauss-Kahn.

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PANEL STATEMENT

BY DOMINIQUE STRAUSS-KAHN,
MANAGING DIRECTOR OF THE INTERNATIONAL MONETARY FUND (IMF)

Thank you, Jean-Claude, for the introduction and for inviting me to appear on this panel of central bankers. I'll try to answer briefly today's question: "Where do we stand in the aftermath of the crisis?"

Two years ago in Washington, the President of the United States decided to convene for the first time a G20 meeting at the Head of State level. That meeting set a precedent for cooperation between countries. Thanks to this cooperation the global economy was prevented from undergoing something that could have been as bad as the Great Depression. This cooperation was relatively easy to achieve, because everybody was scared, and so the will to work together and to find a consensus was very strong.

Now we are entering a second phase. The crisis is not over, but many may be thinking that the worst is behind us, and so this willingness to try to work together is not as strong as it has been. Against this background, I will comment on three main topics: the macroeconomic situation, financial sector reform, and the governance of the global economy.

1 THE MACROECONOMIC SITUATION

The macroeconomic recovery has proved to be very uneven. This fact was discussed extensively in Ben Bernanke's speech. Growth is very low in Europe and very high in many emerging countries, with the United States in-between. Because the recovery is uneven, it is very fragile. This makes it absolutely necessary to support growth, even if supporting growth creates other problems. The macroeconomic stimulus that helped to avoid a large-scale depression also had some undesirable side effects. But one always needs to prioritise, and the hierarchy of problems at this time was clear: supporting growth was more important than the possible bad side-effects of this policy.

Thus, wherever it is possible – and it is not possible everywhere – support for growth is still absolutely necessary. We are still far from the end of the crisis. Therefore, developments such as whether US economic growth picks up to 4%, or goes down to 2% or even less, have huge consequences for the rest of the world.

But, at the same time, here lies the big contradiction, because we also need to restore confidence. Restoring confidence relies on addressing the public debt situation of many countries, especially, but not only, in Europe. It is not only a question of the countries "at the edge of the cliff" (for those, there's no choice): it also concerns other countries.

They absolutely have to provide medium-term consolidation plans, even if they don't apply them immediately. Markets have to be convinced that all these governments are determined to reduce debt ratios to sustainable levels. Debt ratios are moving in the right direction, but I'm not sure that they are moving fast enough.

The problems are particularly difficult in countries where the debt ratios are not obviously sustainable in the long term, even if there are no immediate crises. These problems have to be faced with strong commitment in the medium term.

Those countries that are "at the edge of the cliff" need strong programmes, like the programme supported by the European Commission, the ECB and the IMF in Greece. I must say that I am very happy with the cooperation we have with the different institutions – the European Commission and the ECB. The Greek programme has been very important. Greece represents only 2.5% of the euro area's whole GDP, so it might seem that its influence is not very big. In reality, the linkages that we have now in the global economy, and even more so in the euro area, are such that even the collapse of a country representing such a small percentage of euro area GDP could have a lot of consequences. I am glad to see that the Greek programme is on track. This programme is difficult, but I think the Greek government is really bold and is doing what it has to do.

Other countries, especially the emerging market economies, are facing a different set of problems: their macroeconomic imbalances trigger large and unexpected capital inflows and currency pressures. These countries revalue their currencies until they believe they hit a limit of revaluation; they sterilise and put in place prudential control measures. The problems these countries are facing trigger backlashes against free capital mobility.

In the medium term there is no way to rebalance the global economy without an increase in the value of many emerging countries' currencies. We have to recognise this. Revaluation can be done progressively – it probably *has* to be done progressively – but the idea that we can solve the so-called imbalance problem without some important changes in the relative value of currencies is something I just cannot understand, even on paper. I am not that pessimistic with regard to the prospect of gradual exchange rate realignment. I know that there is a perception that the G20 summit in Seoul was rather a failure, but I am not exactly of this point of view and I will say a few words on this later, when I discuss the governance question.

2 FINANCIAL SECTOR REFORM

Let me shift to the second topic: the financial sector. A lot has been achieved on this front. You all remember the promise made by the Heads of State of the G20 in London in April 2009. The promise was to fix the financial sector so that this kind of crisis would never happen again. Probably that promise was a bit too ambitious, but at least the citizens are expecting that the problems we

identified in the financial sector will be fixed. So I welcome the release by the Basel Committee of what are commonly known as the Basel III rules. There are still open issues concerning implementation, which I will not enter into now, but the progress is clear.

Regulation is necessary, but not sufficient, since there are at least three pillars within a stable financial system: regulation, supervision and crisis resolution. We need more work on supervision, as even the best regulation will not work without supervision. We also need more work on crisis resolution, especially cross-border resolution. The issues of "too important to fail" institutions and moral hazard make this area very difficult, and this is probably one of the reasons why we haven't made more progress. The areas of supervision and crisis resolution are crucial for the IMF, and I hope that the EU can help show the way forward and that the progress is quick. Will we have a new financial crisis in two years? Hopefully not. In five years, in ten years, in 15 years? Who knows? So it is important that we are ready in case a new crisis comes. This is fundamental to the public's trust in the economic institutions. This trust would be seriously undermined if another crisis emerged looking like the previous one.

We also have to better address the risks posed by the non-bank sector, and advance the agenda of creating a macro-prudential framework. The IMF is contributing to this work too. This agenda may change part of the work of the central banks.

3 GLOBAL GOVERNANCE

The last topic I would like to cover is governance. The way this crisis was addressed at the global level was in my view absolutely unprecedented in mankind's history: a lot of countries facing the same problem at the same moment in time put in place the same policy in a concerted way. This was a new beginning for global governance. During this crisis the general public has come to understand clearly that globalisation is not any longer only a topic for lectures and conferences: it is a reality. And it has become obvious that it is impossible to find a domestic solution to a global problem. This means that global governance in economic and financial matters has to be strengthened.

The progress of global governance will be difficult. We are in the second phase of the G20. The first phase – the crisis phase – was easy. But in the second phase the threat appears less dramatic than before and it seems that most of the crisis is behind us. Domestic concerns start to predominate, which is politically and ethically absolutely legitimate – politicians are elected to address the problems of their own people. But contradictions may arise between domestic concerns and the consideration of global consequences, and these contradictions have to be solved.

European countries have moved a long way from the contradictions they faced 40 years ago. They came to understand that cooperation was the only way forward and that the benefits of cooperation were huge. It took 20-25 years to largely overcome the worries associated with national public opinions on sovereignty. Governance issues at the global level are similar, but I guess it will not take 25 years to solve them, partly because we just do not have 25 years for this. It was very obvious in Seoul that on the intellectual side everyone understands that big players have big responsibilities, and that the bigger you become the more responsibility you get. Free-riding, trying to take advantage of the situation without looking at the consequences for the rest of the world, carries clear risks as it may backfire on your own economy.

That intellectual perception notwithstanding, the reality of politics is sometimes very different. The future of the global economy depends on our capacity to solve this contradiction. I am optimistic: I think we will have ups and downs, good G20 summits and less good G20 summits, but over time – in 12 months, in 18 months, in two years – a really strong consensus *can* emerge. This is more than a wish: this is a possibility. The opposite outcome would be a disaster for the global economy.

4 CONCLUSIONS: WHERE WE STAND

So let me conclude on where we stand in the aftermath of the crisis. Clearly the global economy after the crisis cannot be the same as before. The lessons we have to draw are of two kinds.

The first lesson is that we need to fix the outstanding problems that formed part of the roots of the crisis, even if we know that the next crisis will have different roots.

The second lesson is that we need to be creative and imagine what the next global system will be like. For me, a cooperative system is the only possibility, because in the end such a system is a win-win solution for the global economy. Everybody is better off in a cooperative system than in a situation where everybody follows their own policy without taking into account what is going to happen to others.

With this cooperative system in mind, at the IMF we are developing a new kind of process: the spillover report. These reports will introduce a different type of analysis of countries' policies than was used previously. I think this will be helpful for the international community. We all need to progress in understanding that we, especially the big countries, are players in a global game. The idea that countries can find their own solutions for their domestic purposes is an idea from yesterday that cannot bring any good to the global economy. Cooperation has been successful and cooperation is the direction in which we need to continue.

PANEL STATEMENT

BY HENRIQUE MEIRELLES, GOVERNOR OF THE CENTRAL BANK OF BRAZIL

Thank you, Jean-Claude, for the introduction. With reference to the question of where we stand now, I will address two main issues. First, I will discuss the macroeconomic policies adopted in response to the crisis. Second, I will spend some time on the global imbalances. I will discuss these issues from an emerging markets' point of view and, in particular, from the Brazilian point of view.

I MACROECONOMIC POLICIES DURING THE CRISIS

The first phase of the crisis did not affect Brazil. We were growing, as were most emerging markets, at a very fast pace until the Lehman Brothers' collapse in the third quarter of 2008. The Lehman Brothers' bankruptcy was the turning point: it triggered an almost complete collapse of cross-border credit lines. Since about 20% of the credit in Brazil was cross-border funded, this led to a series of consequences.

First, we experienced a very sharp drop in liquidity. The domestic credit market was impaired. As a result, industrial output dropped sharply (with around a 20% decrease in only two months in late 2008) and GDP contracted at the annualised rate of 13% in the last quarter of 2008.

At the same time, we had a run against the currency, with an almost 50% depreciation in a short period of time. Inflation expectations rose. The situation started to dangerously resemble the pattern of past emerging market crises. In these past episodes, higher prices decreased the purchasing power of the average worker, which decreased demand. In response, corporations increased margins, rather than decreasing prices, in order to offset the declining sales. The result was a stagflation that has characterised some emerging market economies, particularly during the 1980s and a good portion of the 1990s.

We addressed these threats with policies which roughly followed those described by Ben Bernanke in his speech earlier today, but with distinct aspects appropriate for our case. We immediately adopted non-standard measures to address impairments to the transmission channel in Brazilian financial markets. The main problems were in the dollar credit market. Therefore, we started lending our foreign exchange reserves, first to the banking system and then to corporations. We also intervened in the dollar forward market because there was a liquidity problem there as a result of all the derivatives issued by exporters trying to hedge. Other measures followed, such as sales of dollars in the spot market and a reduction of the required reserves.

However, while undertaking all these measures we kept the policy rate steady and we reiterated our commitment to the inflation target. We stated that we would only decrease rates in the event that we saw inflation expectations falling.

These policies had important effects. First, the commitment to price stability and the fact that the interest rate was kept at the same level discouraged further runs against the currency. If we had lowered the rate, it would have made it even cheaper to bet against the currency. Second, thanks to the non-standard measures, the normal functioning of the credit markets was restored quickly. Credit flows, which had fallen dramatically in late September/October, were almost back to normal in December. At the same time, the run on the currency abated.

Subsequently, a fiscal stimulus was adopted and applied in December 2008. In January 2009 we started lowering the policy rate. That led to a quick recovery. Brazil lost about 800,000 jobs during the crisis. But 1.2 million new jobs were created in 2009 and, in 2010 so far, about 2.5 million new jobs have been created. Unemployment is at the lowest level ever, currently standing at 6.5%. Industrial output grew fast to begin with, then stabilised somewhat, and is now slowly picking up again.

Thus, growth is currently strong, as in many other emerging markets. We expect GDP growth of 7.3% for the year 2010, with market expectations a little higher than that, and next year we expect some moderation, back to the potential growth rate.

2 GLOBAL IMBALANCES

We now come to the question of global imbalances. In Brazil, as well as in Mexico, South Africa and many other countries, growth is basically led by domestic demand. In Brazil, we have a strong labour market, fast credit expansion, a high level of consumer and business confidence, and very large public investment in order to cope with the higher rate of GDP growth.

This is leading to a strong growth in imports. Imports have expanded by 38% in Brazil, and by more than 30% in India, while high growth rates are also being observed in South Africa and other countries. As a result, in the case of Brazil, the current account deficit is widening from around USD 49 billion to an expected USD 67 billion next year. We are expecting to see a similar situation in South Africa, India and other countries.

Thus, emerging market economies are not all in the same position in terms of global imbalances. True, in general, the emerging market economies are growing faster than the developed economies. But among the emerging market economies we observe two different situations in terms of imbalances. Some of these economies have external surpluses. Others like Brazil, for instance, have external deficits.

Brazil's external deficit is a cause for concern for us. In the past, the correction of current account deficits has not always happened in an orderly way and has often been accompanied by the "run for the exit" phenomenon. We also worry that the capital inflows accompanying the current account deficit may contribute to excess liquidity and asset price bubbles.

We are taking a number of measures to address these concerns. We have raised the policy rate by 200 basis points and we had withdrawn all the non-standard measures by May 2010. Most of the fiscal stimulus was withdrawn by March of the same year. In parallel, we are strengthening prudential rules in the credit market. Fiscal authorities have applied a small tax on capital inflows. Our international reserves, which proved to be so instrumental during the crisis in 2008, also have a clear macro-prudential role.

We are dealing with the disproportionate effects that the global imbalances are having on our economy. The measures we have applied are working well and our economy is now better protected than it was in the past. Having said that, we are of course interested in global rebalancing, and thus strongly favour concerted international efforts to tackle the global imbalances.

PANEL STATEMENT

BY BEN S. BERNANKE, CHAIRMAN OF THE BOARD OF GOVERNORS, US FEDERAL RESERVE SYSTEM

The last time I was here at the ECB, almost exactly two years ago, I sat on a distinguished panel much like this one to help mark the 10th anniversary of the euro. Even as we celebrated the remarkable achievements of the founders of the common currency, however, the global economy stood near the precipice. Financial markets were volatile and illiquid, and the viability of some of the world's leading financial institutions had been called into question. With asset prices falling and the flow of credit to the non-financial sector constricted, most of the world's economies had entered what would prove to be a sharp and protracted economic downturn.

By the time of that meeting, the world's central banks had already taken significant steps to stabilise financial markets and to mitigate the worst effects of the recession, and they would go on to do much more. Very broadly, the responses of central banks to the crisis fell into two classes. First, central banks undertook a range of initiatives to restore normal functioning to financial markets and to strengthen the banking system. They expanded existing lending facilities and created new facilities to provide liquidity to the financial sector. Key examples include the ECB's one-year long-term refinancing operations, the Federal Reserve's auctions of discount window credit (via the Term Auction Facility) and the Bank of Japan's more recent extension of its liquidity supply operations. To help satisfy banks' funding needs in multiple currencies, central banks established liquidity swap lines that allowed them to draw each other's currencies and lend those funds to financial institutions in their jurisdictions; the Federal Reserve ultimately established swap lines with 14 other central banks. Central banks also worked to stabilise financial markets that were important conduits of credit to the non-financial sector. For example, the Federal Reserve launched facilities to help stabilise the commercial paper market and the market for asset-backed securities, through which flow much of the funding for student, auto, credit card and small business loans, as well as for commercial mortgages. In addition, the Federal Reserve, the ECB, the Bank of England, the Swiss National Bank and other central banks played important roles in stabilising and strengthening their respective banking systems. In particular, central banks helped develop and oversee stress tests that assessed banks' vulnerabilities and capital needs. These tests proved instrumental in reducing investors' uncertainty about banks' assets and prospective losses, bolstering confidence in the banking system and facilitating banks' raising of private capital. Central banks are also playing an important ongoing role in the development of new international capital and liquidity standards for the banking system that will help protect against future crises.

Second, beyond necessary measures to stabilise financial markets and banking systems, central banks moved proactively to ease monetary policy to help support their economies. Initially, monetary policy was eased through the conventional

means of cuts in short-term policy rates, including a coordinated rate cut in October 2008 by the Federal Reserve, the ECB and other leading central banks. However, as policy rates approached the zero lower bound, central banks eased policy by additional means. For example, some central banks, including the Federal Reserve, sought to reduce longer-term interest rates by communicating that policy rates were likely to remain low for some time. A prominent example of the use of central bank communication to further ease policy was the Bank of Canada's conditional commitment to keep rates near zero until the end of the second quarter of 2010.[1] To provide additional monetary accommodation, several central banks – among them the Federal Reserve, the Bank of England, the ECB and the Bank of Japan – purchased significant quantities of financial assets, including government debt, mortgage-backed securities or covered bonds, depending on the central bank. Asset purchases seem to have been effective in easing financial conditions; for example, the evidence suggests that such purchases significantly lowered longer-term interest rates in both the United States and the United Kingdom.[2]

Although the efforts of central banks to stabilise the financial system and provide monetary accommodation helped set the stage for recovery, economic growth rates in the advanced economies have been relatively weak. Of course, the economic outlook varies importantly by country and region, and the policy responses to these developments among central banks have differed accordingly. In the United States, we have seen a slowing of the pace of expansion since earlier this year. The unemployment rate has remained close to 10% since mid-2009, with a substantial fraction of the unemployed out of work for six months or longer. Moreover, inflation has been declining and is currently quite low, with measures of underlying inflation running close to 1%. Although we project that economic growth will pick up and unemployment decline somewhat in the coming year, progress thus far has been disappointingly slow.

In this environment, the Federal Open Market Committee (FOMC) judged that additional monetary policy accommodation was needed to support the economic recovery and help ensure that inflation, over time, is at desired levels. Accordingly, the FOMC announced earlier this month its intention to purchase an additional USD 600 billion of longer-term Treasury securities by the end of the second quarter of 2011, a pace of about USD 75 billion per month. The Committee will also maintain its current policy of reinvesting principal payments from its securities holdings in longer-term Treasury securities. Financial conditions eased notably in anticipation of the Committee's announcement, suggesting that this policy will be effective in promoting recovery. As has been the case with more conventional monetary policy in the past, this policy action will be regularly reviewed in light of the evolving economic outlook and the Committee's assessment of the effects of its policies on the economy.

1 Recent work at the Bank of Canada (see He (2010)) suggests that the bank's forward guidance may have pushed back expectations of when policy accommodation would be withdrawn. For a differing view, see Chehal and Trehan (2009).

2 For the United States, see Gagnon *et al*. (2010), D'Amico and King (2010) and Hamilton and Wu (2010); for the United Kingdom, see Joyce *et al*. (2010).

I draw several lessons from our collective experience in dealing with the crisis. (My list is by no means exhaustive.) The first lesson is that, in a world in which the consequences of financial crises can be devastating, fostering financial stability is a critical part of overall macroeconomic management. Accordingly, central banks and other financial regulators must be vigilant in monitoring financial markets and institutions for threats to systemic stability and diligent in taking steps to address such threats. Supervision of individual financial institutions, macro-prudential monitoring and monetary policy are mutually reinforcing undertakings, with active involvement in one sphere providing crucial information and expertise for the others. Indeed, at the Federal Reserve, we have restructured our financial supervisory functions so that staff members with expertise in a range of areas – including economics, financial markets and supervision – work closely together in evaluating potential risks.

Second, the past two years have demonstrated the value of policy flexibility and openness to new approaches. During the crisis, central banks were creative and innovative, developing programmes that played a significant role in easing financial stress and supporting economic activity. As the global financial system and national economies become increasingly complex and interdependent, novel policy challenges will continue to require innovative policy responses.

Third, as was the focus of my remarks two years ago, in addressing financial crises, international cooperation can be very helpful; indeed, given the global integration of financial markets, such cooperation is essential. Central bankers worked closely together throughout the crisis and continue to do so. Our frequent contact, whether in bilateral discussions or in international meetings, permits us to share our thinking, compare analyses and stay informed of developments around the world. It also enables us to move quickly when shared problems call for swift joint responses, such as the coordinated rate cuts and the creation of liquidity swap lines during the crisis. These actions and others we have taken over the past few years underscore our resolve to work together to address our common economic challenges.

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GENERAL DISCUSSION

Trichet thanked all panellists. Referring to Strauss-Kahn's statement, he said he would love to fully echo the opinion that the European governance framework could be an exemplary model for global governance. However, Europe still has some progress to make in internalising the externalities of countries' policies.

Trichet also agreed with Strauss-Kahn's views on global governance. Global governance has changed dramatically. It was of great importance that the G7 passed the baton to the G20. At the level of central banks, the baton of the G10 was passed to the Global Economy Meeting, with the Economic Consultative Committees as its "steering group".

The development of the Basel rules has progressed, with the support of the international community. Trichet remarked that this success is due to the fact that all of those gathered – Brazilian, Mexican, Russian and all other colleagues included – are working together.

Commenting on the transatlantic differences in policies, Trichet highlighted the difference in financial structures. The ECB focuses mainly on banks, as they provide 70% of financing in Europe, compared with about 30% in the United States.

Overall, the sentiment in the Governing Council is that the perception ten years ago that the ECB was somehow peculiar has now largely disappeared. The two-pillar strategy is now widely recognised. Also, Trichet was satisfied to hear Bernanke talking about an inflation objective of "about 2% or a bit below" in a recent speech, since he recalled that the ECB had been criticised for this asymmetry in its definition of price stability. He agreed with the panellists that times are extremely demanding, so there is no room for complacency, and ended by inviting questions from the floor.

Agustín Carstens Carstens (Governor of the Bank of Mexico) agreed with the thrust of Meirelles' panel statement and asked Strauss-Kahn about the IMF's change of stance on capital controls two years earlier – the IMF had adopted a less hostile approach to capital controls, in contrast to its absolute rejection before. He asked what the IMF had learned about capital controls since its change of approach and if these controls worked or not.

Carstens agreed with Bernanke that the world needs a strong US economy and also an increase in US savings. He asked what specific policies could be used to align US consumption and permanent income, given that the imbalance between consumption and permanent income in the United States was at the source of the crisis.

Finally, he referred to some euro area governments' calls to allow defaults or haircuts on euro area sovereign debt. He underscored that the financial system and its functioning rely on the existence of a "safe asset" and asked Trichet how

likely it is that such an approach will be adopted and went on to query what a world without a safe asset would mean.

Strauss-Kahn answered that, first, there is no doubt that it is better to have unrestricted capital flows in the long run, as they are part of the necessary market adjustment. There may, however, be scope for intervention in the short run. Second, problems may exist relating to both capital inflows and outflows. Managing outflows raises particularly tricky questions about investors' liberty. For instance, in Iceland the IMF-supported program had to handle capital outflows. Third, regarding capital inflows, the first line of defence is to allow an increase in the value of the currency. He agreed that, in the short run, disruptions may justify temporary capital controls, but such controls are not a solution for the medium term and should not be used as a substitute for good policies, including structural reform. The IMF is considering a framework for qualifying capital controls and identifying those that are less harmful.

Bernanke stressed that current account deficits and surpluses are general equilibrium phenomena, emerging from the interaction of many factors across countries. Thus, he rejected the view that the United States can tackle its current account deficit on its own while other countries stand aside. The US current account deficits preceding the crisis were not primarily caused by a change of consumption behaviour by US households. Rather, the consumption-income imbalance partly arose from the export-led strategies of some emerging market economies. The evidence for this view is that long-term interest rates at that time were low, not high. If the US deficits had been driven by US demand, long-term interest rates would have been high.

But he agreed that deficit countries have to do their part to improve saving relative to investment. In the longer run, the United States needs to address its fiscal position. Raising households' savings is difficult, as policy tools are less well suited for this task. But Bernanke stated that one thing they have learned from the crisis is that credit standards do make a difference. In the United States, credit at times was made available to people who were not able to manage it. Saving rates have risen significantly since credit standards have tightened. Exchange rates by themselves are unlikely to suffice for rebalancing, and structural adjustments are needed on both sides.

Trichet remarked that the euro area is too often viewed as a collection of individual countries rather than as a single entity. The euro area as a whole is approximately in balance with respect to the rest of the world. Regarding Carsten's question, he answered that the ECB is calling for the same framework for managing sovereign debt crises in the euro area as the one that exists at the global level and has been operating for decades. He hoped that Europe's framework would crystallise soon.

Rania Al-Mashat (Central Bank of Egypt) asked Strauss-Kahn if the new governance structure of the IMF will contribute to addressing the global imbalances more effectively. Will emerging markets take more responsibility for the external consequences of their policies and take measures that reduce

their surpluses even if they dampen their growth? **Strauss-Kahn** answered that, by adjusting quotas, the IMF has solved a long-lasting question of legitimacy, although this was only one of many important results of the Seoul G20 summit. Although IMF quotas may not be the most important factor, they do signal the increasing recognition of big emerging market economies as key global players. Strauss-Kahn hopes that this recognition will be associated with more globally-oriented economic policies in these countries. For example, China, in his view, understands its role in solving global imbalances and is moving its policy in the right direction, speed being the only issue.

Sukudhew Singh (Central Bank of Malaysia) first expressed a concern about the growth prospects of small open economies currently facing sharply appreciating exchange rates and growing commodity prices. Second, he asked Bernanke about the benefits of injecting additional liquidity. He pointed out that while the Federal Reserve had injected liquidity of about 10% of GDP, credit to the economy had increased by only about 2-3% of GDP and financial institutions' deposits with the Federal Reserve had increased by 7.4% of GDP. Fiscal and macro-prudential policies are in a contractionary mode and monetary policy is doing all or most of the "heavy lifting". Is monetary policy "pushing on a string"? Aren't central banks running the risk of overpromising and potentially compromising their credibility?

Bernanke responded that asset purchases work through portfolio substitutions, motivating investors to move between assets and causing changes in term premia and relative prices. Asset purchases are financed by increasing financial institutions' reserves with the central bank, but looking at changes in reserves is not a good criterion for judging monetary policy efficacy. Monetary policy efficacy should be measured by its impact on overall financial conditions. There is evidence that this impact has been significant. There is concern over how much changes in asset prices will impact real activity, and this is not yet known. That being said, the fear of "pushing on a string" has come up every decade since the 1930s, but retrospectively there is no example of when it was true. For example, it is now known that monetary policy changes and gold inflows were an important part of the recovery starting in 1933. In the light of all the evidence, Bernanke is sceptical about the "pushing on a string" idea. But he agreed that central banks should not overpromise; the effects of monetary policy are meaningful, but moderate, so any help from the private sector and other policies is very useful in the current circumstances.

Geanakoplos said that non-standard tools amount to lending at more favourable terms than markets terms (both lower rates – a standard tool – and lower collateral). One lesson from the crisis is that in crisis times the private sector asks for too much collateral. By contrast, in normal times the private sector may not ask for enough collateral. Therefore, central banks should continuously manage collateral. Collateral regulation should be the additional policy tool commensurate with the new added responsibility for financial stability. Central banks other than the Federal Reserve and the ECB are already starting to manage loan-to-value ratios. It was mentioned that the US financial regulator already manages collateral, but it would be natural for central banks to do this.

The current practice resembles the Soviet Union approach where one bureau managed prices, while another bureau managed quantities.

Bernanke said that the Federal Reserve is moving in the direction Geanakoplos suggested. To a significant extent, price and quantity departments are both in the central bank now: the Federal Reserve implements monetary policy and also carries out macro-prudential supervision. For example, under the Dodd-Frank Act, the Federal Reserve is involved in the process of setting margin and capital requirements for OTC derivatives held by major banks. The Federal Reserve is also involved in the Basel III Accord, which not only controls leverage via capital requirements, but also includes a time-varying counter-cyclical buffer component. The Federal Reserve historically has not formally managed loan-to-value ratios, but it is analyzing the costs and benefits of a range of macro-prudential tools. This may not go as far as Geanakoplos would like, but the basic principle of supervising financial firms with a view to promoting broader financial stability is accepted and incorporated in a lot of what the Federal Reserve is doing.

Meirelles remarked that Brazil does have the same entity dealing with both macro-prudential and monetary policy and this proved essential during the crisis. It is important to take an integrated approach, with the coordination of macro-prudential, micro-prudential and monetary policies. He also emphasised the importance of global coordination.

Trichet stressed that the macro-prudential supervisor in Europe – the European Systemic Risk Board (ESRB) – is a separate institution from the ECB. The ECB is responsible for delivering price stability. But, given its expertise and its stake in stability, it is not surprising that it is called to extensively support the ESRB.

Spence Hilton, James McAndrews, Cornelia Holthausen, Jürgen Stark, Marvin Goodfriend and Rafael Repullo

SESSION 5

PANEL
MONETARY POLICY OPERATIONS – EXPERIENCES DURING THE CRISIS AND LESSONS LEARNT

IMPLEMENTING MONETARY POLICY IN CRISIS TIMES – THE CASE OF THE ECB[1]

BY NUNO CASSOLA, ECB
ALAIN DURRÉ, ECB
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ABSTRACT

This paper discusses the implementation of monetary policy during the economic and financial crisis of 2007-10. After summarising the different measures adopted by the ECB during these turbulent times, we present a stylised theoretical model that allows us to focus on the main trade-offs faced in implementing monetary policy. We argue that it is the level of key policy interest rates and the width of the interest rate corridor set by the standing facilities, and not the quantity of liquidity that is provided to the market, that are key to sustaining (some) private intermediation in the money market in the presence of increasing credit and liquidity risk. The model highlights the trade-offs faced by central banks when deciding on the degree and timing of its interventions. The main implications of the theory are supported by the empirical evidence.

1 INTRODUCTION

This paper analyses the crisis management tools and monetary policy decisions of the ECB and the Eurosystem (hereafter 'the ECB') during the 2007-10 economic and financial crisis. This crisis exposed widespread market failures in various segments of the money and credit markets and an apparent intertemporal link between liquidity and credit risks. Against this background, the purpose of this paper is as follows. First, it provides a simple theoretical model designed to capture the main challenges for monetary policy implementation faced by a central bank having an operational framework similar to that of the ECB during the financial turmoil. The main focus of our analysis is on the trade-offs faced by central banks in setting the levels of key policy interest rates and in choosing the width of the interest rate corridor of their standing facilities. We assume that central banks may care about both the level of short-term interest rates – in particular, the deviation from the target rate – as well as trading activity in the interbank market. We argue that, in the presence of increasing credit and liquidity risks, a central bank is compelled to change the way it sets its policy rates if it wants

1 The authors would like to thank Laurent Clerc, Philipp Hartmann, Paul Mercier, Francesco Mongelli, Huw Pill and the members of the Monetary Policy Committee for their helpful comments on previous drafts. We are grateful to Vincent Brousseau and Piet Philip Christiansen for their valuable input. The opinions expressed in this paper are those of the authors and do not necessarily reflect the views of the European Central Bank or of the Eurosystem.

to prevent a market breakdown. Interestingly, it may be possible to avoid market collapse even though the ultimate source of the crisis – increasing credit risk – is not directly affected by the actions of a central bank. In our model, the volume of liquidity provided by the central bank is determined by the recourse of banks to the standing facilities, which in turn depends on market conditions and are not a discretionary choice of the central bank. Accordingly, various degrees of central bank intermediaton are possible, from total absence to complete replacement of the market. The intertemporal structure of credible central bank decision-making is emphasised while highlighting key issues related to the exit strategy from non-standard policies. Second, the paper presents some novel econometric evidence for the specific case of the ECB. In particular, it supports the main empirical implications of the theory, namely that the volume of credit provided by the ECB contributed to a decline in the spreads between unsecured and secured interbank market rates and in the liquidity risk premium, albeit at the cost of decreasing money market activity.[2]

The remainder of the paper is organised as follows. Section 2 briefly recalls the main market developments since August 2007 and, in parallel, introduces the measures implemented by the ECB and the challenges it faced. Section 3 presents the theoretical model. Section 4 reports the econometric evidence. After offering some concluding remarks in Section 5, Section 6 contains a literature review of both theoretical and empirical studies related to the actions of central banks during the crisis.

2 THREE PHASES IN THE CRISIS: MAIN CHALLENGES TO MONETARY POLICY IMPLEMENTATION

To discuss the implementation of monetary policy in the euro area during the crisis, it is useful to divide the period between 9 August 2007 and the time of writing (October 2010) into three phases, as follows (see Trichet (2010) for a similar breakdown of this period).

The first phase, "market turmoil", runs from 9 August 2007 – the day the French bank BNP Paribas announced that it had suspended the redemption of shares in the funds they had invested in sub-prime mortgages – until 15 September 2008 – the day Lehman Brothers failed following a run by its short-term creditors and prime brokerage costumers.

The second phase, "financial crisis", covers the last quarter of 2008 and the first three quarters of 2009. This period was marked by a sharp contraction in global output and trade, followed by a sluggish recovery. In fact, in the autumn and winter 2008/09, macroeconomic developments very closely tracked those observed at the start of the Great Depression of the 1930s. Moreover, it cannot

2 See Mercier and Papadia (2011) for a comprehensive narrative and analysis of the crisis period.

be overemphasised that the global economy entered its worst contraction since the 1930s against a backdrop of dysfunctional money and financial markets and severely weakened banking systems. During this phase the ECB/Eurosystem implemented enhanced credit support measures.

The third phase, from November 2009 onwards, is labelled "phasing-out" and "sovereign debt crisis". During this period the ECB announced and initiated the gradual phasing-out of enhanced credit support measures. However, a sovereign debt crisis started in late 2009 that reached a climax in the spring of 2010 and led to a reassessment of the phasing-out process. This is where the euro area stands at the time of writing. It is characterised by tensions in sovereign debt markets affecting, for different reasons, four euro area countries (Greece, Ireland, Portugal and, to some extent, also Spain).

For further reference[3], Chart 1 shows the provision and absorption of liquidity by the Eurosystem during the three phases; panel A of Chart 2 shows the EONIA rate and trading volume; panel B shows the rate of and activity in the overnight repo market; and panel C depicts the EURIBOR-OIS three-month interest rate spread. See also Tables 1-3.

2.1 MARKET TURMOIL

On 9 August 2007 severe tensions emerged in the euro interbank market with increasing credit and liquidity risk premia and declining market activity.[4] During the period from August 2007 to September 2008, the implementation of monetary policy by the ECB was mainly based on the so-called frontloading[5] of the fulfilment of the minimum reserve requirements. The main objective of this policy was to steer the overnight interest rate (EONIA) close to the key policy rate – the minimum bid rate in the main refinancing operations – which was achieved also through an increase in the frequency of fine-tuning operations (i.e. within the reserve maintenance period) on top of the regular fine-tuning operation on the last day of the reserve maintenance period.[6] Moreover, during the market turmoil phase, the ECB changed the term structure of its refinancing operations, increasing the weight of its longer-term refinancing operations (the three-month operation) from one third of the total outstanding credit before the crisis to two thirds. Supplementary operations were introduced with three and six-month maturities. This period was also marked by the beginning of unprecedented cooperation among the major central banks on liquidity policy measures (in particular between the ECB and the US Federal Reserve).

3 All charts and tables referred to in this paper are presented in the Annex at the end of the paper.

4 For a detailed description of the interaction between the Eurosystem's refinancing operations and the functioning of the money market during normal periods (i.e. prior to August 2007), see Beaupain and Durré (2008).

5 The frontloading policy consists in allotting significantly more than the strict refinancing needs of the banking system – benchmark allotment – at the beginning of the reserve maintenance period, and gradually reducing the surplus until the end of the reserve maintenance period.

6 See for instance Cassola, Holthausen and Würtz (2008) and Cassola and Huetl (2010) for further details and analysis of this period.

In retrospect, the main challenges faced by the ECB in its monetary policy implementation during this period seem to have been:

(i) how to calibrate the "right" amount and timing of frontloading;

(ii) how to steer the overnight interest rate without relying on the ECB to intervene "too" frequently, given the preference of the Governing Council of the ECB for a "hands-off" market-based approach to steering interest rates;

(iii) understanding why the reserve averaging mechanism was no longer sufficient to stabilise money market conditions (e.g. liquidity hoarding by banks, enhanced counterparty credit risk, cross-border market segmentation and idiosyncratic vs. aggregate liquidity uncertainty);

(iv) how to split the provision of liquidity between short and longer-term refinancing.

As Chart 1 shows, this phase was marked by a stable provision of refinancing in line with the aggregate liquidity deficit of the banking system, with virtually zero net recourse to the standing facilities, occasional fine-tuning operations and an increasing diversification of the weight and maturity of longer-term refinancing operations. During this phase the ECB managed the tensions in money markets arising from the financial market turmoil through a combination of automatic stabilisers and frontloading. Indeed, the design of the ECB's operational framework turned out to be crucial for its crisis management in the early stages of the crisis.[7] However, longer-term money market rates and overnight interest swap spreads remained elevated, were continuing to increase and were somewhat volatile (see Chart 2, panel C), while term funding markets remained seriously impaired. With hindsight, those were signs of the financial storm that was in the making (see Chart 3).

2.2 FINANCIAL CRISIS

The period between October 2008 and March 2009 was marked by a sharp contraction in global output and trade, against a backdrop of dysfunctional money and financial markets and severely weakened banking systems. During this period the main objectives of the monetary policy measures were to support the banking system and thereby ensure that one key element in the monetary policy transmission mechanism in the euro area was not disrupted, and also to prevent a systemic banking crisis. The ECB took several bold steps. First, the minimum bid rate was cut in a sequence of steps from 4.25% to a record low of 1% (the last rate decrease was implemented on 13 May 2009). Second, all refinancing operations were conducted at a fixed rate with full allotment. Fine-tuning operations were discontinued, except for the one on the last day of the reserve maintenance period. Third, between October 2008 and January 2009 the interest rate corridor of standing facilities was narrowed to 100 basis points.

7 See Cassola, Holthausen and Würtz (2008) for a decription and analysis of the automatic stabilisers.

The corridor was later restored to 200 basis points, but was narrowed again to 150 basis points when the minimum bid rate was decreased to 1%, in order to ensure that the rate on the deposit facility was above zero (see Chart 4). Fourth, the eligibility criteria for collateral was temporarily extended and, in addition, the credit threshold for eligibility was lowered from A- to BBB- for marketable assets (except asset-backed securities) and non-marketable assets (with an additional haircut). Fifth, international coordination with other central banks was strengthened. For example, on 8 October 2009 the key policy interest rate was reduced by 50 basis points in a concerted and historic move with other central banks including the Bank of England, the US Federal Reserve System and the Swiss National Bank. In addition, the ECB continued to provide liquidity in foreign currencies, most notably US dollars.

From April until October 2009 a sluggish economic recovery set in. Money market interest rates remained at very low levels with EONIA reaching its "effective lower bound", i.e. a level that is close to zero, but still allows some interbank market activity (deposit facility rate at 0.25%). Further support to the banking system was provided by the ECB through two additional measures. First, the ECB announced three refinancing operations with a maturity of one year (settled in July, September and December 2009). These operations were conducted with full allotment and fixed-rate tender procedures. Second, the ECB established its first monetary policy outright portfolio, under the covered bonds purchase programme.[8] The main objectives of the two measures were to further promote the decline in money market term rates; to encourage banks to maintain and expand their lending to households and corporations, in particular to small and medium-sized enterprises; and to help improve market liquidity, namely in the covered bond market (see Charts 3 and 7).[9]

In retrospect, the main challenges faced by the ECB in implementing its monetary policy during this period seem to have been the following.

(i) The aggregate liquidity situation in the banking system became largely driven by counterparties' bidding behaviour. This led to a situation of large and persistent recourse to the deposit facility (i.e. "excess reserves"). As a result, EONIA became more volatile, which seems to have been linked to the size of the time-varying liquidity surplus. In fact, EONIA became increasingly volatile when recourse to the deposit facility ("excess reserves") dropped below €50 billion (i.e. the liquidity demand schedule became more inelastic in this range). Nevertheless, after the settlement of the first one-year refinancing operation, a large "structural" (i.e. longer-term) liquidity surplus emerged and, as a result, EONIA stabilised at the bottom of the interest rate corridor, albeit at the cost of reduced activity in the overnight unsecured interbank market.

8 See Beirne, Darlitz, Ejsing, Grothe, Manganelli, Monar, Sahel, Tapking and Vong (2010) for a detailed description of the programme and its impact.
9 See also Charts 5 and 6 which are discussed in greater detail in Section 4.

(ii) The collateral framework became increasingly complex, with higher counterparty risks for the ECB, notwithstanding refinements in the risk control framework.

(iii) Faced with a market meltdown, the ECB had to step in to replace private financial intermediation. The question is when and at what pace to cease such a role. If done too early or too quickly, it may reignite the crisis; if it is too prolonged or is discontinued too slowly, it may have a persistent, detrimental impact on market functioning and efficiency.

(iv) The broad collateral framework and the full allotments interacted and, over time, tended to generate counterparties' "dependency" on refinancing from the ECB indeed, a significant proportion of the collateral posted with the ECB became rather illiquid (e.g. asset-backed securities).

(v) Choosing the exact composition of the bonds to be purchased under the programme raised issues of a more general nature related to forming a monetary policy outright portfolio in the particular context of the euro area. In fact, a monetary policy outright portfolio should be composed of assets with low risk and high liquidity, encompassing all euro area countries (e.g. weighted by the respective national central bank's capital share in the ECB). This proved to be difficult given incomplete financial market integration in the euro area, non-homogeneous domestic capital markets partially owing to fragmented legislation and standards, and renewed signs of market fragmentation across borders.

As Chart 1 shows, this period was characterised by a marked increase in the total amount of outstanding refinancing from the ECB, which stood above the aggregate liquidity deficit of the banking system (autonomous factors plus minimum reserve requirement) with a compensating large and persistent net recourse to the deposit facility. Interestingly, in spite of full allotment, fixed-rate tenders, banks significantly stepped up the frontloading of the fulfilment of their minimum reserve requirements. The share of the total amount of outstanding refinancing attributed to one-year longer-term refinancing operations increased markedly. In fact, the outstanding volume of one-year operations alone stood above the aggregate liquidity deficit of the banking system.

2.3 PHASING-OUT AND THE SOVEREIGN DEBT CRISIS

The period after October 2009 was, and still is, marked by evidence that the economic recovery in the euro area is likely to be gradual, but nevertheless sustained. Therefore, the Governing Council of the ECB decided that the "phasing-out" of the non-standard measures should be gradual, which has been facilitated, to a large extent, by the very nature of the measures undertaken. For example, by not renewing the one-year longer-term refinancing operations and other supplementary refinancing operations with three and six-month maturities, the aggregate liquidity surplus of the banking system was likely to be significantly reduced or even eliminated in steps. (This is indeed what happened in July 2010.) On the collateral side, eligibility requirements for asset-backed

securities were tightened (in December 2009) and the other measures taken (enlargement of the list of assets and reduction of the rating threshold) were expected to expire at the end of 2010. In addition, the supply of USD and FOREX swaps was discontinued and variable rate tender procedures were reintroduced for regular three-month refinancing operations.

In retrospect, no major challenges were faced in connection with the implementation of monetary policy during this period as corporate and covered bank bond spreads remained contained and term funding markets continued to improve (see Chart 2, panel C, and Charts 3 and 7). Nevertheless, a remaining issue was, and continues to be, the reliance of some counterparties on the Eurosystem for refinancing illiquid and non-marketable assets (e.g. asset-backed securities). The presence of such counterparties – if part of large banking groups, or small banks in large numbers – could complicate, somewhat, the return to variable rate tenders. In fact, if this procedure were applied to all refinancing operations with a sudden reduction in the allotment volumes by the ECB, it could lead to a sharp increase in tender rates, both in short and longer-term refinancing operations, and could eventually also lead to higher than warranted money market rates – from the point of view of maintaining price stability – thereby generating uncertainty about the monetary policy stance of the ECB.

In late 2009/early 2010, spreads of Greek government bonds relative to German bonds widened sharply (see Chart 8). Even though these developments could be interpreted as a result of the market's increasing concerns about the sustainability of public finances in Greece, clear signs of contagion to other euro area bond markets emerged towards the spring of 2010, affecting Ireland and Portugal and, to some extent, also Spain.

Liquidity in those segments of the euro secondary debt market dried up. These developments triggered a market dynamic that threatened to degenerate into a vicious liquidity spiral. In fact, a sequence of sovereign debt rating downgrades was accompanied almost in tandem by downgrades of (most) marketable securities issued by financial institutions headquartered in those countries affected by the sovereign debt crisis, and also led to further downgrades across a broad range of assets in the private securities markets. This implied – in some cases from a pure risk management perspective – a reduction in investors' and banks' exposure to a whole range of assets issued by domestic residents in those affected countries, triggering distressed sales that led to "one-way" selling markets with a further impact on the prices of those assets. The rating revisions and price declines, in turn, implied frequent margin calls and downward revaluation of the assets of the banking system, leading to sudden and sharp reductions in the value of banks' collateral in the euro area. Eventually, private repurchase markets were affected, with some government paper no longer being accepted as collateral when posted by banks headquartered in an affected country (meaning that markets attached a high positive correlation between sovereign and banks' default risk). Money market spreads widened again, while volumes in the overnight segment declined (see Chart 2), bid/ask spreads widened (see Chart 9) and setbacks occurred in the covered bond market (see Chart 3) and corporate bond market (see Chart 7).

At this stage, systemic financial stability in the whole euro area became a matter of serious concern and the transmission mechanism of monetary policy became seriously impaired.

In response to those events, on 10 May 2010 euro area governments announced a comprehensive package of measures, including the European Financial Stability Facility. On the same day the ECB announced the launch of the Securities Markets Programme. Under this programme, the ECB can intervene in the euro area (private and public) debt securities markets to ensure depth and liquidity in dysfunctional market segments and to restore the proper functioning of the monetary policy transmission mechanism. In addition, the ECB reintroduced some of the non-standard measures that had been withdrawn earlier. In particular, the ECB reintroduced the fixed-rate tender procedure with full allotment in the regular three-month refinancing operations for the period as from the end of May, and announced a new six-month refinancing operation with full allotment, which took place in May 2010. Moreover, the temporary liquidity swap lines with the US Federal Reserve were also resumed.

As this phase is still ongoing, it is too early to draw any lessons from the experience. Nevertheless, confidence seems to have been restored, notably in the functioning of the money market, as both the liquidity premia and the volatility of interest rates have declined (see Charts 10 and 11).

3 LIQUIDITY RISK, CREDIT RISK AND CENTRAL BANK INTERVENTIONS: A THEORETICAL MODEL

In this section, a simple theoretical model is derived. The purpose of the model is to capture some of the main trade-offs that central banks faced during the financial turmoil. The model focuses on the interaction between central bank policies and the money market, and thus does not cover the full range of aspects related to central bank decision-making. After the model is presented, possible central bank interventions are discussed. Finally, elements of the different phases of the financial crisis, as described in Section 2 above, are mapped into the model.

3.1 MODEL ASSUMPTIONS

As the events in 2007 and 2008 showed that both liquidity and credit risk were important elements for the functioning of money markets, both types of risk play a role in the model. Moreover, we aim to capture some intertemporal aspects of central bank decision-making. Time runs from $t = 0$ until $t = 3$, i.e. encompasses three periods. To keep the analysis as simple as possible, we assume that there is no private information about credit risk.

3.1.1 BANKS

There is an infinite number of risk-neutral banks. At time 0, these banks collect funds of size 1 from claim-holders, such as depositors, with a fixed-term savings contract. These funds are promised to be repaid at time 3. For simplicity, we normalise the interest paid to depositors to zero (for instance, because there is deposit insurance).

Credit risk. Banks invest the funds obtained at time zero in a risky project that pays off a risky return at time 3, and in a safe, liquid asset, namely central bank money. It is assumed that the central bank requires all banks to invest λ in central bank funds at this point in time. Then, the amount of investment in the risky asset is $1-\lambda$. We assume that the risky project succeeds and yields a return $R > 1$ with probability $1-q$, but fails with probability q, in which case it yields zero. The parameter q characterises credit risk. Information about the potential failure of a project is revealed over time in the following way: with probability q_1, the risky project fails in between $t = 1$ and $t = 2$, and with probability q_2, the project fails between $t = 2$ and $t = 3$. Thus, the projects succeeds if and only if it has not failed in either period, i.e. $1-q \equiv (1-q_1)(1-q_2)$ or $q \equiv q_1+(1-q_1)q_2$. We assume that information about whether a project has failed or not before time 2 is known at time 2. At this point in time, a bank that is known to default is not able to repay any existing payment obligation.

Liquidity needs. For an interbank market to emerge in the interim periods $t = 1$ and $t = 2$, we assume that banks are hit by exogenously given liquidity demands, in a very stylised way. At time 1, half of all banks need liquid assets of 2λ, while the other half needs 0. This is a temporary demand which only lasts for one period, i.e. until time 2. This demand can emerge because of exogenously given payment obligations that are not modelled in further detail. Thus, an interbank market can emerge in which those with liquidity needs (we call them "type B" banks) borrow λ from those with excess liquidity ("type A" banks). These funds are repaid at time 2.

At time 2, the situation is reversed: type A banks now have additional liquidity needs of λ. We assume that a liquidity shock can occur in the economy as follows. With probability $1-p$, there is no liquidity shock, and type B banks have zero liquidity needs (normal liquidity situation). With probability p, however, there is a liquidity shock which implies that type B banks again face liquidity needs of λ. The table below summarises the liquidity outflows faced by banks in the two interim periods.[10]

Notice that the liquidity shock is an aggregate shock – the total demand for liquidity of the banking system increases.

Table Banks' liquidity outflows

	$t=1$	$t=2$
Type A	0	λ
Type B	2λ	$\begin{cases}\text{prob } 1-p: 0\\ \text{prob } p: \lambda\end{cases}$

10 Another model where repeated (and alternating) transactions between agents can lead to contagion of illiquidity from future periods to earlier periods has recently been proposed by Moore (2010).

We assume for now that credit risk and liquidity risk are independent. This is of course a stark simplification – one would expect both to be highly correlated, especially in crisis times – but is without loss of generality, and allows us to distinguish better the implications of both types of risk.

The law of large numbers then implies that a fraction q of all type A banks will fail, as well as a fraction q of all type B banks.

3.1.2 THE CENTRAL BANK

In the model, the central bank interacts with banks by offering two standing facilities. The first is a deposit facility which allows banks to deposit unlimited amounts of liquid assets at the central bank at interest rate $1+r_t^D$, where t is a time index. The second is a lending facility, which allows banks to borrow unlimited amounts of central bank liquidity at interest rate $1+r_t^L$. Borrowing from or depositing at the central bank always lasts for one period. Contrary to most other theoretical models, the *level* of standing facility interest rates is the main choice variable for the central bank in this model – not the quantities injected. We believe that this is the best way to characterise central bank interventions. Indeed, as discussed in Section 2, the main choice variable of the ECB during the height of the financial crisis was not the quantity of liquidity injected, but rather the interest rate at which it intervened. This is the case for all open market operations that are conducted as a fixed-rate, full allotment tender after October 2008.[11]

In reality, central banks often conduct open market operations at yet a different interest rate, usually in between the two standing facility rates. For model tractability, we abstract from this possibility in the main part of the model and assume that the $1+r^L$ is the interest rate for *any* lending from the central bank (i.e. including open market operations).

The central bank in this model may concern itself with two factors: first, it may want to ensure that interest rates in any given period do not deviate too far from its target rate. Second, it may aim to have an active interbank market in which liquidity is distributed among banks with as little central bank intervention as possible.[12] The actions taken by the central bank will depend on the weight attributed to each of these objectives.

11 Also the very first one-day fine-tuning operations on 9 August 2007 and on the subsequent days, or the longer-term operations with a maturity of one year.

12 This objective can be justified on the grounds of some well-established economic principles, such as the efficient formation of prices in a competitive environment as well as the benefits of peer monitoring by market participants. As an example of the latter, the tensions in financial markets, which materialised openly for the first time in August 2007 in money markets, might have been noticed much later if this market had been completely under the control of central banks.
Reflecting these concerns, the Treaty on the Functioning of the European Union (TFEU) specifies that "the ESCB shall act in accordance with the principle of an open market economy with free competition, favouring an efficient allocation of resources, [...]". (Article 127 TFEU).

3.1.3 THE INTERBANK MARKET

The above set-up can give rise to the emergence of an interbank market, both at time 1 and at time 2. At time 1, type A banks can lend an amount λ to type B banks for one period, while at time 2, type B banks can lend an amount λ to type A banks, again for one period. The market interest rates are $1+r_1$ and $1+r_2$, respectively.

Notice that lending in the interbank market is risky: a fraction q_t of the borrowing banks will go bankrupt before $t = 2$ and will not be able to repay the loan.

To simplify the analysis, we make a few assumptions:

– **A1 No diversification in the interbank market.** At any one time, banks can lend to or borrow from no more than one bank.

– **A2 Indifference.** Whenever banks are indifferent about whether they borrow (lend) in the interbank market or from (to) the central bank – i.e. because market interest rates are equal to one of the two standing facility rates – banks choose to borrow (lend) in the market.

– **A3 Transaction amounts.** Banks can only borrow or lend multiples of λ from/to each other or the central bank.

These assumptions are made for ease of exposition, but are without loss of generality.[13]

The main results derived from the analysis of the interbank market at time 1 are presented below. This is the more general case, in which the agents (banks as well as the central bank) take decisions in anticipation of future events. Nevertheless, we solve the model by backward induction and start with lending and borrowing decisions at time 2.

3.2 THE INTERBANK MARKET AT TIME 2

In this section, we determine under which conditions an interbank market may emerge at time 2. Expected liquidity outflows faced by banks are summarised in the table. A first condition for an interbank market to emerge is that there is both liquidity supply and demand. This, however, depends on the events in time 1: if type A banks have deposited their excess funds (λ) at time 1 with the central bank, they have these funds available at time 2 and can use them to cover the expected outflows λ at time 2. If, however, they have lent in the interbank market, a fraction q_1 of these banks will be in a situation in which the borrowing bank has not repaid them. Depending on interest rates, there may be incentives for these banks to borrow in the interbank market at time 2 (if they have not gone bankrupt themselves because their own risky project failed).

13 For instance, A3 implies that interest payments made or received at time 2 do not affect the amount lent or borrowed in the following period.

At the same time, type B banks (those that did not go bankrupt in the meantime) can face positive or zero liquidity outflows (see table): in the normal state of the world, they have zero outflows, and can lend their funds λ in the interbank market. If, however, a liquidity shock has occurred, type B banks need their liquidity to cover their own outflows λ and they cannot lend in the interbank market.

Thus, in our setting, an interbank market can only be active at $t = 2$ in the following circumstances:

- **Market continuity**. There was an interbank market at time 1 (otherwise, all type A banks would have sufficient funds at time 2).

- **Market stability**. There is no liquidity shock (otherwise none of the banks would have excess liquidity to lend out).

We now characterise interest rates in the interbank market. We assume that times are normal, i.e. type B banks face no liquidity outflows.

Type B banks have the following choice: if they store their excess funds λ in the central bank's deposit facility, they will definitely obtain an interest rate of $1+r_2^D$. If they lend this amount in the interbank market, they obtain $1+r_2$ with probability $1-q_2$, since q_2 denotes the probability by which the borrowing bank (type A) may go bankrupt and not be able to repay the loan. In both cases, the excess funds will have to be paid back by the borrower at time 3. Thus, the type B bank will lend his excess funds only if $(1-q_2)(1+r_2)\geq 1+r_2^D$ or

$$1+r_2 \geq \frac{1}{1-q_2}(1+r_2^D) \tag{1}$$

In this equation, the term $1/(1-q_2)$ reflects the credit risk premium: the higher the probability that a lending bank will not receive the funds back because of a possible bankruptcy, the higher the interest rate it will charge. Notice that the rate on the deposit facility provides a lower bound for market interest rates (for the case that $q_2 = 0$).

Let us now turn to the decision of type A banks who are in need of liquidity. These have the choice to either borrow λ in the interbank market at rate r_2 or to borrow from the central bank at rate r_2^L. It follows that type A banks participate in the interbank market as borrowers at time 2 if and only if

$$1+r_2 \leq 1+r_2^L. \tag{2}$$

The central bank's lending rate thus provides an upper bound for market interest rates (see Chart 12). Moreover, conditions (1) and (2) together imply the following.

Lemma 1 *A necessary condition for an active interbank market to exist at time 2 is that*

$$\frac{1+r_2^D}{1+r_2^L} \leq 1-q_2 \tag{3}$$

The lemma establishes a relationship between the rates on the two standing facilities. Essentially, it says that, depending on the extent of credit risk, the interest rate corridor needs to be of a certain minimal width for an interbank market to be possible. Suppose, for instance, that there was no credit risk in the economy, i.e. $q_2 = 0$. In this case, equation (1) collapses into $1+r_2 \geq 1+r_2^D$ and equation (3) into $1+r_2^D \leq 1+r_2^L$. Without credit risk, the standing facility rates r^D and r^L could even be equal and this would still not hinder an interbank market from emerging in the model (recall assumption 2 above). With increasing credit risk ($q_2\uparrow$), however, the corridor between the two standing facility rates would need to become larger for an interbank market to emerge. This is because credit risk drives a wedge between the deposit rate and the lowest acceptable market interest rate from the point of view of lenders.

The liquidity that is in the market at time 2 will determine the equilibrium interest rate within this corridor. When there is excess liquidity, banks know that all those funds that are not traded in the market can be placed in the deposit facility at rate r_2^D. Given that there is an infinite number of small banks, competition will drive down the interbank market rate so that equation (1) holds with equality.[14] By contrast, when there is a liquidity shortage in the banking sector, interest rates will be driven up to the level of the central bank's lending rate.

In particular, we are considering the case of a normal liquidity situation, in which there are $\frac{1-q_1}{2}$ lenders in the market at time 2 (i.e. out of the 50% of banks that are of type B, a fraction $1-q_1$ has not gone bankrupt), while there are $\frac{1-q_1}{2}q_1$ borrowers (out of the 50% of type A banks, $1-q_1$ has not gone bankrupt, and of those, q_1 have not been repaid in the time 1 interbank market). In this case, there is excess liquidity in the market at time 2 and interest rates will indeed be driven down to $1+r_2 = \frac{1}{1-q_2}(1+r_2^D)$.[15] This analysis raises the following conclusions.

(i) The width of the interest rate corridor formed by the two standing facility rates, $r_2^L - r_2^D$, is crucial for the question of whether an interbank market can emerge.

(ii) The higher the credit risk (q_2), the wider the corridor of standing facility interest rates needs to be for an interbank market to emerge.

14 As in standard models with interest rate corridors, any banks that are left with a liquidity surplus or a shortage at the end of the trading day have to resort to one of the standing facilities to cover their shortfall or deposit their excess funds. The probability of an aggregate recourse to either facility ties the interbank market rate to the rates on these facilities.

15 Notice that the structural surplus that is in the market under normal liqudity conditions is an assumption – it is not related to a liquidity surplus that results from additional liquidity injections by the central bank.

3.3 THE INTERBANK MARKET AT TIME 1

An interbank market can also emerge at time 1, but with reversed roles: some of the type A banks now have excess liquidity of λ, while type B banks have a liquidity shortage of the same amount. Contrary to $t = 2$, there is no liquidity risk in this period, as the aggregate amount of liquidity is known with certainty.

We again derive conditions under which an interbank market can emerge. Consider first type A banks, which have excess liquidity at time 1. Chart 13 displays their decision tree.[16]

Again, potential lenders in the market at time 1 have the choice between lending in the market at market interest rate $1+r_1$ or depositing their excess liquidity at the central bank at rate $1+r_1^D$. Lending in the interbank market entails credit risk, namely the possibility of the borrower's bankruptcy. The situation is more complex than at time 2, however. This is because type A banks know that if they are not repaid in the time 1 interbank market, they will have to borrow at time 2 – either in the interbank market or from the central bank. This needs to be taken into account when deciding on their optimal interbank market participation at time 1. Taking into account all possible events (see Chart 13), we find that type A banks lend in the interbank market at time 1 only if $1+r_1 \geq 1+\hat{r}_1$, where

$$1+\hat{r}_1 \equiv \frac{1}{1-q_1}\left(1+r_1^D\right)+\frac{q_1}{1-q_1}\left[(1-p)\frac{1+E\left(r_2^D\right)}{1-q_2}+p\left(1+E\left(r_2^L\right)\right)\right]. \tag{4}$$

The first term on the right-hand side is the time 1 equivalent of the right-hand side of equation (1): lenders participate in the interbank market only if they are compensated for credit risk. The second term stems from the expected cost of borrowing at time 2, should the borrower not repay his/her loan. With probability $1-p$, there is no liquidity shock, and the bank faces a low cost of borrowing, given by the right-hand side of equation (1). With probability p, there is a liquidity shock, there will be no interbank lending and the bank will have to resort to the lending facility of the central bank at time 2, at the expected interest rate $1 + E(r_2^L)$. Here, the liquidity risk premium denotes the premium that lenders will demand at time 1 because of the risk of a liquidity shock, i.e.

$$\frac{q_1}{1-q_1}p\left[\left(1+E\left(r_2{}^L\right)\right)-\frac{1+E\left(r_2^D\right)}{1-q_2}\right].$$

The higher the risk premium, the higher the minimum interest rate that lenders in the $t = 1$ market are willing to accept. Notice that the liquidity risk premium depends on banks' expectations about future central bank interest rates.

Consider now type B banks, which are potential borrowers in the interbank market at time 1. For these banks, the borrowing decision at time 1 does not depend on the foreseen events at time 2 and their decision problem is equivalent to the one at time 2: type B banks borrow in the interbank market at time 1 only if

16 Recall that interest payments are only credited to the receiving bank at $t = 3$.

the interbank market interest rate does not exceed the lending rate by the central bank, thus only if $1 + r_1 \leq 1 + r_1^L$. Taken together, these results imply the following.

Lemma 2 *A necessary condition for the interbank market at time 1 to emerge is that*

$$\frac{1+r_1^D}{1+r_1^L} + \frac{q_1}{1+r_1^L}\left[(1-p)\frac{1+E(r_2^D)}{1+q_2} + p(1+E(r_2^L))\right] \leq 1-q_1.$$

A first result of lemma 2 is that, as in time 2, the interest rates on the central bank's standing facilities provide upper and lower bounds for the market interest rates (see Chart 14). The condition differs from the one in lemma 1, however, because now there is the second term on the left-hand side, which represents future expected borrowing costs that the lender will have to bear if the interbank loan is not repaid. This links financial conditions at time 1 to those at time 2. To summarise, the analysis in this section has shown the following.

(i) The conditions for the existence of an interbank market become stricter if market participants are concerned about liquidity in future periods.

(ii) There is an interaction between credit and liquidity risk: in the absence of credit risk ($q_1 = 0$), time 2 liquidity risk would not play a role for the level of activity in the interbank market at time 1.

(iii) For a given pair of standing facility rates, if either time 1 credit risk or liquidity risk increase, conditions for the existence of an interbank market may no longer be met.

Equilibrium interest rates at time 1 will again depend on aggregate liquidity conditions. Recall that the supply of liquidity by type A banks at time 1 is λ and equals the demand for liquidity by type B banks. With this equality, the probability that one bank will have to resort to one of the standing facilities to either deposit or lend excess funds is equal. In this case, the risk-free market interest rate should be in the middle of the corridor,

$$r_1 = \frac{r_1^D + r_1^L}{2} .$$

Finally, let us consider a scenario in which credit and liquidity risk are perfectly correlated. In this case, the middle branch of the event tree in Chart 13 would disappear and equation (4) would reduce to.

$$1 + \hat{r}_1 \equiv \frac{1}{1-q_1}(1 + r_1^D) + \frac{q_1}{1-q_1}\left[1 + E(r_2^L)\right]$$

The conditions for the existence of an interbank market as in lemma 2 would become

$$\frac{1+r_1^D}{1+r_1^L} + q_1\frac{1+E(r_2^L)}{1+r_1^L} \leq 1-q_1$$

This implies that, for the same level of credit and liquidity risk, conditions for the emergence of an interbank market can only become stricter (as the left-hand side of this equation is at least as large as the left-hand side in the equation in lemma 2). Therefore, correlation of credit and liquidity risk would exacerbate the problem of a possible market breakdown.

3.4 CENTRAL BANK DECISION-TAKING

The design of central bank operational frameworks is usually geared towards the efficient and smooth transmission of monetary policy signals to the financial sector. In normal times, the objective is usually to steer interest rates without dominating trading in the money market. In the case of the ECB, interest rates and the provision of liquidity were chosen with the aim of steering short-term money market rates close to the midpoint of its standing facilities rates (which was the minimum bid rate of the main refinancing operation). In crisis times, when tensions introduce distortions in the money market that might hamper the transmission of monetary policy, the central bank's objectives become more complex. This section does not aim to derive the optimal policy for a central bank, but instead intends to illustrate some of the main trade-offs that many central banks faced during the financial turmoil. We focus on the central bank's choice at time 1 because it is the more general case where the dynamic nature of decision-making comes into play.

Consider first, as a benchmark, a situation in which all agents expect **tranquil financial conditions**. We take this to be a situation in which credit risk is rather low (q low) and liquidity risk p is zero. With a corridor that is not too narrow, there will be some interbank market lending at $t = 2$. The credit risk component of interest rates at time 2 will be very small, so that time 2 market rates will be very close to the deposit facility rate. For $p = 0$ there is no liquidity risk premium for time 1 interest rates. Owing to balanced liquidity conditions, time 1 interest rates will be close to the midpoint of standing facility rates (plus a negligible credit risk premium). That is, the central bank can choose standing facility rates symmetrically around the target interest rate. The corridor can be wider or narrower, depending on how far the central bank is willing to allow rates to deviate from the target rate.

Consider now a sudden **increase in credit risk** (ceteris paribus). This will imply an upward shift of market rates both at time 1 and at time 2, since the credit risk component would increase. The central bank in this model has no tools available that could induce a reduction in credit risk.[17] Instead, the central bank could adjust the rates on its standing facilities: if it was primarily concerned about trading activity in the interbank market, it could widen the corridor formed by standing facility rates by increasing the level of the lending rate and reducing the one on the deposit rate. If it was also concerned with the level of rates, it could choose to change the corridor in an asymmetric way primarily by lowering the deposit rate.

17 Also, in reality, a high level of credit risk in a financial crisis could be addressed by other forms of public intervention, and not by central bank liquidity tools.

Next, consider **a sudden increase in liquidity risk** when there is a non-negligible credit risk.

Time 2. If a liquidity shock has materialised at time 2, the interbank market, by assumption, breaks down at time 2. All banks in need of liquidity will have to resort to the central bank's lending facility. This significantly increases the cost of liquidity for banks. In order to stabilise rates closer to their original level, the central bank could lower the rate on the lending facility r_2^L.

Time 1. Suppose that liquidity risk has increased ($p\uparrow$) so that the time 1 interest rate increases significantly. The central bank could affect market conditions by changing standing facility rates both at time 1 and at time 2 as follows.

(i) First, it could change time 1 standing facility rates. As in the analysis of time 2, the central bank could widen the corridor (by a reduction of the deposit rate r_1^D or an increase in the lending rate r_1^L) to ensure continued interbank trading. To stabilise the level of interest rates, it should primarily lower the level of the deposit facility rate.

(ii) Second, it could commit to lowering the lending rate for the next period (time 2), as a tool to mitigate the expected cost of a liquidity crisis. A reduction of future lending facility rates would reduce the liquidity risk premium in today's interbank market. However, the central bank needs to be aware that this will influence future market conditions and make the emergence of an interbank market in the future less likely.

Notice that liquidity "injections" play no role whatsoever in this model. Banks' liquidity demand is purely a result of the central bank's access conditions for standing facilities. This scenario is, in our view, closer to capturing the "real" institutional environment in which the money market functions and the central bank interacts with the banking system.[18]

These considerations illustrate several key trade-offs faced by central banks during the financial turmoil. First, a central bank faces a trade-off when deciding on the level of intermediation it deems necessary: the more favourable it chooses banks' conditions for access to central bank refinancing (and depositing), the higher the level of central bank intermediation will be. In this way, on the one hand, it ensures that all banks have access to the necessary liquidity, but on the other hand, this strategy can reduce market activity.

Second, it faces a trade-off along an intertemporal dimension. If the central bank chooses to promise a narrower corridor in the near future (at time 2) with the aim of allowing for more interbank trading at time 1, it can, at the same time, negatively affect the extent of interbank trading at time 2. This feature can be problematic especially in a situation in which economic conditions are expected

18 Indeed, the financial press often referred to the ECB's "liquidity injections" implying that it had deliberatly chosen these particular amounts. Instead, they were the outcome of the interest rates applied.

to improve: in this case, a forward-looking central bank policy should aim to reduce future support measures, i.e. by committing to a widening of the corridor. However, if it does so, it might cut banks off from refinancing today.

Such decisions are further complicated in real life because of a series of other factors. To name a few, financial crises are typically characterised by a high level of uncertainty about future market conditions; market participants' credit risk differs across banks and tends to contain private information; and central banks may not be able to change their interest rates frequently owing to concerns regarding the predictability and credibility of their policies. Extensions of the model along those dimensions could further improve its ability to capture the main dilemmas faced by central banks in the crisis.

3.5 THE DIFFERENT PHASES OF THE CURRENT FINANCIAL CRISIS

Section 2 described the various phases of the 2007-10 financial turmoil from the ECB's perspective. In this section, we attempt to map the measures taken during these phases (at least those parts related to money markets) into the theoretical model.

Phase 1: Frontloading. During the initial phase of the turmoil, higher credit and/or liquidity risk implied higher spreads between short-term interest rates in the euro area and the midpoint of the corridor of standing facility rates. There was no need to adjust interest rates on standing facilities as the money market continued to function. Instead, the higher spreads between overnight rates and the midpoint of the corridor were addressed by the ECB through frontloading, in order to steer rates towards the middle of the corridor. The details of this adjustment process (volume of liquidity supplied, frequency of interventions) posed the main challenge to the ECB during this phase. In the model, this corresponds to a situation with a moderate increase in credit and liquidity risk, which did not imply the collapse of the interbank market.

Phase 2: Fixed-rate, full allotment tenders. During the second phase of the crisis, trading in the interbank market all but collapsed. With the aim of ensuring that the banking sector continued to have access to liquidity, the ECB introduced tenders at a fixed rate and with full allotment. In terms of the model, the full allotment at the fixed rate of the refinancing operations (which was the midpoint of the corridor of standing facility rates) was the de facto equivalent of halving the corridor (in all periods): now the price of unlimited lending from the central bank was reduced from the standing facility rate to the rate applied to all refinancing operations. As would be predicted by the model, the interbank market interest rates somewhat declined and activity in the interbank market was low. Thus, the ECB took on a more prominent role as an intermediary in the money market. The alternative to this type of intervention would, however, have been to accept a situation in which interbank trading broke down completely.

Phase 2: One-year refinancing operations. Later on in the second phase, market conditions were still not yet expected to improve. Low trading activity in interbank markets might have been related to the uncertainty about future market conditions, as highlighted in the model. In this environment, the introduction of open market operations with a one-year maturity increased certainty for banks as regards their liquidity situation and gave a strong signal that short-term money market rates should stay at low levels for a long period of time. In fact, the liquidity surplus in this period caused market rates to move towards the lower bound given by the corridor of standing facility rates. However, at the same time, it negatively affected money market activity throughout the maturity of the longer-term operations.

Phase 3: Phasing-out. The intertemporal nature of the model highlights that the question regarding the appropriate time to exit is not a trivial one. On the one hand, once conditions in the market improve, the central bank would like to immediately scale down the measures that were taken to alleviate the tensions. On the other hand, it might have made promises during earlier periods of the crisis on its support measures in later periods, which it should keep if it does not want to lose credibility. As a result, support measures might be in place longer than optimal ex post, so that they imply a long-run cost of implicit pre-committing to certain policies.

4 THE MARKET IMPACT OF THE MONETARY POLICY MEASURES

As mentioned in the previous section, the central bank can influence liquidity demand by banks via the level at which it sets the key policy rates and the width of the interest rate corridor. Such an influence materialised in the case of the ECB as the introduction of the fixed-rate, full allotment procedure has de facto endogeneised central bank liquidity provision. The main goal of this section is thus to assess briefly the impact of the monetary policy measures taken during the first two phases of the crisis and to present an econometric analysis of the interaction between the ECB measures and money market dynamics.

4.1 ASSESSMENT

4.1.1 MARKET TURMOIL PHASE

The monetary policy measures taken during the market turmoil phase were effective in the sense that EONIA was kept close to the key policy rate (minimum bid rate) and trading volumes increased (see Chart 2, panels A and B), without a significant increase in the number of fine-tuning operations (see Chart 1). However, longer-term money market rates and overnight interest swap spreads remained elevated, were increasing and were somewhat volatile (see Chart 2, panel C), while unsecured term funding markets remained seriously impaired.

4.1.2 FINANCIAL AND SOVEREIGN DEBT CRISIS PHASES

The enhanced credit support policies were successful in reducing the levels of market interest rates, including longer-term interest rates (see Chart 4), in narrowing money market spreads (see Chart 2, panel C) and, more generally,

in bringing down the costs of refinancing for households and firms as well as in supporting the liquidity flow to the banking system and individual institutions. However, the EONIA transaction volume declined significantly (see Chart 2, panel A). Interestingly, activity in the overnight repo market was less significantly affected (see Chart 2, panel B). Thus, the decline in activity in the unsecured overnight interbank market may have been due, at least partially, to its substitution by increasing activity in the secured segment. The policies pursued were successful in narrowing corporate and covered bank bond spreads (see Charts 3 and 7). Eventually, funding costs in the term markets improved significantly and forward term EURIBOR volatility declined (see Chart 2, panel C and Chart 11).

During this period, money market rates were declining rapidly and were generally below the fixed rate in the main refinancing operation, thereby implying that further provision of liquidity via shorter-term refinancing operations was relatively costly when compared with prevailing market conditions (see Chart 4). The fact that these operations were still persistently bid with volumes at around €100 billion suggests that some banks (or banking groups) remained distressed throughout this phase. In this respect, it is noteworthy that the three-month EONIA swap rate index has remained below 1% (the level of the fixed-rate tenders) since 12 February 2009 with an average of 50 basis points (minimum of 33 basis points and a maximum of 98 basis points); however, it remained below 50 basis points between 7 July 2009 and 6 July 2010, i.e. roughly throughout the life of the first one-year longer-term refinancing operation.

Panel A of Chart 5 shows the average behaviour of EONIA during the last 28 days of the reserve maintenance period in two different phases of the crisis. Panel B shows the corresponding average daily reserve surpluses of the banking system. It is worth noting that, before the bankruptcy of Lehman Brothers, the EONIA was steered very close to but above the minimum bid rate, except on the last day when it dropped owing to surplus liquidity not being totally absorbed by the fine-tuning operation on that day. After the settlement of the first one-year refinancing operation, EONIA was steered close to but above the deposit facility rate, except on the last day when it increased owing to some surplus liquidity being absorbed by the fine-tuning operation on that day. Panel B shows the sharp increase in the frontloading pattern after the switch to fixed-rate, full allotment tenders.

Chart 6 illustrates the non-linear daily "liquidity effect" in the euro overnight interbank market. The spread of EONIA over the deposit facility rate (at the bottom of the interest rate corridor) is plotted against the daily net recourse to the deposit facility on all days in the reserve maintenance period, except the last two. Chart 6 (panels A and B) refers to the full allotment period. Before the settlement of the first one-year refinancing operation (Chart 6, panel A), the demand schedule had two "kinks": one kink giving rise to strong daily liquidity effects owing to rigidity in demand (i.e. interest rate elasticity = 0) at around €25 billion (or below €50 billion); the other giving rise to a segment of perfectly elastic demand above €100 billion. Between these two kinks lies a range of inelastic

demand, roughly above €25 billion and below €100 billion. During the life of the first one-year refinancing operation, there were no visible daily liquidity effects, as demand was perfectly elastic (Chart 6, panel B).

4.2 EMPIRICAL EVIDENCE

To analyse the interaction between the ECB measures and the dynamics of money market interest rates, we estimate an unrestricted vector autoregressive (VAR) model:

$$Y_t = A(L)\,Y_t + B(L)X_t + \eta_t$$

where the vector of endogenous variables is as follows: *ois*3*m* is the spread between the euro interbank offered rate (EURIBOR) and the overnight interest swap (OIS) rate for a maturity of 3 months; *prem_6m in 6m* is a term liquidity premium; *qs*3*mdepo* is the quoted (bid/ask) spread for the three-month EURIBOR interest rate; *orp* is the accumulated volume of the ECB monetary policy outright portfolio; *total_refi* is the total outstanding volume of ECB refinancing operations; *eonia_vol* is the daily EONIA volume; and *repo_vol* is the daily volume in the overnight repo market. The vector of exogenous variables X_t contains an intercept and the changes in the minimum bid rate (policy rate).[19] The number of lags in the VAR (2) was selected in accordance with two information criteria (HQIC and SBIC) following the discussion in Verbeek (2004).[20] Generalised impulse response functions, originally proposed by Pesaran and Shin (1998), were computed for one standard deviation shock over a period roughly equivalent to one reserve maintenance period[21] and are reported in Charts 15-17.

4.3 THE DATA

The main data sources are Reuters and the ECB. The sample covers the period from 1 January 2007 to 19 October 2010 with daily frequency (993 observations in total). However, we restrict the analysis to the crisis period, i.e. as from 9 August 2007.

The variables related to the ECB actions are displayed in Chart 1. The money market variables deserve a bit more explanation.

19 Alternative specifications of the exogenous vector with various dummies that capture special events have also been tested. These additional materials are available on request to the authors or at http://www.ecb.europa.eu/events/conferences/html/cbc6.en.html.

20 Other information criteria tend to suggest a VAR(5) or a VAR(6). However, the results appear independent of the lag structure chosen. Furthermore, standard misspecification tests suggest that both specifications are stable and that VAR residuals are not auto-correlated. ARCH effects of order 3 are present, however. For space reasons, the misspecification tests are available on the ECB website. Granger-Causality tests point out the importance of feedback effects between the variables in the vector Y_t. All these tests can be found at http://www.ecb.europa.eu/events/conferences/html/cbc6.en.html.

21 The estimations were made using the software Eviews 6. For the variable relating to total refinancing, this amounts to around €25 billion and the response unit of spreads is defined in percentage points.

As regards the variables related to market activity, available information is limited given the over-the-counter (OTC) nature of the money market. Volume transactions are only available for the overnight (both secured and unsecured) segments. By contrast, we need a proxy for the term segments. The proxy for market activity in the term segment, *qs3mdepo*, is the quoted spread (i.e. the difference between the ask price and bid price) for the three-month deposit rate.[22] It is reported in Chart 9. In practice, this variable denotes the implicit transaction cost that a trader would pay when buying at the displayed ask price and directly selling at the quoted bid price. This variable is related to market activity in the sense that the more borrowers and lenders are able to trade in the market, the more competitive prices will be and the narrower the quoted spread should be. In this situation, the market will be more liquid in the microstructural sense. Given the OTC nature of transactions in these segments, this is the best available proxy for activity in the term segments of the money market.

The proxy for market tensions is defined as the spread between the EURIBOR and the OIS rate at a three-month horizon (hereafter referred to as "*ois3m*"). Chart 2 (Panel C) provides this value for other maturities as well. By construction, this spread includes both a liquidity risk component (uncertainty about access to market liquidity in the future, which is applicable to all money market segments) and a credit risk component (provided by the uncollateralised nature of EURIBOR transactions). It may also include a "confidence" factor. Although the EURIBOR and OIS curves are expected to move very closely by arbitrage in normal times (as used to be the case until August 2007), evidence from the 2007-10 financial crisis suggests significant changes to the dynamics of both interest rates, probably reflecting fluctuations in the credit risk premium (see Brousseau, Chailloux and Durré (2009)).[23]

As regards the liquidity premium, it is generally suggested that it can be estimated indirectly by removing the credit risk premium usually approximated by the credit default swap (CDS) premium from the EURIBOR-OIS spread (see, for example, McAndrews, Sarkar and Wang (2008) or Taylor and Williams (2009)). Although CDS premia may be good proxies of credit risk, they present a drawback in terms of maturity with respect to the money market.[24] For the purpose of this exercise, a liquidity risk premium is calculated for the six-month horizon[25]; it is extracted from the below combination of spreads using a decomposition technique explained in Brousseau, Nikolaou and Pill (2010):

$$12 * spread_{12m} - 6 * spread_{6m}^{6m} - 6 * spread_{6m}$$

22 We focus the analysis of the unsecured term segment on the three-month maturity given the important role played by the EURIBOR in futures contracts and pricing in retail banking.

23 Brousseau, Chailloux and Durré (2009) show, in particular, that the two interest rates do not Granger-cause each other anymore in the financial crisis phase, in contrast with the dynamics observed in the pre-crisis sample period.

24 It is indeed evidenced that the market for CDS premia with a maturity closer to the maturity of the money market (i.e. one-year maturity) is much less liquid than the CDS market at the five-year horizon.

25 A six-month horizon is chosen to limit overlapping information with the three-month spread between the EURIBOR and the OIS interest rates.

where $spread^{i,j}$ denotes the spread to the forward OIS of the forward rate agreement for a *j−month* maturity in *i−month*, while $spread_j$ denotes the spread to the OIS of the deposit for a *j−month* maturity. Chart 10 presents this liquidity premium measure for a variety of maturities.

4.4 RESULTS

The generalised impulse response functions of the money market variables to shocks to *orp* and *total_refi* suggest the following. First, shocks to *total_refi* lead to a decrease in the spread between the EURIBOR and the OIS three-month rates and in the liquidity premium (see right-hand side of Chart 15). These effects show some persistence even after 25 business days. Second, shocks to the monetary policy outright portfolio do not seem to have a significant impact on the spreads and the liquidity premium (see left-hand side of Chart 15). Third, shocks to *orp* and *total_refi* tend to increase the quoted spread (see Chart 16). Fourth, shocks to *total_refi* tend to decrease EONIA volumes but not repo market volumes (see right-hand side of Chart 17). Fifth, shocks to *orp* do not seem to have a significant impact on EONIA volumes, although they have a positive, very short-term impact on the repo market (see left-hand side of Chart 17).

Although some caution is needed before making any firm conclusions, these preliminary empirical findings may be interpreted as follows. On the one hand, the combined effect of the decrease in the key policy rates and the full accommodation of liquidity demand by banks contributed to the decline in the liquidity premium. These measures contributed to improving market participants' confidence. At the same time, the apparent absence of any impact from the monetary policy outright portfolios on money market spreads and the term liquidity premium in the money market is not necessarily surprising since these measures were not directly targeting the money market per se, but rather the tensions in other market segments which were negatively affecting the liquidity position of banks. At the same time, this measure seems to have produced positive effects beyond those covered by the VAR specification. For instance, there is evidence that the covered bonds purchase programme has significantly helped to reactivate activity in both the primary and secondary market segments.[26] Still, following the establishment of this portfolio, it is interesting to note that the trading volume in the overnight (both secured and unsecured) market has increased, while the spreads between the EURIBOR and the OIS interest rates have tended to decrease (see Chart 2).

As regards the impact on market activity, the following observations can be made. First, a persistent negative impact on the trading volume in the EONIA market confirms the implications of our theoretical model, according to which increased intermediation by a central bank reduces market activity.[27] A similar picture is

26 See in particular Beirne, Darlitz, Ejsing, Grothe, Manganelli, Monar, Sahel, Tapking and Vong (2010).

27 Such an impact seems to have also materialised in the overnight segment of the electronic platform, as discussed in Beaupain and Durré (2010).

obtained for the term segment. In short, these empirical findings broadly support the implications of our theoretical model discussed in Section 3.[28]

5 CONCLUDING REMARKS

The financial crisis of 2007-10 represented a difficult challenge for the ECB and a test of its operational framework. Several features of the operational framework – such as the large number of counterparties, the broad range of assets that were already accepted as collateral in ECB refinancing operations before the crisis, as well as the flexibility to quickly adjust operational procedures – proved extremely valuable in addressing those challenges and significantly alleviated the ECB's task of ensuring the transmission of its monetary policy.

This paper has highlighted the challenges that the ECB faced during different phases of the financial crisis, both from a practical and a theoretical perspective. The paper argues that, while too little intervention could imply high deviations of market interest rates from their target and a severe hampering of the monetary transmission mechanism, too much intervention could introduce too strong an intermediation role for the central bank, which would replace interbank trading activity to a large extent. One implication of the theoretical model is that, while credit risk and liquidity risk are clearly interlinked, monetary auhtorities mostly have an impact on the liquidity risk contained in money market spreads. This main finding seems to be supported by the empirical evidence, which shows that the ECB's non-standard measures led to a reduction in money market spreads through a reduction of the liquidity premium.

In the light of the aforementioned considerations, central banks may need to significantly increase the extent to which they intermediate in financial markets, where necessary, to compress the liquidity risk component of spreads, even if this may lead to a temporary substitution of the interbank market. In extreme circumstances like those observed around September 2008, this would not necessarily be problematic if the interbank market were on the verge of collapse. By contrast, the key questions are rather the duration and extent of the liquidity measures and the extent to which the central bank wishes and is able to affect the credit risk component of the market spreads. Although these questions are not tackled in this paper, they certainly deserve further research. As regards the trading dynamics in the interbank market observed before and during the 2007-10 financial crisis, the main risk could be that easy access to certain central bank funding may reduce the incentives of market participants to actively manage liquidity, as well as other potential problems such as moral hazard. To avoid the materialisation of these risks without compromising the economic recovery, the key challenge for central banks in the near future will be to phase

28 This result is certainly mostly related to the proper microstructure effect of the unsecured segments of the money market. Indeed, there is evidence that the more uncertain lenders are, the larger the quoted spreads, which in turn are updated less frequently. In the presence of liquidity hoarding and reluctance by cash-rich banks to lend in the unsecured market, larger quoted spreads simply reflect decreased market activity. This is also in line with the evidence reported in Angelini, Nobili and Picillo (2010).

out the non-standard measures in due time, while adjusting, when necessary, their operational framework to accommodate possible changes in how the interbank market functions.

6 RELATED LITERATURE

With the emergence of non-standard measures conducted by major central banks in response to the 2007-10 financial crisis, several recent academic papers have studied the possible impact of these measures.

A first set of papers tries to assess the macroeconomic impact of the central bank actions (both standard and non-standard), notably Lenza, Pill and Reichlin (2010) and Curdia and Woodford (2010) among others. Lenza, Pill and Reichlin (2010) mainly focus on the possible impact of the ECB's non-standard measures in the aftermath of the bankruptcy of Lehman Brothers in relation to the evolution of money and credit developments (hence banks' balance sheet). These authors provide empirical evidence of the effectiveness of the ECB's actions in supporting financial intermediation, credit expansion and economic activity. In particular, one of their key findings is that the fluctuations in financial and monetary aggregates during the recent crisis did not deviate from the historical regularities observed in the pre-crisis sample period (i.e. before 9 August 2007), despite the distortions observed in the interbank market. On the other hand, Curdia and Woodford (2010) compare the impact of both quantitative easing and "targeted asset purchases" by a central bank on the aggregated demand, based on an extended New Keynesian model. Although quantitative easing is seen as ineffective, even at the zero lower bound on the policy rate[29], they conclude that central bank credit policies in the form of targeted asset purchases may be effective when private financial intermediation is severely disrupted.

Closer to the issue discussed in our paper, a second strand of literature offers a more theoretical discussion on central bank actions in response to the recent crisis and makes empirical assessments of the impact of central bank actions during the crisis on the dynamics of financial markets and, in particular, the money markets. Based on theoretical modelling, Heider and Hoerova (2009) and Heider, Hoerova and Holthausen (2009), for example, provide a rationale to explain market frictions and disrupted market activity in the presence of credit risk. Using a structural model of unsecured and secured lending, Heider and Hoerova (2009) propose a three-period model, where banks' trade-off between liquidity and return on the one hand and banks' heterogeneity in terms of liquidity shocks on the other hand, justifies the existence of an interbank market. Following the specifications contained in Freixas and Holthausen (2005), Heider and Hoerova (2009) offer a compelling explanation based on the counterparty risk of the developments observed in the money market since the onset of the financial crisis on 9 August 2007 and, in particular, the decoupling of interest rates between the

29 This is especially the case if: (i) the increase in reserves leads to an increase in central bank holdings of Treasury securities rather than an increase in central bank lending to the private sector; and (ii) there is no impact on agents' expectations of future interest rate policies.

unsecured and secured money market segments. Since the volatility of the repo rate can be increased notably by the scarcity of collateral, one of the natural policy conclusions of their paper is that the enlargement of the list of collateral eligible in central bank refinancing operations may help reduce tensions in the secured segment of the money market. At the same time, these authors suggest some limitations that such a policy has in resolving the underlying problems of the distortions in the unsecured segment when they are driven by credit risk concerns. In the same vein, Heider, Hoerova and Holthausen (2009) discuss a model where the existence of asymmetric information and concerns about the solvency of specific banks can lead to the breakdown of trading activity in the money market. Interestingly, the three different regimes they propose (namely (i) a situation of low spreads and an active money market; (ii) a market with increased spreads and continued trading, but lower trading activity owing to adverse selection; and (iii) a breakdown of market activity) nicely reflect the developments observed in the money market in the recent pre-crisis and crisis periods. These authors demonstrate the important role played by counterparty risk. It is shown that when higher average counterparty risk is combined with a high dispersion of risk in the presence of asymmetric information in the market, hoarding of (possibly excess) reserves emerges and trading in the interbank market breaks down. Eisenschmidt and Tapking (2009) also justify banks' hoarding of liquidity in a model where lenders are not concerned about their counterparties' credit risk, but about the risk that they may need liquidity themselves in future periods. The implications of both models seem to be supported by the empirical findings reported by Keister and McAndrews (2009) for the United States. Among the possible policy responses to these developments, Heider, Hoerova and Holthausen (2009) emphasise the importance of structural measures (like regulatory rules on transparency and liquidity requirements) beyond pure liquidity measures such as refinancing operations by central banks, asset purchases of illiquid assets or interbank loan guarantees.

Having demonstrated the need for central banks to step in to cope with illiquid banks, the question on the appropriate operational tools to be used remains. In this respect, Perez Quiros and Rodriguez Mendizabal (2010) and Cassola and Huetl (2010) offer an interesting theoretical discussion on the effectiveness of an asymmetric interest rate corridor and of the frontloading liquidity measure, respectively. Extending the model described in their 2006 paper by incorporating a specification for fine-tuning operations, Perez Quiros and Rodriguez Mendizabal (2010) discuss to what extent the use of asymmetric standing facilities could be a powerful policy tool for controlling prices and quantities in the overnight interbank market where the preference of banks is driven by the expectations of tight liquidity conditions in the future. In their model, the demand for funds by banks is a function of the marginal cost of funds, which is in turn equal to the interest rate on the main refinancing operation and to the marginal expected value of those funds throughout the reserve maintenance period. Consequently, the probability of having recourse to the standing facilities is included in the marginal cost of funding, i.e. the rate of the main refinancing operation, and thus the only way to affect banks' demand for excess reserves is to change the relative price of the regular refinancing operations with respect to the interest rates applied to the standing facilities. These authors also show how the existence

of fine-tuning operations at the end of the reserve maintenance period decreases the elasticity of demand at the regular main refinancing operations.

In the light of the liquidity measures chosen by the ECB between August 2007 and September 2008, Cassola and Huetl (2010) offer a rationale for the so-called frontloading policy which consists in shifting the timing of the supply of funds available during the reserve maintenance period. These authors also extend the model of Perez Quiros and Rodriguez Mendizabal (2006) in three main respects: (i) by casting it into a regime-switching model in which banks change their liquidity management from a backward-looking liquidity shock correction mode into a forward-looking reserve management regime; (ii) by incorporating the end-of-period fine-tuning operations, the impact of some calendar effects on the overnight interest rate and banks' daily excess liquidity; and (iii) by considering three different types of market distortions, namely credit rationing, market segmentation and aggregate negative liquidity shock. By calibrating their theoretical model, Cassola and Huetl (2010) show that to replicate the trading patterns observed during the turmoil period, it is necessary to combine increasing market segmentation and lending constraints (i.e. credit rationing) as, in contrast to the pre-crisis period, increasing liquidity volatility does not appear sufficient or indeed necessary to explain the developments under the crisis mode. As a result, they also show that market segmentation and credit rationing were not significantly important before August 2007. To evaluate the impact of possible liquidity measures, they also simulate different scenarios regarding the frontloading and liquidity operations on the last day of the reserve maintenance period. Their simulation exercises show that the absence of frontloading during the turmoil would have led to significantly higher EONIA levels and lower trading volumes in the interbank market. Their assessment of the frontloading policy appears to be in line with the evidence reported in Cassola, Holthausen and Würtz (2008).

On the empirical side, recent studies provide mixed evidence as regards the impact of central bank actions on the dynamics of money markets during the 2007-10 financial crisis. Using simple linear econometric regressions for the daily change of the LIBOR-OIS spreads, McAndrews, Sarkar and Wang (2008) find that a cumulative reduction of more than 50 basis points in the spreads can be associated with the Term Auction Facility launched by the US Federal Reserve. By contrast, when estimating the level of the LIBOR-OIS spreads on the basis of a no-arbitrage model of the term structure, Taylor and Williams (2009) do not support this finding and conclude that the most influential factor on these spreads is the counterparty risk. In their model, the absence of any impact of the Term Auction Facility on spreads is explained by the fact that it has no impact on total liquidity, expectations regarding future overnight interest rates or credit risk. Estimating a six-factor, arbitrage-free, Nelson-Siegel joint model of US Treasury yields, financial corporate bond yields and term interbank rates, Christensen, Lopez and Rudebusch (2009) find empirical evidence, however, that central bank liquidity operations (like the Term Auction Facility) have lowered LIBOR rates in the period spanning December 2007 to July 2008. More specifically, the shift in model estimates after the announcement of the liquidity measures (notably by analysing differences in the dynamics of both

the money market and the bank bond market) suggests that central bank actions like the Term Auction Facility have helped lower the liquidity premium in term money market interest rates. From a broader perspective, Aït-Sahalia, Andritzky, Jobst, Nowak and Tamirisa (2010) propose an event study approach using parametric and non-parametric means tests to estimate the market reaction to (fiscal and monetary) policy announcements in the United States, the United Kingdom, Japan and the euro area. Concerning the specific case of central banks' actions, these authors report the following empirical findings. They first conclude that monetary policy rate cuts are clearly associated with significant declines in the LIBOR-OIS spreads, while announcements of liquidity support do not appear to have such a clear-cut effect on spreads. By contrast, announcements of liquidity provision in US dollars through swap arrangements between the US Federal Reserve and other major central banks are associated with statistically significant, but small reductions in spreads, which is also reported in Chailloux, Gray, Klüh, Shimizu and Stella (2008). Similarly, these authors also find that announcements of FOREX swaps by the ECB and the Bank of England have significant positive spillover in the United States and global money markets. In the specific case of the asset purchase programmes, they observe an initial decline followed by a subsequent increase in credit and liquidity risk premia, although these effects do not appear statistically significant.

In the light of the aforementioned studies, two main observations can be made. On the one hand, both the liquidity and credit risk components play an important role in the fluctuations of the interest rate spreads without necessarily co-moving over time. Indeed, despite mixed empirical findings, the current (both theoretical and empirical) analyses tend to suggest that while it may be obvious that the liquidity risk component is affected by central bank actions, it is less obvious for the credit risk component, should this be desirable. On the other hand, none of the studies highlight the trade-off that a central bank may face in a crisis situation, potentially on account of the difficulty of disentangling the liquidity from the credit risk component in the money market spreads. However, this question appears of crucial importance to help central banks consider the optimal limits of its intervention. In this respect, Chailloux, Gray, Klüh, Shimizu and Stella (2008) remark that, although pure liquidity measures by central banks are clearly justified (which should in turn have decreasing effects on the liquidity risk component), it is less clear, if not questionable, whether central banks should embark on operations going beyond the unique objective of supporting a resumption of market functioning to ensure a smooth distribution of liquidity in the money market. For these authors, "the central bank cannot come to be seen as the market maker of last resort in all markets nor the lender of last resort for all institutions". In this respect, Chailloux, Gray, Klüh, Shimizu and Stella (2008) notice that a central bank which accepts illiquid assets as eligible collateral may encourage banks to retain tradable collateral to be used in more restrictive markets such as the repo market and to see the central bank as a liquidity provider of *first* resort. In sum, if there are limits to central bank intervention, notably to contain moral hazard, there should also be conditions under which the central bank should not expect to influence the interest rate spreads beyond the liquidity risk premium.

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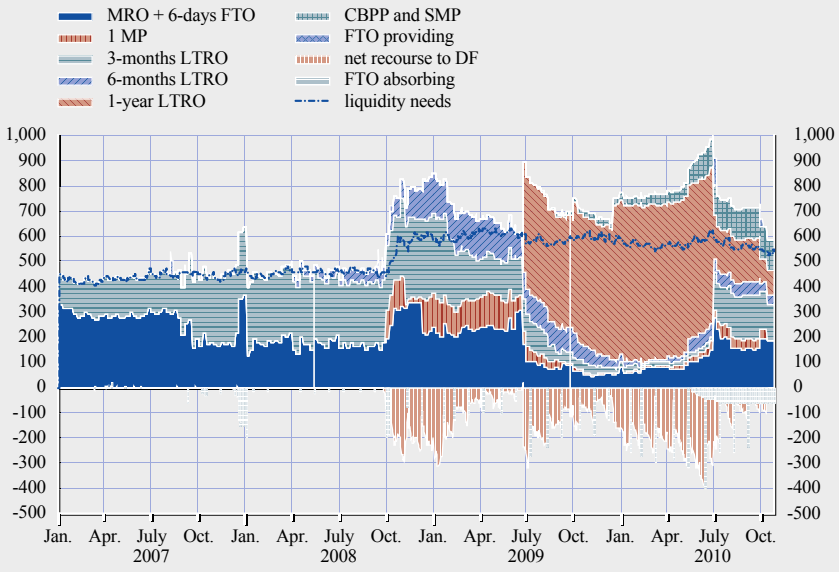
ANNEX

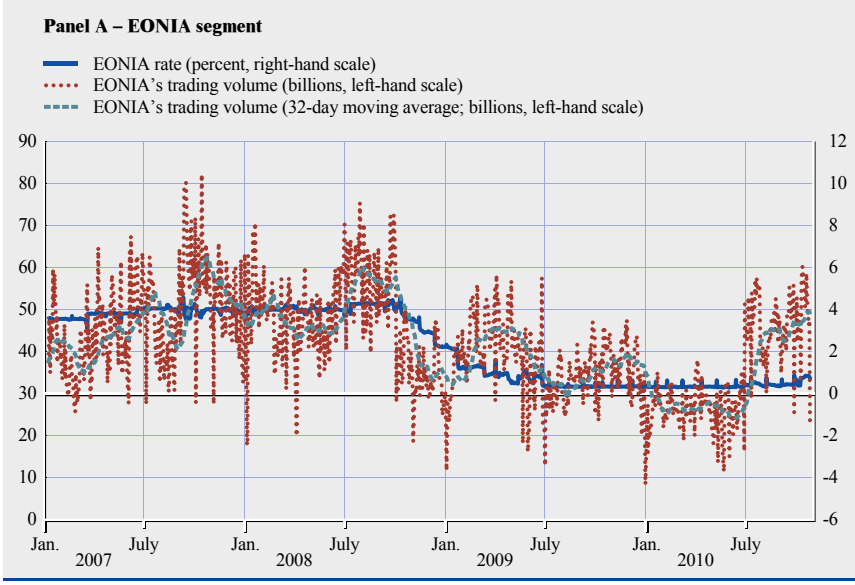
Chart 1 Provision and liquidity absorption by the Eurosystem

(EUR billion)



Source: ECB.

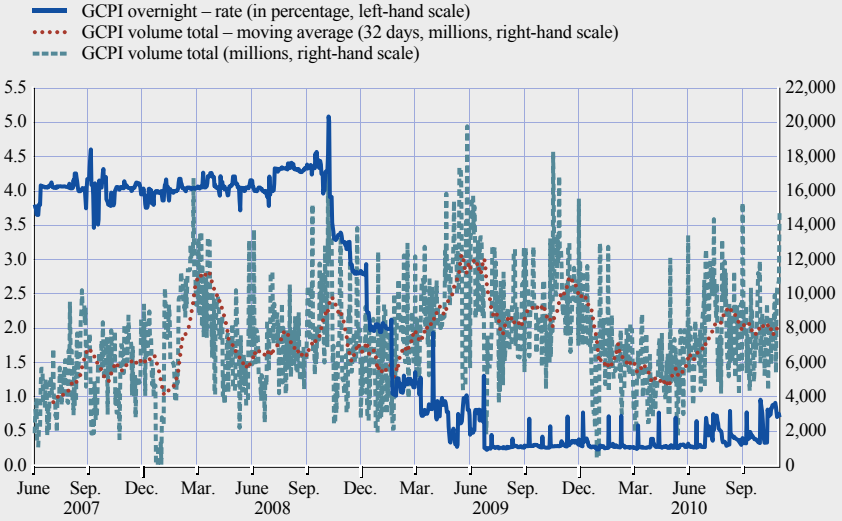
Chart 2 Activity and prices in the euro money market



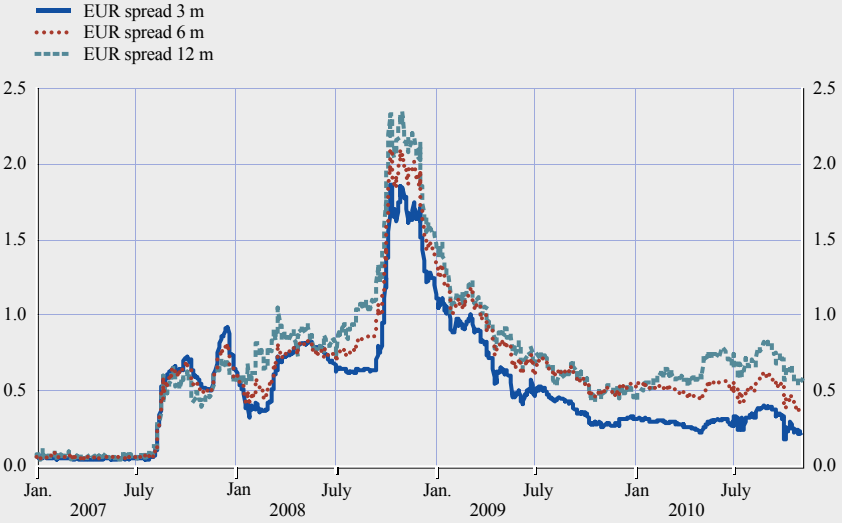
Source: ECB.

Chart 2 Activity and prices in the euro money market (cont'd)

Panel B – Repo Segment



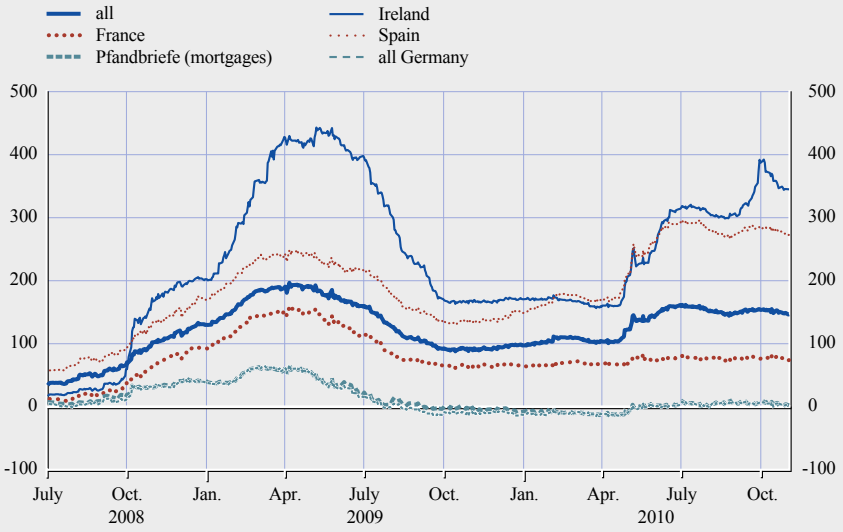
Panel C – EURIBOR-OIS spreads



Source: ECB, Reuters.

Chart 3 Covered bond spreads against 5-year swap rate

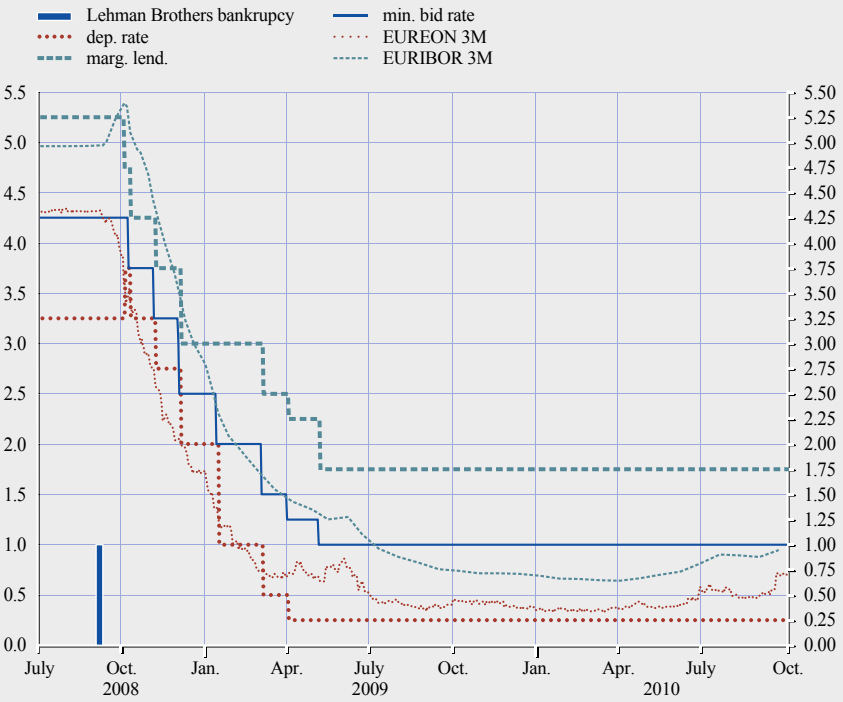
(basis points)



Source: ECB.

Chart 4 Levels of key ECB interest rates, EURIBOR 3-month rate and 3-month OIS interest rate

(interest rates in percentage)

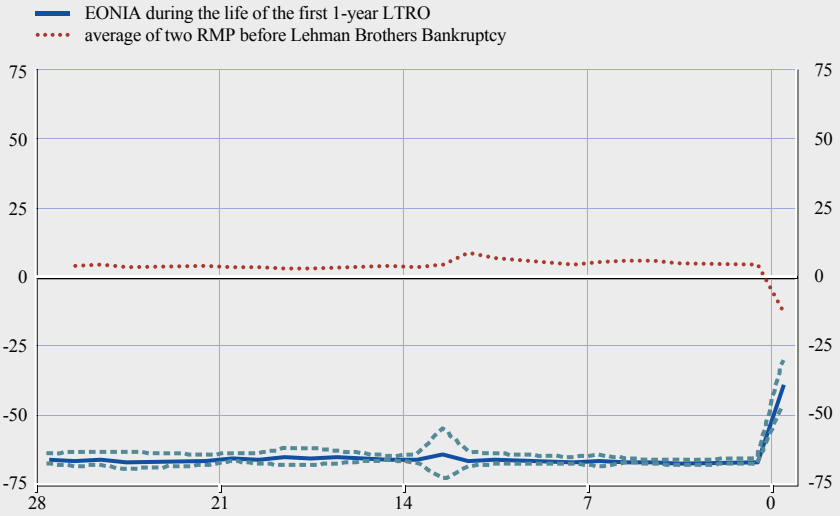


Source: ECB, Reuters.

Chart 5 EONIA-Minimum Bid Rate (MBR) spreads (Panel A) and average daily reserve surplus (Panel B) before and after September 2008

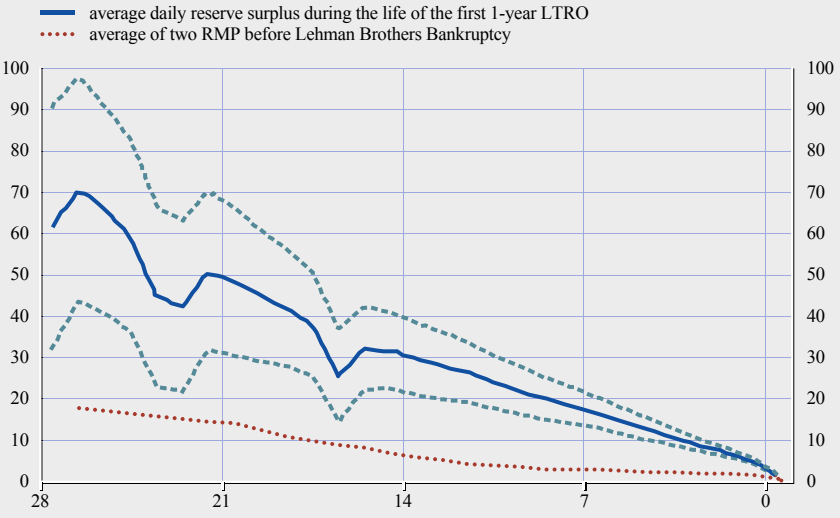
Panel A

x-axis: number of days until the end of the RMP
y-axis: spread EONIA – MBR (basis points)



Panel B

x axis: number of days until the end of the RMP
y axis: EUR billion

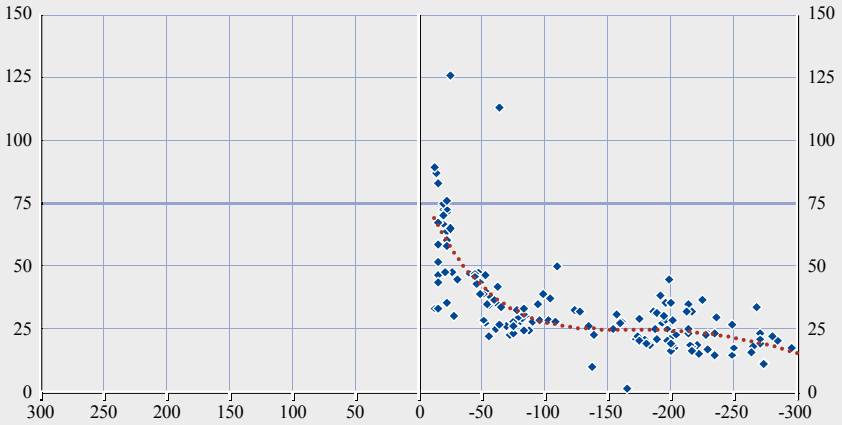


Source: ECB.

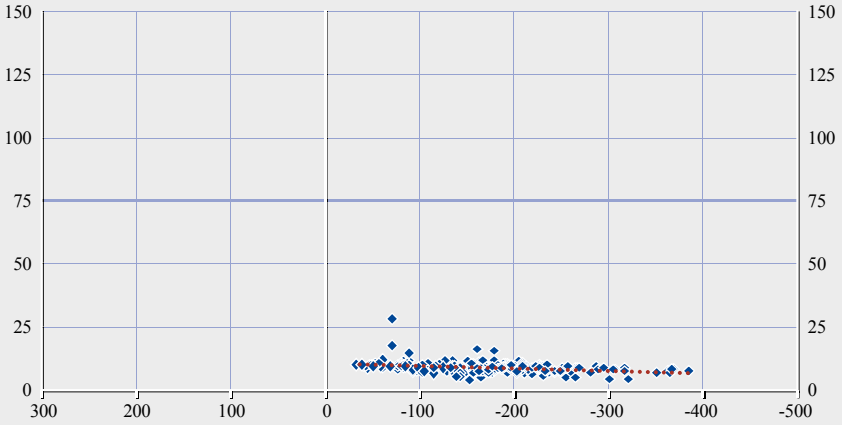
Chart 6 EONIA against the deposit facility rate and net recourse to marginal lending facility before and after September 2008

x-axis: net recourse to the marginal lending facility (MLF-DF)
y-axis: EONIA spread over the deposit facility rate (basis points)

Panel A
(with full allotment before 1-year LTRO)



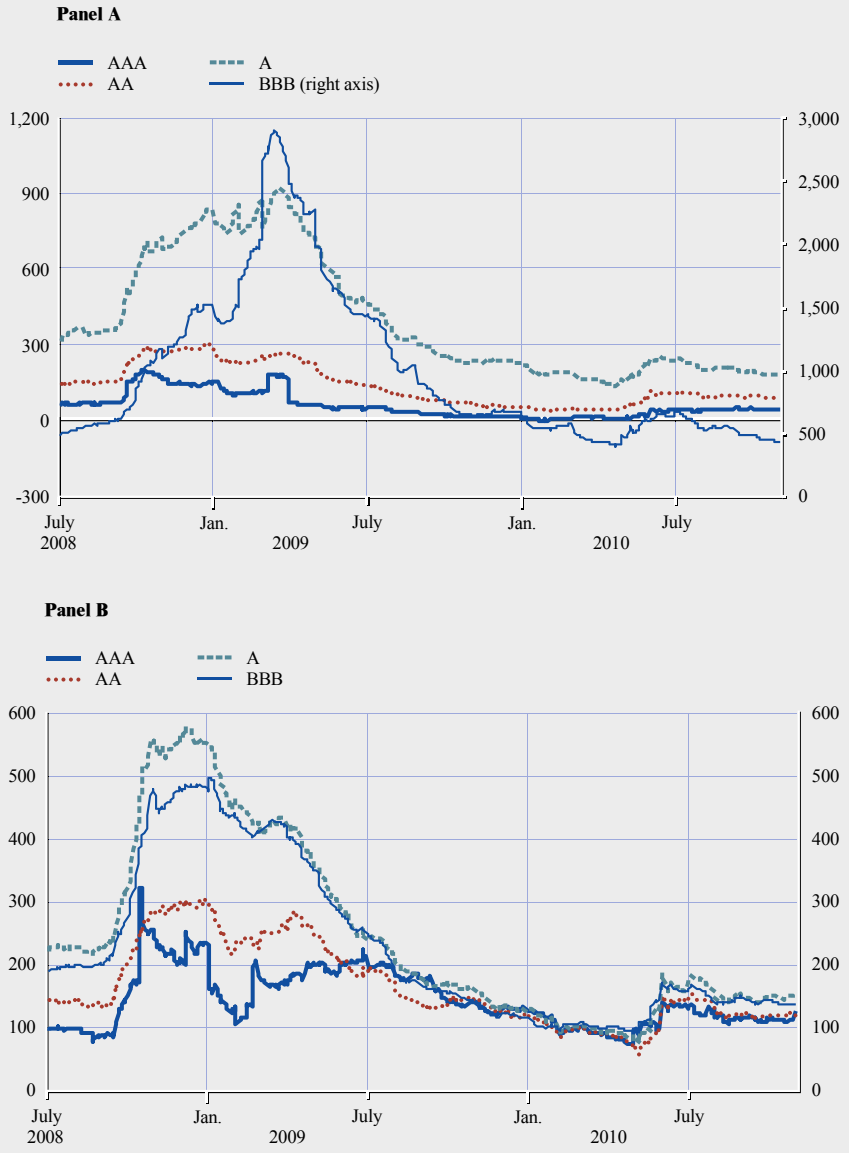
Panel B
(with full allotment tenders during the life of the first 1-year LTRO)



Source: ECB.

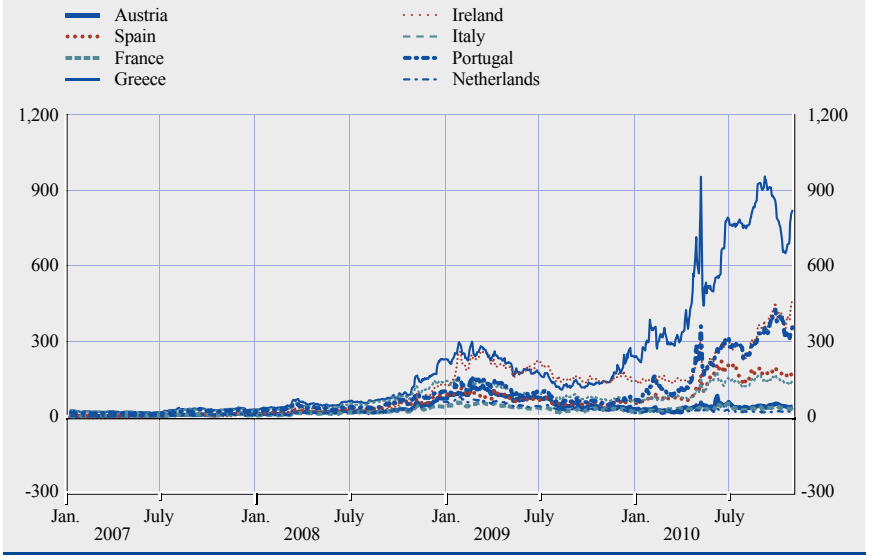
Chart 7 Corporate bond spreads for financial (Panel A) and non-financial (Panel B) sectors

(basis points)



Source: Reuters.

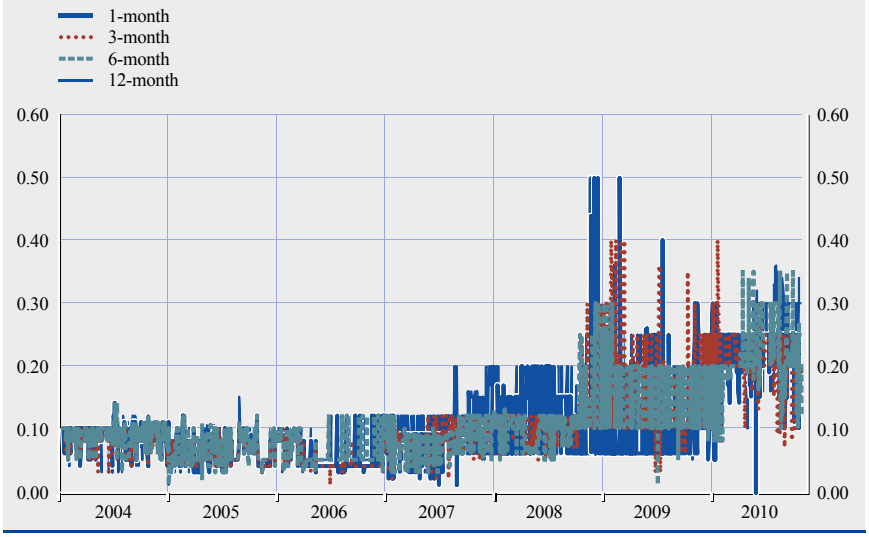
Chart 8 10-year Government bond spreads against German Bund



Source: Reuters.

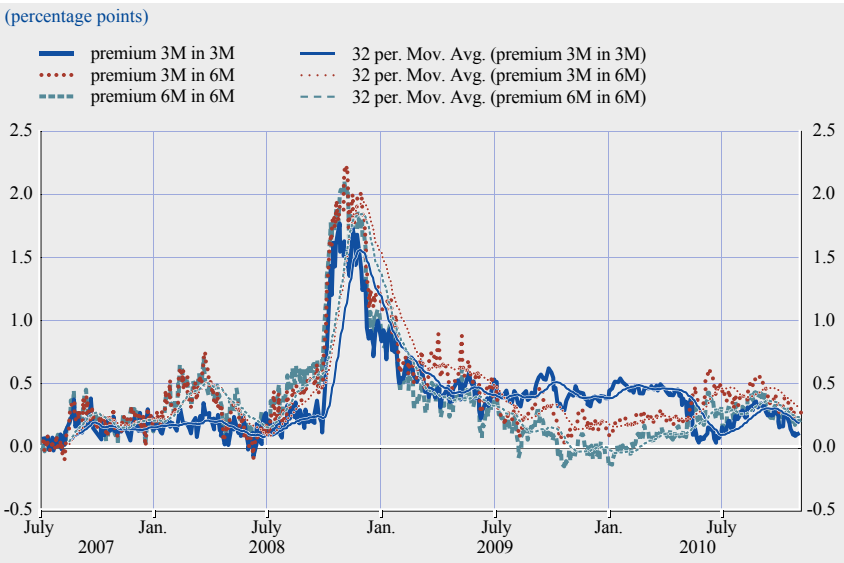
Chart 9 Quoted spreads in the deposit money market at various maturities

(percentage points)



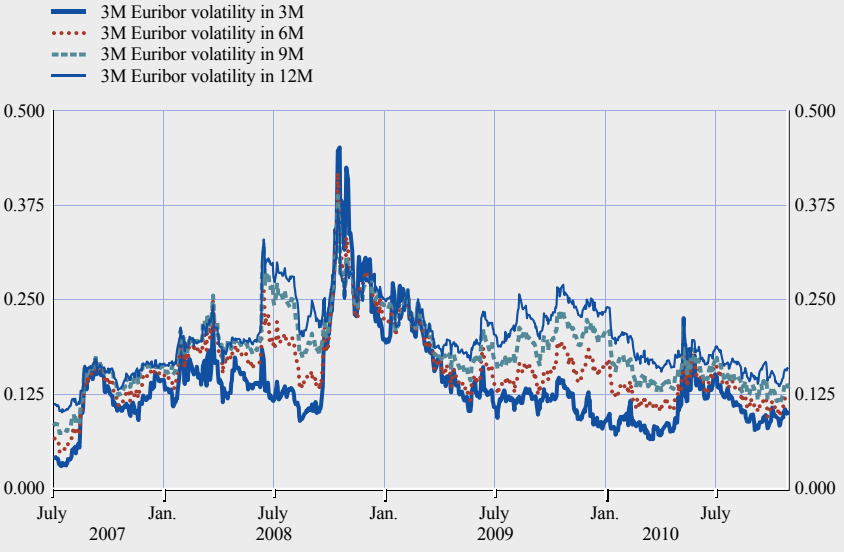
Source: Reuters.

Chart 10 Liquidity premium based on the Forward Rate Agreements



Source: Reuters. Authors' calculations.

Chart 11 Forward term EURIBOR volatility



Source: Reuters. Authors' calculations.

Chart 12 Conditions for an interbank market at time 2

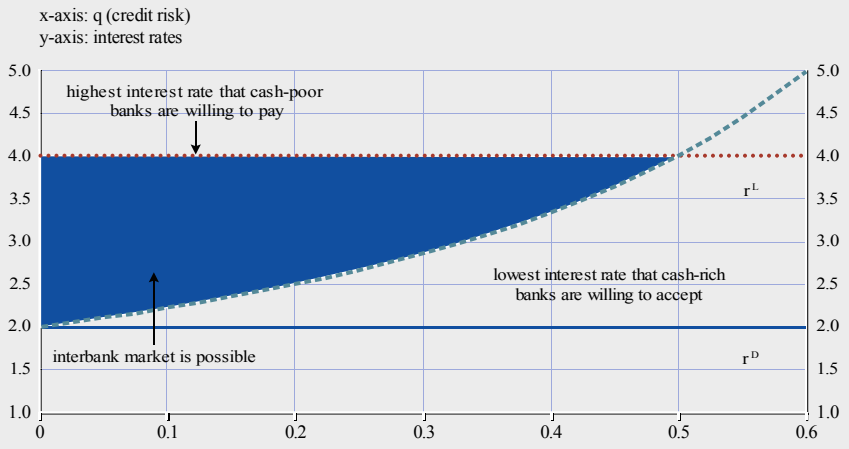


Chart 13 Type A banks' decision tree

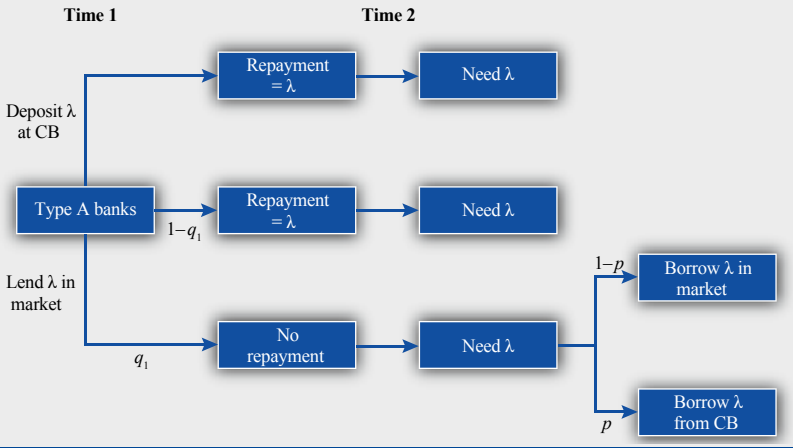


Chart 14 Conditions for an interbank market at time 1

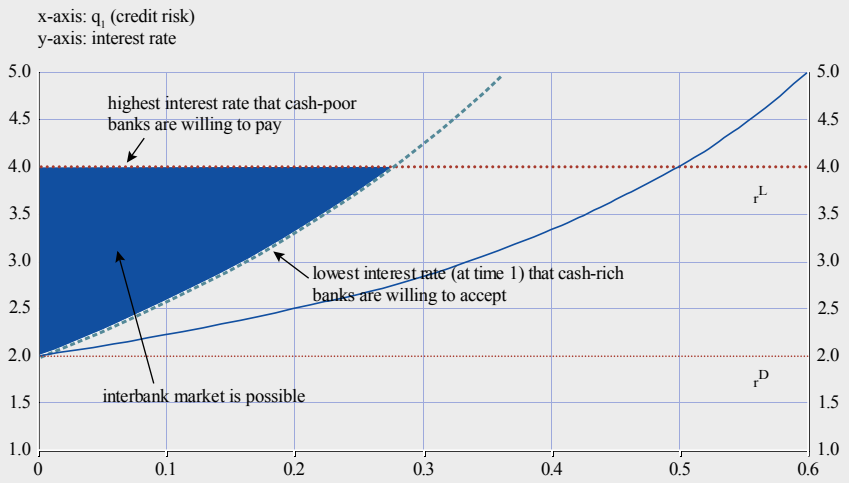
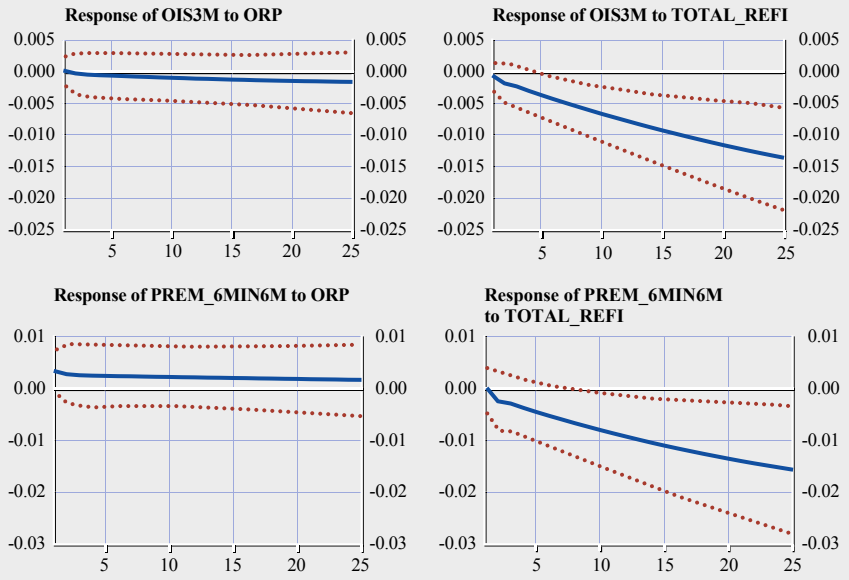


Chart 15 Generalised Impulse Response Functions of spreads and liquidity premium to shocks to ECB liquidity policy measures

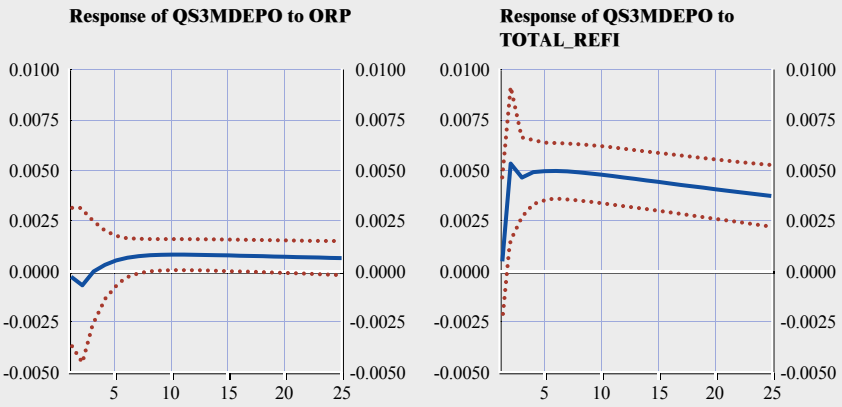
(response to Generalized One S.D. Innovations ± 2 S.E.)



Source: Authors' calculations.

Chart 16 Generalised Impulse Response Functions of quoted (bid/ask) spread to shocks to ECB liquidity policy measures

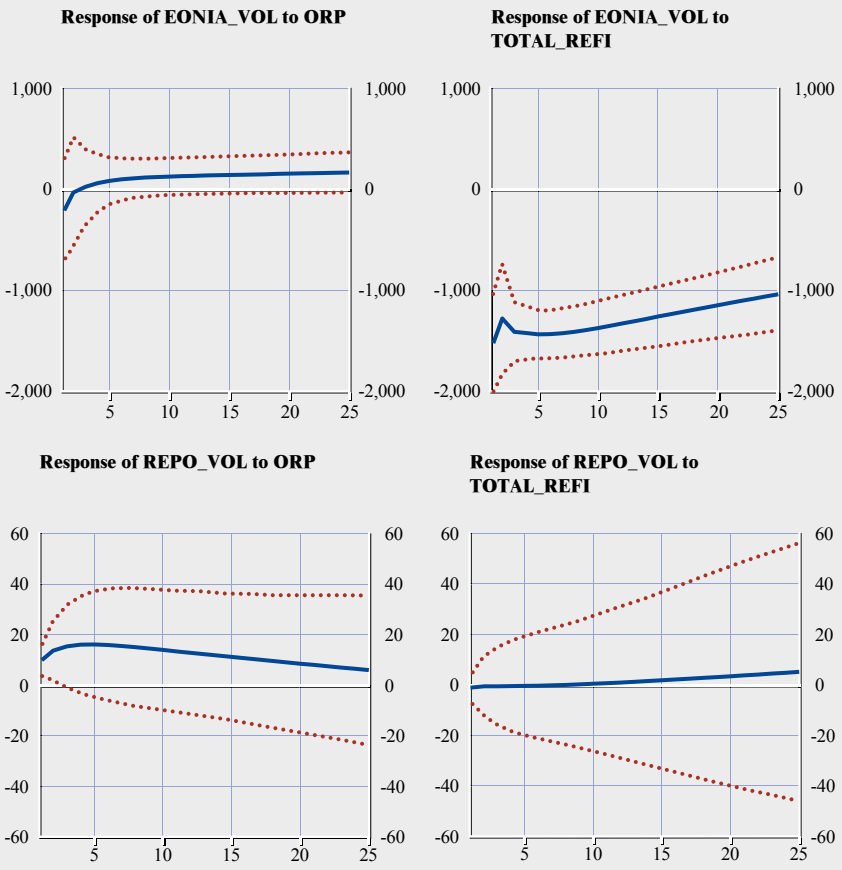
(response to Generalized One S.D. Innovations ± 2 S.E.)



Source: Authors' calculations.

Chart 17 Generalised Impulse Response Functions of trading volume in the overnight market to shocks to ECB liquidity policy measures

(response to Generalized One S.D. Innovations ± 2 S.E.)



Source: Authors' calculations.

Table 1 Ad-hoc refinancing operations in EUR

	Providing FTOs				Absorbing FTOs						Total
	1-day	3-day	5-day	6-day	1-day	2-day	3-day	5-day	6-day	7-day	
Phase I (09 August 2007-14 September 2008)	6	1	1	-	17	2	1	2	1	-	31
Phase II (15 September 2008-31 October 2009)	20	-	-	1	16	-	-	-	-	-	37
Phase III (1 November 2009-30 September 2010)	-	-	-	2	11	-	-	-	-	21	34
Total	26	1	1	3	44	2	1	2	1	21	102

Table 2 Liquidity-absorbing operations in FX

	CHF					USD								Total
	6-day	7-day	8-day	14-day	84-day	5-day	6-day	7-day	8-day	16-day	28-day	83-day	84-day	
Phase I (09 August 2007-14 September 2008)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phase II (15 September 2008-31 October 2009)	1	52	-	-	4	1	1	10	1	1	3+1 TAF	1	3	79
Phase III (1 November 2009-30 September 2010)	-	11	-	14	-	-	-	-	-	-	-	-	-	25
Total	1	63	-	14	4	1	1	10	1	1	4	1	3	104

Table 3 Liquidity-providing operations in USD

	Term Auction Facility (TAF)															Total
	1-day	3-day	4-day	5-day	6-day	7-day	8-day	15-day	16-day	28-day	35-day	83-day	84-day	85-day	91-day	
Phase I (09 August 2007-14 September 2008)	-	-	-	-	-	-	-	-	-	16	1	-	2	-	-	19
Phase II (15 September 2008-31 October 2009)	16	3	1	1	1	51	-	-	1	12	-	1	13	1	1	102
Phase III (1 November 2009-30 September 2010)	-	-	-	-	-	8	2	1	-	-	-	-	-	-	-	11
Total	16	3	1	1	1	59	2	1	1	28	1	1	15	1	1	132

CHALLENGES AND LESSONS OF THE FEDERAL RESERVE'S MONETARY POLICY OPERATIONS DURING THE FINANCIAL CRISIS[1]

BY SPENCE HILTON, FEDERAL RESERVE BANK OF NEW YORK
JAMES MCANDREWS, FEDERAL RESERVE BANK OF NEW YORK

1 INTRODUCTION

The Federal Reserve has undertaken a large number of policy initiatives in response to the financial crisis. In the span of little more than one year, from August 2007 until December 2008, its conventional monetary policy instrument – the overnight federal funds rate target – was lowered from 5.25% to a range of 0-0.25%, its effective lower bound. Even more noteworthy have been a number of so-called unconventional or non-standard policy actions that have dramatically altered the size and composition of its asset holdings, which in total expanded from USD 874 billion in August 2007 to USD 2.3 trillion as of March 2010. This significant expansion only hints at the range and number of individual policy actions taken over this period.

This paper reviews the experiences of the Federal Reserve during the crisis and identifies some of the major lessons learned for the future design of its policy implementation framework. But rather than an exhaustive review of the actions taken by the Federal Reserve and their various motivations, in the first part of this paper we discuss three key challenges it faced in fashioning its responses and how they were addressed, namely: (i) constraints on the use of its balance sheet imposed by its traditional operating framework; (ii) stigma associated with borrowing from its traditional lending facilities; and (iii) the need for new collateral arrangements to support non-traditional forms of lending. In the second part of this paper, we consider the lessons learned during the crisis for the design of the future operating framework, focusing on three components of the framework: (i) policies for administered and market interest rates;

1 The views expressed in the paper are those of the authors and are not necessarily reflective of views at the Federal Reserve Bank of New York or the Federal Reserve System. We wish to thank Jim Clouse, Michael Fleming, Antoine Martin, Susan McLaughlin, Josh Rosenberg, and Brian Sack for their helpful comments. Dennis Kuo and Michael Walker provided excellent research assistance. Any errors or omissions are the responsibility of the authors.

(ii) the structure of the portfolio of domestic assets; and (iii) the role and objectives for reserve balances in the framework.[2]

2 CHALLENGES IN RESPONDING TO THE FINANCIAL CRISIS

In this overview, we will focus on three key challenges faced by the Federal Reserve in its response to the crisis, some of which could apply to central banks more broadly while others were specific to the circumstances faced by the Federal Reserve. Among the many challenges encountered by Federal Reserve policy-makers, those relating to the inflexibility of the balance sheet size, the stigma of discount window borrowing and risk management challenges when lending to an expanded set of counterparties and/or when lending on a non-recourse basis provide particular insight into the range of policy options for and policy designs of the Federal Reserve's response to the crisis.[3]

2.1 BALANCE SHEET CONSTRAINTS

The implementation of interest rate policy by the Federal Reserve at the time of the crisis depended on close control of the supply of reserves and other balances made available to banks (as explained, for instance, in Bernanke (2005)) to maintain the market's effective federal funds rate close to the target rate. That method of monetary policy implementation conferred only a limited degree of flexibility on the size of the Federal Reserve's asset holdings, so long as the target federal funds rate was above zero. Because of this, the Federal Reserve faced limits on the amount of lending to banks, primary dealers and others it could conduct (until it received the authority to pay interest on reserves in October 2008).

As an example of the limited flexibility of the Federal Reserve's balance sheet, for each Term Auction Facility (TAF) operation, the Open Markets Desk (hereinafter "the desk") at the Federal Reserve Bank of New York was

2 Following some brief concluding observations, two appendices are provided. In the first appendix, we review the recent literature on the effectiveness of various Federal Reserve lending facilities during the crisis. In the second, we provide an outline of the many policy actions taken by the Federal Reserve from August 2007 to March 2010. Following Appendix B are two figures. Figure 1 provides a graphical timeline of significant policy actions with a graphical depiction of the growth in the assets and liabilities of the Federal Reserve during the same time period. Figure 2 plots the federal funds and interest on reserves rates over this period. In-depth treatment of select liquidity facilities and other Federal Reserve responses to the crisis can be found in various articles in *Economic Policy Review* and in *Current Issues in Economics and Finance*, both of which are Federal Reserve Bank of New York research publications and are available online at http://www.newyorkfed.org/research/epr/2010.html. For an overview and theoretical treatment of the different forms of "credit easing" provided by the Federal Reserve, see the speech given by Chairman Bernanke on 13 January 2009 entitled "The Crisis and Policy Response" , available at http://www.federalreserve.gov/newsevents/speech/bernanke20090113a.htm.

3 This list of major challenges faced by the Federal Reserve in crafting responses to the crisis is not intended to be exhaustive. For example, devising strategies to provide further monetary stimulus when near the zero bound on short-term interest rates was another considerable challenge encompassing many dimensions, which we do not address in this paper.

required to take countervailing actions to offset the injection of reserves that would otherwise occur as reserve funds were awarded to winning TAF bidders. Had the Federal Reserve not taken these offsetting actions, the quantity of reserve balances would have increased, putting downward pressure on market interest rates in the money markets.

Other operations that were introduced or changed to mitigate the disruptions in financial markets were also constrained. In addition to the TAF, the Federal Reserve had implemented Reciprocal Currency Arrangements, or FX Swaps, with a number of other central banks, in which it lent dollar funds to those central banks which, in turn, lent funds to commercial banks in their jurisdictions (Board of Governors (2007d)). The Federal Reserve had also made changes to its securities lending facility (Federal Reserve Bank of New York (2007a, 2007b)), reducing the effective lending rate and increasing the supply of Treasury securities made available to lend to primary dealers. As part of its response to stresses in the repo market, on 7 March 2008 the Federal Reserve announced a series of special open market operations made against mortgage-backed securities, called Single-Tranche Repo operations, intended to improve conditions in term funding markets (Board of Governors (2008d)). A consequence of these actions was that the Federal Reserve was increasingly constrained in the amount of further lending in which it could engage.

Offsetting (or sterilising) a TAF loan essentially required the desk to sell Treasury securities. The ability of the Federal Reserve to engage in offsets of this type was constrained by the amount of securities it had at the start of the crisis, the amount of lending it was engaged in, and the amount of securities it had lent out. Furthermore, the desk had to organise a significant amount of data and calculate a large number of factors when deciding on its daily operations. As a result of these considerations, the Federal Reserve focused on ways to reduce the reserve effects of its lending operations. TAF auctions settled three days following the auction and this delayed settlement was helpful as the desk had a few days to arrange the countervailing operations, which could vary in amount depending on the amount of funds awarded in a particular auction.

The Term Securities Lending Facility (TSLF), announced on 11 March 2008 (Board of Governors (2008e)), was designed to be reserve neutral as a consequence of the balance sheet constraints faced by the Federal Reserve. Operated as a periodic auction, primary dealers bid for a loan of general collateral Treasury securities (rather than for balances that would increase the amount of reserves outstanding) in exchange for collateral that included all collateral eligible for tri-party repurchase agreements arranged by the Open Market Trading Desk as well as investment grade corporate securities, municipal securities, mortgage-backed securities and asset-backed securities. This design had two significant advantages given the operational framework used for the implementation of interest rate policy at the time. First, the operation of the TSLF did not affect the quantity of reserves outstanding, so no offsetting operations by the desk were required to implement interest rate policy. Second, the predictability of reserve balances was not impaired, which allowed the settlement of auctions to proceed on the day following an auction rather than three days following, as was the

case with TAF auctions. Nonetheless, and notwithstanding its lack of impact on reserve balances, the TSLF did "consume" some of the balance sheet capacity of the Federal Reserve, in that Treasury securities that were lent out to dealers were not available for sale, if need be, to offset other lending carried out by the Federal Reserve.

The Federal Reserve, as a consequence of its operational framework, its policy to target a positive federal funds rate and the initial size of its balance sheet, was constrained in the overall size of its lending programmes. The size of all of its programmes was equal to the size of the Federal Reserve's holdings of securities at the time of the crisis. For example, by selling its holdings of Treasury securities, the Federal Reserve could have announced much larger sizes of auctions for the TAF and FX Swaps; however, the Federal Reserve did not have the capacity to offset auctions that would award more funds than its outstanding holdings of other securities while still maintaining its interest rate policy. Consequently, it is possible, as a theoretical matter, that the Federal Reserve's response to the crisis could have been inefficiently constrained, prior to it being given the authority to pay interest on reserves, by the accident of the size of its holdings of Treasury securities when entering the crisis.[4]

To help address this limitation, later in the crisis, the creation of the Supplementary Financing Program (SFP) was announced on 17 September 2008 (U.S. Department of the Treasury (2008)), the day following the large loan made to AIG (Board of Governors (2008j)). The SFP consisted of a series of sales of Treasury bills by the Treasury, the proceeds of which were deposited with the Federal Reserve, thereby draining reserves. This device was intended to allow the Federal Reserve to maintain its interest rate policy even as its asset holdings soared well beyond their level immediately prior to September 2008; in the absence of the SFP, reserve balances would also have increased even more significantly and even greater downward pressure would have been placed on the federal funds rate. The SFP better enabled the Federal Reserve to continue to support its target rate, which was 2% on 16 September 2008 and was reduced to 1.5% on 8 October 2008. However, the SFP has limitations of its own. Importantly, the sales of Treasury securities are limited by the statutory debt ceiling established by Congress and altered only periodically. In addition, SFP operations are set by the Treasury and must accommodate their auction schedule, rather than timed for deposits to occur synchronously with loans or asset purchases made by the Federal Reserve. As a result, the Federal Reserve needed additional flexibility to manage its interest rate policy during intervals in which the SFP was fixed in size.

2.2 STIGMA OF DISCOUNT WINDOW BORROWING

Stigma, a perception that a suspected borrower from the discount window is of low credit quality, has long been a concern of potential borrowers from the discount window (Peristiani (1991, 1998)). Many analysts have regarded

4 Also important in limiting the operational response may have been the fact that, at the time, the Federal Reserve did not have effective temporary tools for draining large amounts of reserves.

the Federal Reserve's policies prior to 2003 as potentially reinforcing stigma. The pre-2003 discount window policy was to lend to depository institutions at a rate below the target federal funds rate, but with amounts and frequencies that were at least widely perceived to be rationed. Following the failure of Continental Illinois, banks became even more reluctant to borrow at the discount window. In 2003 the Federal Reserve changed its administration and set the borrowing rate at the discount window above the federal funds target rate and made other changes to eliminate any perception of rationing, but a reluctance to borrow persisted (Furfine, 2003). The reluctance to borrow from the discount window was seen as a constraint during the crisis, as it impeded the policy objective of distributing funds widely against available collateral.

The main explanation for banks' reluctance to borrow at the discount window is that such borrowing will be inferred by market participants as a sign that a borrower is financially weak. In addition to Furfine (2003), more recent work by Armantier, Ghysels, Sarkar and Shrader (2010) and Ennis and Weinberg (2010) documents that stigma remains a current problem. The studies show that banks are willing to pay higher interest rates in the interbank market than the interest rate at which they could borrow directly from the discount window. This is evidence that banks are willing to pay to avoid the stigma associated with discount window borrowing.

The abrupt rise in term funding rates on 9 August 2007 led the Federal Reserve to intervene quickly on 10 August to reassure markets that it stood ready to supply liquidity, intervening an unprecedented three times that day with open market operations to maintain the effective federal funds rate close to the target rate (Board of Governors (2007a)).[5] On 17 August 2007 the Board of Governors announced changes in the Primary Credit Program of the discount window. It lengthened the period over which credit could be extended from overnight to 30 days and reduced the spread of the primary credit interest rate over the federal funds target rate from 100 to 50 basis points. The following day the Federal Reserve encouraged borrowing from the discount window during a conference call with major banks organised by The Clearing House (Lanman (2007)). During the call, Vice Chairman Kohn and Federal Reserve Bank of New York President Geithner counselled that use of the discount window would be viewed by the Federal Reserve as a sign of strength (Smith, Mollenkamp, Perry and Ip (2007)). Although some initial borrowing occurred after these moves, discount window borrowing was negligible during the second half of 2007 despite widespread recognition that money markets were impaired and the availability of term funding was scarce.

Stigma essentially prevented the Federal Reserve from following Bagehot's dictum of lending freely against good quality collateral. Stigma also seemingly prevented banks from borrowing from the Federal Reserve even when it was in their economic interest because the interest rate offered by the Federal Reserve was below the market rate for a loan of the same term. In December 2007 the

5 See Federal Reserve Bank of New York, "Temporary Open Market Operations", available at http://www.newyorkfed.org/markets/omo/dmm/historical/tomo/temp.cfm

Federal Reserve announced the creation of the TAF, in part to overcome the problem of discount window stigma, pointing out that "this facility could help promote the efficient dissemination of liquidity when the unsecured interbank markets are under stress" (Board of Governors (2007d)).

The TAF had several design features that served to reduce the stigma associated with borrowing from the primary credit facility of the discount window. Its principal feature was that it was organised as an auction, in which banks bid simultaneously on the date of the auction. In addition, the minimum rate of interest at which banks could bid was set equal to a market standard, namely the overnight index swap (OIS) rate. The one-month OIS rate is the rate market participants are willing to swap for a stream of variable payments, for the same principal amount, where the variable payment is equal to the effective federal funds rate each day over the month. As the swap is settled at the end of the period with a net payment between the fixed and variable legs, there is very little counterparty credit risk relative to a loan of the same size. Consequently, the OIS rate would, in most cases, be an advantageous rate at which to borrow.

A second feature of the TAF is that the rate at which the winners in the auction would pay for borrowed funds was a uniform price. This feature was designed, in part, to encourage wide participation by healthy banks: even a healthy bank with access to interbank markets would face little cost in submitting a bid at the minimum bid rate and could get a bargain were it to be awarded funds. Moreover, awarding a number of banks funds at the auction-determined rate would make it more difficult to infer who had borrowed from the Federal Reserve from public reports on the breakdown of weekly lending by district. A third feature of the TAF was the delayed settlement of the auction, in which funds were delivered to winning bidders three days after the auction; as a result, borrowing via the TAF did not signal an immediate need for funding.

In sum, the auction format enabled banks to approach the Federal Reserve collectively rather than individually to obtain funds, with a delay of a few days, at a competitive rate set by auction rather than at an administered rate premium set by the Federal Reserve. Thus, institutions might attach less of a stigma to TAF auctions than to traditional discount window borrowing.[6] The paper by Armantier, Ghysels, Sarkar and Shrader (2010) tests this by examining individual bank bids in the TAF, showing that banks bid at considerably higher rates in the TAF than the current discount rate, suggesting that banks faced significantly less stigma in the TAF than at the window.

The auction method of reducing the risk of stigma in its lending facilities carried over to the TSLF, which allocated Treasury securities to primary dealers against specific types of collateral. Primary dealers are broker-dealer firms, financial intermediaries that depend heavily on short-term money markets and face concerns of stigma, much as do banks (see Fleming, Hrung and Keane (2009) on this point).

6 See the paper by Armantier, Krieger and McAndrews (2008) for more on the TAF design.

For many other lending facilities implemented by the Federal Reserve, certain limitations of the auction method of distributing funds – such as the difficulty of collecting bids in a timely and secure fashion, the necessity of auctions occurring periodically rather than continuously, and the greater certainty of borrowing costs provided by fixed-rate facilities – led to alternative types of allocation methods. Nonetheless, the method of auctioning funds to banks for discount window purposes proved feasible and, judging from the widespread participation alone, effective in reducing banks' concerns about stigma.

2.3 APPROPRIATE COLLATERAL ARRANGEMENTS

In their normal course of operations, Federal Reserve Banks extend discount window loans only on a collateralised basis and only with full recourse to the borrower. During the crisis, however, the Federal Reserve lent to many counterparties with whom it had no prior relationship, and who did not maintain deposit accounts nor collateral pledged at the Federal Reserve. As a result, the Federal Reserve had to design new ways to manage its credit risk and to secure its lending to a wide variety of counterparties against a wide variety of collateral. We refer to this broad risk management challenge as finding appropriate collateral arrangements.

Banks regularly maintain large amounts of collateral pledged to the Federal Reserve Banks in case they need to request a discount window loan at short notice. During the most severe phase of the financial crisis after the bankruptcy of Lehman Brothers, the Federal Reserve created a number of lending facilities to improve conditions in a wide variety of short-term funding markets, with most of these facilities authorised under Section 13(3) of the Federal Reserve Act. That section states that "[i]n unusual and exigent circumstances, the Board of Governors of the Federal Reserve System, by the affirmative vote of not less than five members, may authorize any Federal Reserve bank, during such periods as the said board may determine, at rates established in accordance with the provisions of section 14, subdivision (d), of this Act, to discount for any individual, partnership, or corporation, notes, drafts, and bills of exchange when such notes, drafts, and bills of exchange are endorsed or otherwise secured to the satisfaction of the Federal Reserve bank: *Provided*, That before discounting any such note, draft, or bill of exchange for an individual, partnership, or corporation the Federal Reserve bank shall obtain evidence that such individual, partnership, or corporation is unable to secure adequate credit accommodations from other banking institutions."[7] Because the Federal Reserve, in the lending facilities it created, was lending to borrowers with whom it often had no pre-existing relationship, and because the Federal Reserve was attempting, in many cases, to improve funding conditions broadly rather than focusing on the funding conditions of individual market participants, it faced significant challenges in designing appropriate collateral arrangements: ones that secured its lending to its satisfaction while, at the same time, achieving its broad objective of lending.

7 Federal Reserve Act, Section 13(3), available at http://www.federalreserve.gov/aboutthefed/section13.htm.

A review of all the lending facilities initiated by the Federal Reserve during the crisis is beyond the scope of this paper, but a look into some of the arrangements fashioned by the Federal Reserve reveals some of the difficulties it encountered in designing its facilities. Good examples are provided by the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF) and the Commercial Paper Funding Facility (CPFF).[8]

The AMLF was announced on 19 September 2008 (Board of Governors (2008l)), just four days after the bankruptcy of Lehman Brothers and two days after the Reserve Primary Fund, a large money market mutual fund (MMMF), was disbanded after its net asset value fell below 99.5% of the par value of its liabilities (i.e. it "broke the buck"). The failure of the Reserve Primary Fund led to a widespread withdrawal from "prime" MMMFs. Prime MMMFs are large investors in commercial paper, both asset-backed commercial paper and non-asset-backed commercial paper. Faced with the severe withdrawal pressures during the week of 15 September 2008, MMMFs had to raise funds, often by selling commercial paper below its amortised cost. Selling pressures that led to these fire sale prices threatened MMMFs generally, as well as issuers of commercial paper.

To accommodate the withdrawal requests of MMMF shareholders without putting significant sales pressures on commercial paper and to quickly respond to the widespread withdrawals, the Federal Reserve designed and implemented the AMLF. Under the terms of the AMLF, the Federal Reserve lent to banks and bank holding companies against pledges of asset-backed commercial paper. The specific asset-backed commercial paper must have been purchased from a MMMF after 19 September; been purchased at the fund's acquisition costs adjusted for amortisation; been highly rated and issued by a US issuer and be of short-term maturity; and, in addition, the selling MMMF must have experienced significant withdrawal pressures. Under these conditions, the Federal Reserve would advance a loan equal to the amount of the amortised cost of the asset-backed commercial paper that collateralised the loan. The loan was made on a non-recourse basis. That is, at the maturity of the loan, the Federal Reserve Bank would have no recourse to the bank to which it lent funds for the repayment of the loan; instead, the collateral itself would assure repayment of the loan. This programme relied on the assets backing the asset-backed commercial paper to provide satisfactory security to collateralise the extension of credit, rather than the creditworthiness of the borrowing bank. This was consistent with the objectives of the programme. The objectives of the AMLF included "assist[ing] money funds … in meeting demands for redemptions by investors and foster[ing] liquidity in the asset-backed commercial paper markets and broader money markets" (Board of Governors (2008l)). The non-recourse feature of the programme was vital to provide good incentives for bank participation as, without it, banks would have been at risk of non-performance of the commercial paper they had purchased from the MMMF. As banks were needed to purchase

8 The terms and conditions for the AMLF are available at http://www.frbdiscountwindow.org/mmmftc.cfm?hdrID=14&dtlID ; the paper by Adrian, Kimbrough, and Marchioni (2010) provides a thorough review of the CPFF.

commercial paper at amortised cost from MMMFs to accommodate withdrawal requests, relieving the banks from this risk exposure was important to facilitate rapid and widespread participation by banks and to achieve the programme's goals of providing funds to MMMFs facing heightened withdrawal demands. Were this feature of the facility absent, banks likely would not have been willing to purchase the commercial paper from MMMFs at amortised cost, leading to little participation. This programme was carefully structured both to meet its objectives and to provide satisfactory collateral to the Federal Reserve Banks; however, it was limited in size to the availability of the asset-backed commercial paper held by qualifying MMMFs.

In addition to causing extraordinary disruptions to the operations of MMMFs, the widespread withdrawal demands from MMMFs also resulted in severely strained circumstances for issuers of commercial paper, as the typical demands for commercial paper from MMMFs evaporated as their shareholders withdrew from MMMFs. To address this stress, the Federal Reserve announced the CPFF on 7 October 2008 (Board of Governors (2008p)) as a backstop to the commercial paper market. The CPFF had an unusual structure in that lending by the Federal Reserve Bank was to a special purpose vehicle that purchased eligible commercial paper directly from issuers of commercial paper.[9] Lending was made on a non-recourse basis to the corporation that issued the commercial paper; the lending was secured by a combination of features of the programme.

As explained by Adrian, Kimbrough and Marchioni (2010), a combination of assets held by the special purpose vehicle served as the collateral in the facility. Much of the commercial paper purchased in the facility was non-asset-backed paper, so alternative means of collateralising the lending to the facility had to be fashioned rather than relying on the commercial paper itself. For some of the issuers of commercial paper eligible to issue to the facility (those that were either financial companies or bank holding companies), the issuer could pledge financial assets to provide collateral or could participate in the Federal Deposit Insurance Corporation's Temporary Liquidity Guarantee Program to provide a guarantee on paper issued to the facility, which substituted for collateral. As some non-financial companies could not easily pledge non-financial assets to collateralise their issuance of commercial paper (and as the operational difficulty of doing so was enormous), further alternatives were fashioned. In particular, an "unsecured credit surcharge" of 100 basis points was imposed on any issuance of commercial paper to the facility that was not otherwise secured. In addition to both a facility fee of 10 basis points of the maximum amount an issuer could issue to the facility and the accrual of interest earnings, over time these fees built up a significant cushion of earnings above the value of commercial paper in the facility. When this margin above the value of commercial paper in the facility was measured on a portfolio basis, it provided satisfactory security to the Federal Reserve Bank. In operation, the CPFF experienced no defaults, and substantial earnings accrued to the Federal Reserve and, consequently, to the US Treasury (Federal Reserve Bank of New York (2010)).

9 Another source of information on the design of the CPFF can be found at http://www.newyorkfed.org/markets/cpff_terms_conditions.html.

Similar challenges were encountered in the designs of the Money Market Investors Funding Facility (MMIFF) and the Term Asset-Backed Securities Loan Facility (TALF), and so are more general than the examples we reviewed.[10] The need to fashion appropriate collateral arrangements reflected, in part, the objectives of the Federal Reserve to address market-wide disruptions in particular funding markets. The financial system has moved from one that is heavily bank dependent to one that is more dependent on securitisation markets.[11] The funding of the expanded set of intermediaries in the shadow banking system can become impaired in a financial crisis, in part because markets become more segmented during crises (see Saito and Shiratsuka (2001) for an example). Furthermore, once funding problems arise in one area of the shadow banking system, other parts of the system are affected as well. For example, problems encountered by the heavy withdrawals from MMMFs, part of the assets of which consist of the commercial paper issued by other financial intermediaries, caused funding problems in the commercial paper market.

While banks have regular access to the Federal Reserve's discount window, intermediaries in the shadow banking system do not, nor do "individuals, partnerships and corporations."[12] Consequently, if the policy objectives of the central bank call on it to lend to this wider set of entities, fashioning satisfactory collateral arrangements will likely be a challenge. The risk that such collateral arrangements might result in losses is remote for the general lending facilities designed by the Federal Reserve, but was certainly more elevated in the lending to specific firms, specifically the lending to support the acquisition of Bear Stearns by J.P. Morgan Chase and the lending to AIG (although the Federal Reserve is not expected to incur any losses associated with these loans (Board of Governors (2010b)). In these cases, significant concentration risks were involved with the exposures in the facilities designed to house the assets, namely the Maiden Lane facilities. In light of this, the US Treasury expressed its intention that "[i]n the longer term and as its authorities permit, the Treasury will seek to remove from the Federal Reserve's balance sheet, or to liquidate, the so-called Maiden Lane facilities made by the Federal Reserve as part of efforts to stabilize systemically critical financial institutions."[13]

3 LESSONS FOR THE FUTURE OPERATING FRAMEWORK

The size and composition of the balance sheet of the Federal Reserve, including its holdings of domestic financial assets and supporting operations, are likely to

10 For TALF, part of the collateral was provided by funding from the Troubled Assets Relief Program (TARP), administered by the US Treasury, which assumed a "first loss" portion of funding of the special purpose vehicle for the facility.

11 The paper by Adrian, Ashcraft, Boesky and Pozsar (2010) provides a good guidebook to these changes.

12 Under the Dodd-Frank Act 2010, individuals, partnerships and corporations would have access to Federal Reserve lending under Section 13(3) of the Federal Reserve Act, which, as previously noted, requires that conditions are unusual and exigent and that adequate credit accommodations are not available in the market. In addition, such lending would only be available through a market-wide lending facility, and not to a single institution.

13 Board of Governors of the Federal Reserve System and the U.S. Treasury (2009).

be influenced for some time by the unconventional measures taken in response to the extraordinary financial and economic strains over the past few years. There is still considerable uncertainty regarding what the monetary policy implementation framework will look like when financial and economic strains have receded and operating conditions have normalised. However, policy-makers recognise that the future operating framework could differ in important respects from the framework in place at the onset of the financial crisis, by incorporating important lessons from the financial crisis and utilising authority to pay interest on reserves in its design. In this section, we identify what we perceive as the crisis's major lessons for managing the Federal Reserve's balance sheet to achieve policy objectives and for the design of the future operating framework. This discussion considers three components of the operating framework: (i) interest rate policies, including operating objectives for market rates and use of the authority to pay interest on reserve balances; (ii) the portfolio of domestic financial assets and related operations; and (iii) objectives for the supply of reserve balance liabilities of the Federal Reserve. Interest rate policies, especially those related to the payment of interest on reserves, are closely related to the balance sheet constraints that were a challenge during the crisis. The lessons that concern the portfolio of assets held by the Federal Reserve and related operations relate to the balance sheet constraint challenge, as well as to the risk management challenges associated with collateral arrangements. The objectives for the supply of reserve balance liabilities relate in various ways to all the challenges we reviewed faced by the Federal Reserve during the crisis.

3.1 INTEREST RATE POLICIES

Payment of interest on reserves

On 1 October 2008, the Federal Reserve received authority to pay interest on balances held by depository institutions at Federal Reserve Banks, and it began to use that authority almost immediately.[14] Payment of interest on balances held by financial institutions has been a longstanding practice at many central banks. This authority has typically been incorporated into the design of the operating framework for the purpose of enhancing control over short-term market interest rates or to improve the efficiency of discretionary operations and of banks, and in some cases an interest rate paid on reserves has served as an official policy rate.[15] We fully anticipate that payment of interest on reserves will remain a permanent feature of the Federal Reserve's operating framework that will be used to improve its control over short-term market interest rates, whatever the particular design elements of that framework.

However, a key lesson from the crisis is that remuneration of reserves can enable the central bank to pursue policy objectives that entail changing the size and

14 The Financial Services Regulatory Relief Act of 2006 originally authorised the Federal Reserve to begin paying interest on balances held by depository institutions beginning 1 October 2011. The Emergency Economic Stabilization Act of 2008 accelerated the effective date to 1 October 2008 and the Federal Reserve began to pay interest on banks' required and excess reserve balances on 9 October 2008.

15 These purposes include the avoidance of an implicit "tax" on reserves held to satisfy reserve requirements.

composition of its balance sheet while still achieving conventional objectives for short-term interest rates. This was the foremost reason that the Federal Reserve sought to accelerate the effective date for receiving authority to pay interest on reserves.[16] In its announcement that it would start to pay interest on reserves, the Federal Reserve stated that "the payment of interest on excess reserves will permit the Federal Reserve to expand its balance sheet as necessary to provide the liquidity necessary to support financial stability" and "while also maintaining the federal funds rate close to the target established by the Federal Open Market Committee" (Board of Governors (2008r2008n). Experiences of other central banks, both during and outside of the recent crisis period, also demonstrate that operating frameworks can be quickly and fundamentally reconfigured to achieve assorted policy objectives without sacrificing control over short-term rates. For these reasons, any future operating framework of the Federal Reserve should utilise its authority to pay interest on reserves to preserve this ability to adopt, as needed, other policies that have implications for the size and composition of its balance sheet, including the level of reserves, even when not operating at the zero bound for short-term rates.

Behaviour of and operating objective for short-term market interest rates

Some of the behaviour of the overnight federal funds rate and other short-term rates immediately after the Federal Reserve began to pay interest on reserves in October 2008 was not fully anticipated. As reserve levels began to swell, rates on federal funds and Eurodollar transactions, the most common forms of unsecured overnight bank borrowing, fell below the interest on excess reserves (IOER) rate. Non-bank lenders in short-term funding markets ineligible to earn interest on reserves – including both government sponsored entities (GSEs), which can hold balances at the Federal Reserve, and money market funds and other institutional lenders, which cannot – found that in order to invest all their cash holdings they had to lend a portion to banks that had already accumulated large excess reserve positions.[17] Most surprising was how far rates in overnight funding markets fell below the IOER rate and how volatile these rates were. This behaviour is believed to have been largely an outgrowth of the exceptionally illiquid markets at the time.[18] In the wake of the collapse of Lehman Brothers, trading relationships were severely disrupted as lenders in funding markets dramatically cut or suspended credit and trading lines. At the same time, competition among bank borrowers to earn a spread between the IOER rate and funding costs relied,

16 The ability to set an objective for the portfolio independent of targeting short-term rates that paying interest on reserves can provide is also a central theme in Keister, Martin, and McAndrews (2008).

17 Paying interest on excess reserves did remove incentives that banks have to lend at rates below the IOER rate, as expected. As a result, lending activity by banks in these markets fell dramatically and borrowing rates fell below the IOER rate once the point was reached where banks with structural reserve deficiencies could cover their overdraft positions by borrowing solely from non-bank entities.

18 In response, between October 2008 and December 2008, when the target for the federal funds rate was reduced to its effective lower bound, the Federal Reserve made several adjustments to narrow the spread between the rate paid on required reserves, which was always aligned with the target federal funds rate, and the IOER rate in an attempt to keep the funds rate closer to its target. This spread was eventually eliminated entirely.

in part, on established relationships among counterparties. Risk aversion by lenders reduced their incentives to sell funds on the basis of rate competition alone. Rate volatility quickly damped after the IOER rate was reduced to a mere 25 basis points in December 2008, although since then some observers have continued to question why competition has not established an even tighter spread between the IOER rate and overnight bank funding costs.[19]

The behaviour of market rates relative to the IOER rate since the Federal Reserve began to pay interest on reserves to banking institutions has underscored a notable feature of US financing markets – the important role that non-bank institutional lenders play in unsecured bank funding markets, such as federal funds and Eurodollars, as well as in collateralised funding markets.[20] However, we do not believe that this feature undermines the importance of paying interest on reserves as a key component of the operating framework for controlling short-term interest rates, even with an elevated level of excess reserves. Competitive forces should ordinarily maintain a link between the rate paid directly to banks on reserves and their borrowing costs, even at higher interest rate levels and with elevated excess reserve levels, so long as funding markets are operating reasonably efficiently. Nonetheless, to ensure that it has the tools to control short-term market rates to its satisfaction under all circumstances, even while its balance sheet and excess reserves are exceptionally large, the Federal Reserve has developed the capacity to operate directly with non-bank lenders active in bank funding markets, using temporary reverse repos on which those non-banks can earn interest.[21]

For many years, the Federal Reserve has used the overnight federal funds rate as a guide to its policy stance – in effect, this rate has served as a target for open market operations directed by the FOMC.[22] The measure used to monitor this rate is based on overnight federal funds transactions collected from several brokers active in bank funding markets and published daily by the Federal Reserve Bank of New York. As a by-product of the very large volume of reserves in the banking system, the level of federal funds trading activity has declined considerably and the GSEs are believed to account for most of the remaining

19 For many months after the IOER rate was cut to 25 basis points, the spread over the overnight federal funds rate averaged about 10 basis points. More recently the spread has been close to 5 basis points.

20 For this reason it is not accurate to refer to these as being interbank markets, even when discussing the period before the crisis when interbank activity was a much larger share of total activity.

21 This approach has been likened to use of both a "belt and suspenders" to ensure control of monetary policy. See "The Economic Outlook and the Fed's Balance Sheet: The Issue of 'How' versus 'When'", a speech by William Dudley, 29 July 2009, available at http://www.newyorkfed.org/newsevents/speeches/2009/dud090729.html. Also, the Federal Reserve has explored ways in which it could encourage more competition among banks to borrow from non-banks so as to narrow the spread between the interest rate paid on excess reserves and banks' funding costs when excess reserve levels are elevated.

22 For an example of how the federal funds rate historically has been used as a target, see "Minutes of the Federal Open Market Committee, June 27-28, 2007," which can be found at http://www.federalreserve.gov/fomc/minutes/20070628.htm. The operating directive from this meeting reads, in part: "To further its long run objectives, the Committee in the immediate future seeks conditions in reserve markets consistent with maintaining the federal funds rate at an average of around 5-1/4 percent."

federal funds lending to banks. This reduction in trading activity has raised some concern that the funds rate could become a less reliable indicator of conditions in short-term money markets in a high excess reserves environment. However, correlations between short-term movements in the federal funds rate and other overnight money market rates have remained around pre-crisis levels since December 2008. These relationships appeared to have been only temporarily disrupted amid the exceptional trading conditions immediately after the Lehman Brothers failure. This suggests not only that the federal funds rate remains an effective operating target for policy even with much reduced trading volumes, but also that alternative market-based overnight interest rate measures could serve as effective policy guides if circumstances were to cause federal funds trading activity to decline even further.[23]

Expanded objectives for interest rates

It has been a longstanding practice at many central banks, including the Federal Reserve, to change the stance of monetary policy by fostering changes in a nominal short-term interest rate, whether these are expressed as a change in an explicit target for a short-term rate or are just the expected outcome of discretionary reserve operations and changes in central bank administered rates. The conventional view is that changes in short-term rates, and associated changes in the expected future path of these rates, can have an important influence on macroeconomic conditions operating through their impact on longer-term interest rates and other financial variables.

An important lesson of this past crisis is that even when operating at or near the zero bound for short-term rates, the central bank can still provide additional policy accommodation for achieving its macroeconomic objectives by fostering lower long-term private borrowing rates through a reduction in the term premium.[24] The large-scale asset purchase (LSAP) programmes of the Federal Reserve were seen as having been effective in this way, operating through a number of possible channels, including a "portfolio balance" channel, although they were also partly motivated by other considerations.[25] However, central banks have relatively little experience with operations designed to influence the term premium in long-term rates. Unlike arrangements needed to achieve particular outcomes for short-term interest rates, which are generally well developed and understood, the balance sheet adjustments needed to achieve particular outcomes for long-term rates, which are not easily calibrated. Moreover, the implications for the size and composition of assets on the balance sheet of such operations can place practical restrictions on their use and require the central bank to accept greater financial

23 In practice, availability of timely and representative measures of overnight interest rates in wholesale funding markets is somewhat limited. In part to address this deficiency, on 1 November 2010 the Depository Trust & Clearing Corporation began to publish average daily interest rates for General Collateral Finance repos against Treasury, agency and agency mortgage-backed securities collateral.

24 Enhanced communication that affects the anticipated future path of short-term interest rates can also affect longer-term rates through an expectations channel.

25 An independent impact of LSAPs operating through the expansion of bank reserves by itself cannot be entirely discounted, although we do not believe this to have been an important transmission channel. For a further discussion of the Federal Reserve's LSAP programmes, including its transmission mechanisms, see Gagnon, Raskin, Remache and Sack (2010).

risk. Nonetheless, operations designed to influence long-term interest rates by acting on their term premium remain a useful supplement to operations aimed at controlling short-term rates.

3.2 DOMESTIC PORTFOLIO AND OPERATIONS

Structure of the portfolio and operations

Over the years, the Federal Open Market Committee (FOMC), the policy-making body that directs open market operations, has consistently expressed a strong preference for minimising the extent to which the Federal Reserve's portfolio and its market operations affect the allocation of credit among private borrowers and sectors of the economy. This preference has been reflected in a portfolio that historically has consisted predominantly of outright holdings of Treasury securities.[26] A portfolio consisting primarily of outright Treasury holdings is also seen as having several other favourable characteristics. Their plentiful supply and well-developed secondary markets afford considerable balance sheet liquidity and flexibility, and credit risk is minimal.[27] The acquisition of a sizable amount of agency mortgage-backed securities and agency debt from 2008 to 2010, as well as the extension of a substantial amount of shorter-term credit through a variety of lending programmes earlier, represented major departures from this norm, ones designed to address severe financial and economic strains. But policy-makers have reaffirmed the desire to eventually restore the portfolio to its historical composition of essentially all Treasury securities.[28]

The structure and use of temporary open market operations, most notably short-term repurchase agreements, historically has also reflected a preference to minimise the role of the Federal Reserve in allocating credit and has served to limit its role as an intermediary in funding markets during normal periods to the regular provision of a modest amount of relatively short-term credit.

26 The Federal Reserve Act limits the types of financial assets that may be acquired in open market operations by the Federal Reserve. Included are all US Treasury securities, as well as securities fully guaranteed by the United States, securities issued by US GSEs, and those securities fully guaranteed by GSEs. In 2001 the FOMC considered the management of the Federal Reserve's asset portfolio in light of the rapid declines at that time in the amount of Treasury debt outstanding. Two alternatives considered were purchases of Ginnie Mae securities, which are fully guaranteed by the United States and thus eligible for open market purchases under the Federal Reserve Act, and large-scale extensions of term loans, similar in many ways to the later TAF programme, which could be arranged under discount window lending authority provided in the Federal Reserve Act. Both alternatives were seen as enabling the Federal Reserve to realise its monetary policy objectives. But these, and the other alternatives considered, were viewed as less desirable than maintaining a portfolio of outright Treasury holdings so long as the supply of Treasury debt remained sufficient.

27 The degree of liquidity and flexibility is partly a function of the maturity composition of these holdings, a topic that is not addressed in this paper.

28 See "Minutes of the Federal Open Market Committee, April 27-28, 2010," which can be found at http://www.federalreserve.gov/monetarypolicy/files/fomcminutes20100428.pdf. At this meeting, policy-makers also expressed the desire to reduce the size of the balance sheet and reserve balances "to amounts consistent with more normal operations of money markets and monetary policy". However, this would not preclude making changes to the operating framework that could leave reserve levels much higher than their historical norms in order to improve the functioning of the framework. We consider such possibilities later in this section.

For many years eligible collateral has been limited to US government securities, with counterparties – securities dealers capable of meeting the business needs of the Federal Reserve – being relatively few in number. The use of temporary operations has been structured to avoid routine reliance on standing lending facilities that are available to the wider set of banking institutions against broad pools of collateral.

Many aspects surrounding the use of temporary operations for when the balance sheet has been normalised remain undetermined and could depend on other design features of the operating framework. Indeed, the Federal Reserve has developed the capability to arrange large-scale reverse repurchase agreements with an expanded set of counterparties, although this has been done with the smooth exit from the period of exceptional policy accommodation in mind. Also, the structure of money markets is likely to evolve significantly in the wake of the financial crisis and subsequent financial reform efforts. However, we believe that use of temporary operations in normal operating environments should continue to be structured to limit the Federal Reserve's role in credit allocation and as an intermediary in funding markets.[29]

Whatever the exact form of the Federal Reserve's portfolio once conditions have normalised, a key lesson reinforced by the recent period of financial turmoil is the need for the central bank to be able to alter the size and composition of its balance sheet quickly and effectively in support of unconventional policies during extraordinary episodes. This support could take the form of any of the market-wide, credit-easing measures (outside of lending to individual entities) that were adopted by the Federal Reserve during the crisis – purchasing longer-term or alternative types of assets, various forms of lending to financial institutions, or providing liquidity directly to key credit markets.[30] The Federal Reserve was able to devise new types of operations and facilities fairly quickly amid the financial crisis because many of these newer activities leveraged settlement practices, collateral management arrangements and transactional relationships utilised in its normal open market operations or discount window lending programmes. In the future, this ability to transition from a normal to an exceptional operating mode will be enhanced by the experiences gained during the period of financial turmoil and from the continued availability of some operational tools and procedures that were developed to support certain unconventional activities.

29 To some degree this has been ensured because temporary operations outstanding have typically been a small share of the total balance sheet and of activity in the markets in which intervention has occurred. However, other considerations or circumstances can sometimes result in temporary operations representing a much greater share of each. Even in these circumstances, however, restricting lending activity to operations with Treasury or other high quality collateral should limit the extent to which the Federal Reserve allocates credit to individual borrowers.

30 Where an expansion of assets is involved, specific circumstances will determine whether this also involves a corresponding reduction in existing holdings of Treasury securities, an expansion of reserve liabilities, or some other balance sheet offset.

For these reasons, we do not believe that ensuring the ability to adopt credit-easing policies quickly and effectively in the future requires regular use of these techniques during normal times.[31]

Capacity to manage risk in potential lending operations

The Federal Reserve has gained experience, through operating the lending facilities during the crisis, in evaluating the credit quality of collateral pledged to it. The Federal Reserve Banks employ staff to examine and test the credit quality of collateral that is pledged, and which could be pledged, to the discount window. The Federal Reserve has established acceptance criteria and approaches to valuations, as well as margins for discount window collateral (available at http://www.frbdiscountwindow.org/discountmargins.cfm?hdrID=21&dtlID=83). These practices have served the Federal Reserve and the public well in both publicising the Federal Reserve's policies and in managing its risks.

During the crisis, the Federal Reserve expanded the set of collateral against which it lent, and managed the risks in its lending in ways different from its usual practices at the discount window (of overnight lending, with recourse, to supervised depository institutions, collateralised by a pre-announced set of collateral with preset margins and valuation criteria). In the future, circumstances could result in the Federal Reserve lending for terms longer than overnight, against collateral that has not been previously accepted at the discount window, and possibly on a non-recourse basis. Because of this, a lesson from the crisis is the need for an expanded credit risk management approach in normal times, in which the Federal Reserve evaluates the credit risk characteristics of broad classes of securities that could potentially serve as collateral in a lending facility in unusual and exigent circumstances.

3.3 RESERVE BALANCES[32]

Historical role of reserves in the monetary policy implementation framework

For years prior to September 2008, the level of reserve balances had been largely an outgrowth of the reserve accounting framework adopted by the Federal Reserve for monetary policy implementation and, particularly, the reserve

31 Under the set of arrangements envisioned here, only the primary credit facility would be a permanent standing facility. Use of other tools would by triggered by discrete decisions made by policy-makers. Under the legal framework of the Federal Reserve Act, some types of lending arrangements, including several of the facilities adopted during the recent financial turmoil, can only be invoked if conditions are found to be "unusual and exigent". The Wall Street Reform and Consumer Protection Act of 2010 made several amendments to the Federal Reserve's lending authorities, including new disclosure requirements.

32 Throughout this section, the term "reserve balances" is used to refer to all balances held by depository institutions at Federal Reserve Banks, including the balances held to meet contractual clearing balance agreements, although technically these are not considered to be "reserves".

requirement ratios set by the Board of Governors.[33] The primary function of the reserve accounting framework had been to facilitate control of the overnight federal funds rate, in part by providing a predictable level of reserve demand. In many ways the design details of this operating framework were a relic inherited from an earlier era, when reserve requirements were viewed as a tool that could be used to directly control certain money aggregates. But long after this had ceased to be an important concern of policy-makers, the basic reserve requirement structure remained a serviceable arrangement for targeting short-term interest rates. The exact level of reserve requirements needed for this purpose proved to be somewhat irrelevant.[34] And from 1989 to 2000 the level of reserve requirements and balances steadily fell as a direct consequence of the fact that the Federal Reserve could not pay interest on required reserves. During that period, the Federal Reserve cut reserve requirement ratios close to their statutory minimums in order to lighten the implicit cost they imposed on depository institutions.[35] Depository institutions also subsequently developed mechanisms for effectively circumventing most remaining reserve requirements by employing retail sweep account programmes. As a result, reserve balances averaged around only USD 15 billion in 2007 compared with about USD 40 billion at their peak in 1988.[36]

33 More specifically, it was the level of reserve requirements not satisfied by banks' holdings of vault cash, plus the level of contractual clearing balances, that was most critical for determining the supply of reserve balances that the Federal Reserve would provide. A brief description of reserve requirements and links to other materials that describe the Federal Reserve's reserve accounting framework in more detail and provide some history can be found on the public website of the Board of Governors of the Federal Reserve System at http://www.federalreserve.gov/monetarypolicy/reservereq.htm. Further information, including an overview of contractual clearing balances and the Federal Reserve's broader role in the payments system, is found in Board of Governors of the Federal Reserve System (2005), "The Federal Reserve System Purposes and Functions", available at http://www.federalreserve.gov/pf/pf.htm.

34 The flexibility around maintenance period average requirements that carry-over privileges provided was more critical for dampening the volatility of short-term interest rates than the level of reserve requirements.

35 The statutory minimum reserve requirement ratio was 8% on transaction deposit liabilities and 0% on all other bank deposits. The same legislation that authorised the Federal Reserve to pay interest on reserves also reduced the statutory minimum reserve requirement ratio to 0% on all bank deposit liabilities.

36 These amounts include between USD 1 billion and USD 2 billion of excess reserves in both years. They also include USD 2 billion in contractual clearing balances in 1988 and USD 7 billion in 2007. Measured as a proportion of bank deposit liabilities, the decline in reserve balances would appear much more dramatic, especially if the growth in clearing balances over that interval were excluded. Note that an implicit form of interest could be earned on contractual clearing balances, with practical limits on their use set by the programme, and to some degree their growth was a direct response to the decline in reserve requirements. It had been feared that the decline in reserve balances associated with the advent of retail sweep account programmes might lead to a loss in control over the federal funds rate. But while this decline did contribute to more daily volatility in the overnight rate, it did not undermine the ability to control average levels of the rate around its target. More discussion of the growth in retail sweep accounts and its impact on rate behaviour can be found in Federal Reserve Bank of New York (1998), "Open Market Operations during 1997", available at http://www.newyorkfed.org/markets/omo/omo97.pdf.

Lessons from the crisis for the role of reserves in the design of a new operating framework

Largely absent from the historical operating framework was an ability to provide reserve balances, at reasonable cost and consistent with the Federal Reserve's operating objectives for short-term interest rates, for purposes other than enabling banks to meet their reserve requirements.[37] These other purposes include the potential value of reserve balances for improving efficiency and reducing risks associated with banks' wholesale payment and settlement activities, and satisfying banks' demands for highly liquid risk-free assets at competitive rates. The importance of the ability to supply reserve balances for these other purposes was highlighted during the financial crisis and the ability to pay interest on reserves should allow the Federal Reserve to design an operating framework that explicitly recognises the value of reserve balances to banks for these economic purposes.

Reserve balances play a key role in Fedwire, the major large-value payment system in the United States owned and operated by the Federal Reserve, where their transfer is used to settle transactions between participants, to settle net obligations on ancillary payment systems such as CHIPS and to settle obligations that arise from the operation of equity, bond and money markets.[38] The Federal Reserve provides uncollateralised daylight overdrafts to depository institutions under certain conditions to promote the efficient functioning of Fedwire. Thus, there is a small risk that a Fedwire participant could access uncollateralised credit before the Federal Reserve realises that its financial condition has deteriorated. The Federal Reserve applies a fee for the daylight overdrafts it extends, but its level must balance objectives of managing risk with maintaining payment system efficiency. Also, participants can manage their risks and costs to some degree by choosing the time at which to send payments over Fedwire.

Historically, the net effect of payment system policies and institutional practices combined with low levels of reserves had been a relatively high level of daylight overdrafts and a high proportion of payments settled late in the day. In early 2007 the daily average and peak daylight overdrafts averaged about USD 45 billion and USD 125 billion, respectively. In addition, roughly 60% of the value of funds transfers made over Fedwire was settled after 3.30 pm, with about 30% settled after 5 pm.[39] However, the expansion of reserve balances since September 2008 has led to a substantial decrease in daylight overdraft credit extended by the Federal Reserve and a quickening of settlements. During the first quarter of 2010, average and peak daylight overdrafts were USD 3 billion and USD

37 To some degree the contractual clearing balance programme was an exception. As its name suggests, it was intended to support clearing activities of banks whose reserve requirement levels were low and, in fact, it could be used by banks to satisfy demands for reserve balances for any purpose. But an inability to pay explicit interest on these balances greatly limited the effectiveness of this programme.

38 For an overview of the key wholesale payment systems operated by the Federal Reserve, Federal Reserve System payment systems policies and the experience in the high reserve environment, see Bech, Martin and McAndrews (2010).

39 Fedwire's operating day begins at 9 pm Eastern Time on the preceding calendar day and ends at 6.30 pm. Transfers between banks on behalf of third parties are scheduled to be completed by 6 pm.

13 billion respectively, and the share of payments settled after 3.30 pm and 5 pm had fallen to less than 45% and 20%, respectively. These developments have reduced the intermediary role of the Federal Reserve and the associated credit and operational risks, as well as contributed to other less measurable efficiency gains in payments.[40] Symptomatic of reduced strains and risks in payment systems, there has also been noticeably less volatility in and upward pressure on interest rates in short-term bank funding markets on days that are characterised by relatively high and uncertain payment flows.

Beyond meeting reserve requirements and facilitating payments activities, banks demand reserve balances as a highly liquid asset bearing no credit risk to help manage their balance sheet risks, provided they are available at a competitive rate. The need for such assets can swing substantially, as was demonstrated at several points during the financial crisis when banks' desire to reduce risk exposures was apparent or when banks faced the abrupt need to finance the liabilities of conduits and structured investment vehicles they had sponsored. The ability to supply reserve balances in a flexible manner that is still consistent with maintaining objectives for short-term rates would have been helpful at several points during the financial crisis prior to September 2008 to meet heightened demands by depository institutions for risk-free liquid assets and to help moderate rate pressures seen in short-term funding markets.

The design of a new operating framework should support the supply of reserve balances in a manner that recognises their various attributes described in this section, while also providing a mechanism for the Federal Reserve to achieve operating objectives for short-term interest rates. At the same time, the framework should allow the Federal Reserve to pursue other policy objectives that could entail changing the size or composition of the assets on its balance sheet. This was not feasible so long as the opportunity cost of holding excess reserves was kept relatively high, or other mechanisms were not available to adjust the supply of reserve balances for other purposes in a way consistent with targeting short-term interest rates. But not all frameworks that pay interest on reserves will necessarily satisfy all these objectives. For example, frameworks built around a traditional reserve requirement structure in which there exists a relatively high marginal opportunity cost to holding excess reserves are unlikely to support all these goals. The resulting level of reserve balances would likely be somewhat arbitrary, reflecting the level of the requirements rather than their economic value. And even if reserve requirement ratios were deliberately set to generate a high level of reserve balances in the aggregate, they are not a flexible tool for meeting large shifts in demand or supply arising from various sources and their incidence is unlikely to align with individual bank preferences for holding reserve

40 Coincidentally, both of these improvements were objectives for other revisions to the Federal Reserve's Payment System Risk policy adopted in late 2008, but initiated much earlier, and to be implemented in early 2011. See http://www.federalreserve.gov/newsevents/press/other/20081219a.htm and http://www.federalreserve.gov/newsevents/press/other/20100628a.htm.

balances. More promising are approaches in which either the reserve accounting structure is sufficiently flexible to accommodate even large and frequent changes in individual bank demands for holding reserve balances, or which dispense with a reserve accounting structure altogether and sufficient reserve balances are provided to align market rates with the interest rate paid on reserves.

4 CONCLUSIONS

We outlined three key challenges that the Federal Reserve confronted in pursuing its responses to the financial crisis: (i) constraints on the use of its balance sheet imposed by its traditional operating framework; (ii) stigma associated with borrowing from its traditional lending facilities; and (iii) the need for new collateral arrangements to support non-traditional forms of lending. In the second part of this paper, we considered the lessons learned during the crisis for the design of the future operating framework, focusing on three components of the framework: (i) policies for administered and market interest rates; (ii) the structure of the portfolio of domestic assets; and (iii) the role and objectives for reserve balances in the framework.

Among the lessons we drew are that: (i) any future operating framework of the Federal Reserve should utilise its authority to pay interest on reserves to preserve the ability to adopt, as needed, other policies that have implications for the size and composition of its balance sheet, including the level of reserves, even when not operating at the zero bound for short-term rates; (ii) there is a need for an expanded credit risk management approach in normal times, in which the Federal Reserve evaluates the credit risk characteristics of broad classes of securities that could potentially serve as collateral in a lending facility in unusual and exigent circumstances; (iii) there is a need for the central bank to be able to alter the size and composition of its balance sheet quickly and effectively in support of unconventional policies during extraordinary episodes; and (iv) that the design of a new operating framework should support the supply of reserve balances in a manner that recognises their various attributes, while also providing a mechanism for the Federal Reserve to achieve its operating objectives for short-term interest rates.

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APPENDIX A: EFFECTIVENESS OF THE FEDERAL RESERVE'S LENDING FACILITIES

The literature that examines the effects of the Federal Reserve's various responses to the financial crisis is growing quickly. Here we provide a brief summary. Overall, the facilities examined in the literature to date have been judged to have effects on market interest rates in a way consistent with their objectives, with some notable exceptions. Many of the studies rely on an event study methodology, which limits the extent to which one can make judgments about the appropriate size of a facility or the responsiveness of market interest rates to changes in the size of the programme, largely as a result of the difficulty of precisely identifying the moment at which information was released to the market, or gauging the pace of information releases about programmes whose parameters were released over time.

A number of papers examine effects of the TAF. The TAF was intended to provide access to term funding for depository institutions that were constrained in their access to term funds. Most papers proxy for access to term funding by examining whether the TAF had any effects on the USD term LIBOR (as the LIBOR is an imperfect proxy, finding no effect on LIBOR does not suggest that the TAF reduced constraints on many banks' access to term funds). Papers by Christensen (2009), Christensen, Lopez and Rudebusch (2009), McAndrews, Sarkar and Wang (2008), Taylor and Williams (2009), Wright (2008) and Wu (2008) all analyse the TAF's effects on the USD LIBOR. Taylor and Williams is an outlier, finding no effects for the TAF on LIBOR when testing for perfectly transitory effects, while the other papers find economically significant reductions in LIBOR when using test designs that allow for persistent effects of TAF auctions on the LIBOR. These papers are consistent with the view that the TAF ameliorated stress in the term bank funding market, but they provide little guide to suggest whether an expanded programme, such as that pursued by the Federal Reserve in the autumn of 2008, would have had large effects if pursued in late 2007 and early 2008.

Several evaluations of the FX Swaps have been conducted. Aizenman and Pasricha (2009), Baba and Packer (2009), Fleming and Klagge (2010b), Goldberg, Kennedy and Miu (2010) and Obstfeld, Shambaugh and Taylor (2009) consider a number of aspects of the programme. Fleming and Klagge provide a good overview of the programme and look at the USD LIBOR, the dollar basis for foreign exchange swap trades and the stop-out rates for foreign central banks' auctions of dollars; movements in these variables were generally supportive of the hypothesis that the FX Swaps reduced stress in USD funding markets. Baba and Packer conduct a careful econometric evaluation of deviations in covered interest rate parity during the period between the US dollar and three other currencies, namely the pound sterling, the euro and the Swiss franc. They find that both the level and volatility of deviations from covered interest parity declined with announcements of increases in the FX Swap programme. Goldberg, Kennedy, and Miu caution that it is hard to isolate announcement and operations effects during the volatile periods under study. Those authors conclude that while FX Swaps did succeed in lowering dollar funding costs,

significant credit tiering remained pervasive in these funding markets. Aizenman and Pasricha and, separately, Obstfeld, Shambaugh and Taylor examine the relationships between the FX Swap facilities and various features of the countries with which they were established.

Fleming, Hrung and Keane (2009, 2010) examine the effects of the TSLF on repo rates. They find that the TSLF auctions that swapped the least liquid collateral types for Treasury securities had significant effects in increasing repo rates for Treasury, agency debt and agency mortgage-backed securities rates, suggesting these asset classes were reasonably close substitutes. They also find that the spread between agency debt and agency mortgage-backed securities rates to Treasury rates narrowed following those auctions, suggesting that the TSLF had some beneficial effects in reducing market illiquidity (repo rates for less liquid collateral types are not well reported; consequently, the authors could not directly test the effect of TSLF on those markets).

Adrian, Kimbrough and Marchioni (2010) and Curdia and Woodford (2010) examine the effects of the CPFF on issuance of commercial paper and commercial paper rates. Both papers point out that interest rates on eligible commercial paper fell quickly with implementation of the programme, while ineligible paper did not experience the same fall in rates. In addition, commercial paper issuance of eligible issuers increased markedly after the implementation of the programme.

Artuc and Demiralp (2010), Ashcraft, Bech and Frame (2010) and Armantier, Ghysels, Sarkar and Shrader (2010) analyse various aspects of the discount window. Artuc and Demiralp calibrate a model to the period between 1998 and 2007. They find that the changes to the discount window in 2003 caused a significant decline in stigma costs of borrowing from the discount window. Out-of-sample predictions from the model under-predict the spread between the daily high federal funds rate and the target rate during the crisis. They perform various experiments in varying parameters of the model, finding that a return to the pre-2003 regime would increase volatility significantly. Ashcraft, Bech and Frame point out the role played by the Federal Home Loan Bank (FHLB) system during the period from August 2007 to September 2008 in complementing the discount window, a time when the FHLBs expanded the provision of term credit to banks significantly. They speculate that had the FHLBs not been available, the Federal Reserve would have had to have requested the operation of the SFP or the authority to pay interest on reserves much sooner in the crisis. Armantier, Ghysels, Sarkar and Shrader perform a structural test of stigma in borrowing at the discount window by using the bids submitted in TAF auctions, finding that the realised cost of stigma is in the order of 20 to 40 basis points. Borrowing at the discount window increases a bank's funding costs in the federal funds market, but no such effect is found for TAF borrowing, suggesting that TAF was largely free of stigma.

Cecchetti (2008), Fleming and Klagge (2010a) and Kuttner (2008) examine the asset holdings of the Federal Reserve and focus on the income effects of the Federal Reserve's actions during the crisis. Cecchetti reviews the Federal Reserve's actions early in the crisis and expresses concern with the lending

to assist the acquisition of Bear Stearns by J.P. Morgan Chase, suggesting that it could threaten the Federal Reserve's independence by stepping into fiscal policy. Fleming and Klagge measure the income effects of the Federal Reserve's liquidity facilities between 2007 and late 2009. Given the low credit risks in the programme, it was fairly straightforward to show the considerable income generated by the facilities. Kuttner focuses on this question, in part, and expresses concern about credit losses in the Maiden Lane facilities associated with the lending related to Bear Stearns and the lending to AIG. He points out that such facilities had significant credit risk embedded and that losses in those programmes would likely have exposed the Federal Reserve to reduced political independence as it would likely have sought recapitalisation.

The effects of the purchase programmes of the Federal Reserve are examined by D'Amico and King (2010), Gagnon, Raskin, Remache and Sack (2010), Stroebel and Taylor (2009) and Thornton (2009). D'Amico and King examine the purchase programme's effects using a daily panel data set of securities prices and find significant effects both upon announcement and with each purchase operation. Gagnon et al. consider announcement effects and construct a measure of the amount of long-duration securities removed from the public as the programme operated. Stroebel and Taylor find little effect of the mortgage-backed securities purchase programme after controlling for the co-movement of various risk factors that are correlated with mortgage-backed security prices. Using their measures they find results that confirm the announcement effects of the purchase programmes. Moreover, their measure allows them to calculate an interest rate sensitivity to the size of the purchases, suggesting that, in sum, the large-scale asset purchase programme reduced the ten-year term premium by between 28 and 82 basis points, similar to the measures of the announcement effects of the programme. Thornton measures the slope of the yield curve and finds that the early part of the programme, through the spring of 2009, did not appear to permanently flatten the Treasury yield curve.

This brief review of the effects of some of the policy responses by the Federal Reserve to the financial crisis suggest that the early analyses of the policies generally found evidence in support of the hypothesis that the Federal Reserve's policies were effective in reducing stress in financial markets by reducing elevated costs of borrowing. However, many of the studies rely on reviewing interest rates around programme announcement dates. This approach is limited in many dimensions, but is being supplemented as researchers find alternative methods to test the persistence of the effects found and to measure the sensitivity of interest rates to changes in programme sizes.

APPENDIX B: AN OUTLINE OF ACTIONS TAKEN BY THE FEDERAL RESERVE SYSTEM, AUGUST 2007-MARCH 2010

1. August 2007 up to September 2008
   a. August to December 2007: traditional tools of monetary policy – the target and primary rates and open market operations
      i. Pre-crisis:
         1. On 7 August 2007, the eve of the crisis, the FOMC "reiterated that the predominant policy concern remained the risk that inflation would fail to moderate as expected" (Board of Governors (2008c)).
      ii. No change in policy, just more standard liquidity provision:
         1. On 10 August 2007, amid disruptions in the overnight federal funds market, the Federal Reserve states that: "The Federal Reserve will provide reserves as necessary through open market operations to promote trading in the federal funds market at rates close to the Federal Open Market Committee's target rate of 5-1/4 percent... As always, the discount window is available as a source of funding." (Board of Governors (2007a))
      iii. Reductions in rates:
         1. On 17 August 2007 the Federal Reserve Board announces a "temporary" cut of the spread between the primary credit rate and the target rate to 50 basis points and increased the term to 30 days. It states that "these changes are designed to provide depositories with greater assurance about the cost and availability of funding" (Board of Governors (2007b)).
         2. On 18 September 2007 the FOMC cuts the federal funds rate by 50 basis points to 4.75%, the first of 3 cuts in 2007 that would take the target to 4.25% by 11 December 2007. The FOMC states that this "action is intended to help forestall some of the adverse effects on the broader economy that might otherwise arise from the disruptions in financial markets and to promote moderate growth over time" (Board of Governors (2007c)).
   b. December 2007 to September 2008: auctions. Liquidity programmes: TAF, Swap lines, TSLF, Primary Dealer Credit Facility (PDCF).
      i. At 2007 year-end, "financial strains were exacerbated by concerns related to year-end pressures in short-term funding markets, and similar stresses were evident in the financial markets of major foreign economies" (SBoard of Governors (2008c)).
         1. As such, on 12 December 2007, the Board of Governors-approved Term Auction Facility is announced. The goal: "By allowing the Federal Reserve to inject term funds through a broader range of counterparties and against a broader range of collateral than open market operations, this facility could help promote the efficient dissemination of liquidity when the unsecured interbank markets are under stress." (Board of Governors (2007d)) The first auction is scheduled for 17 December 2007, allocating USD 20 billion in funds.

2. In addition, also on 12 December 2007, the FOMC-approved swap lines with the ECB – USD 20 billion – and SNB – USD 4 billion – are announced, for up to six months (Board of Governors (2007d)).

ii. In January 2008 the FOMC reacts to financial market stress, tightening credit, deteriorating housing and softening labour by cutting the target twice in nine days (22 and 30 January 2008), making a cumulative drop of 125 basis points (Board of Governors (2008a, 2008b)).

iii. Bear Stearns events:

1. 7 March 2008: The TAF is increased to USD 100 billion outstanding. Single-tranche open market operations are announced with 28-day maturity, accepting conventional open market operation collateral (Board of Governors 2008d).
2. 11 March 2008: "In light of the sharp deterioration of some key money and credit markets, the Committee approved the establishment of the Term Securities Lending Facility, under which primary dealers would be able to borrow Treasury securities from the System Open Market Account for a term of approximately one month against any collateral eligible for open market operations and the highest-quality private residential mortgage-backed securities." (Board of Governors (2008h)).
3. 11 March 2008: The FOMC announces that swap lines with the ECB and SNB are increased to USD 30 billion and USD 6 billion, respectively, and the end date extended until the end of September 2008 (Board of Governors (2008e)).
4. 14 March 2008: "The Board voted unanimously to approve the arrangement announced by JPMorgan Chase and Bear Stearns this morning." (Board of Governors (2008f)).
5. 16 March 2008: The Board announces the creation of the PDCF, cuts the spread between the primary credit rate and the target rate to 25 basis points and extends primary credit loans to as much as 90 days (Board of Governors (2008g)).
6. 18 March 2008: "All in all, most members judged that a 75 basis point reduction in the target federal funds rate, to 2.25 percent, was appropriate to address the combination of risks of slowing economic growth, inflationary pressures, and financial market developments." (Board of Governors (k2008h))

iv. Summer of 2008:

1. 30 April 2008: "Participants expressed significant uncertainty concerning the appropriate stance of monetary policy in these circumstances. Some participants noted that the level of the federal funds target… was relatively low by historical standards. Others noted that financial market strains and elevated risk spreads had offset much of the effects of policy easing on the cost of credit to borrowers. On balance, most members agreed that the target for the federal funds rate should be lowered 25 basis points, to 2 percent." (Board of Governors (2008h))

2. 30 April 2008: Swap lines with the ECB and SNB are increased to USD 50 billion and USD 12 billion, respectively, and extended until the end of January 2009. The TSLF Schedule 2 list is increased to include all AAA-rated asset-backed securities. "Bernanke announced his intention to expand the Term Auction Facility to $150 billion." (Board of Governors (2008h)).
3. 30 July 2008: PDCF and TSLF are extended until the end of January 2009. The TSLF Options programme is announced. 84-day TAF auctions are introduced. The ECB swap line is increased from USD 50 billion to USD 55 billion (Board of Governors (2008i)).

2. September 2008 to March 2010
   a. Unconventional lending
      i. Lehman and AIG:
         1. 16 September 2008: "Financial strains had increased over the intermeeting period, although the consequences of the bankruptcy of Lehman Brothers Holdings on September 15 were not yet clear at the time of the meeting. Indeed, the substantial easing of monetary policy over the previous year, combined with ongoing measures to foster market liquidity, was seen as likely to support activity going forward. Thus, members agreed that keeping the federal funds target rate unchanged at 2 percent at the September meeting was appropriate." (Board of Governors (2009b)).
         2. 16 September 2008: "The Federal Reserve Board on Tuesday, with the full support of the Treasury Department, authorized the Federal Reserve Bank of New York to lend up to $85 billion to the American International Group (AIG) under section 13(3) of the Federal Reserve Act . The AIG facility has a 24-month term. Interest will accrue on the outstanding balance at a rate of three-month Libor plus 850 basis points. AIG will be permitted to draw up to $85 billion under the facility… The U.S. government will receive a 79.9 percent equity interest in AIG and has the right to veto the payment of dividends to common and preferred shareholders." (Board of Governors (2008k)).
      ii. Money market mutual funds:
         1. 17 September 2008: The Treasury announces a temporary Supplementary Financing Program to fund the Federal Reserve (Board of Governors (2009b)).
         2. 19 September 2008: The AMLF is announced. Plans to purchase agency discount notes from primary dealers are also announced (Board of Governors (2008l)).
         3. 24 September 2008: The first of several post-Lehman swap line expansions are announced (Board of Governors (2008m)).
         4. 6 October 2008: The Board announces IOR and IOER to begin on 9 October 2008. IOR is set at the average target over a maintenance period less 10 basis points, and IOER is set at the lowest target over a maintenance period less 75 basis points. "The payment of interest on excess reserves will permit the Federal Reserve to expand its balance sheet as necessary to provide the liquidity necessary

to support financial stability while implementing the monetary policy that is appropriate in light of the System's macroeconomic objectives of maximum employment and price stability." (Board of Governors (2008n)).

5. 6 October 2008: The 28 and 84-day TAF auctions are both increased to USD 150 billion in size, which brings the amount outstanding under the TAF to USD 600 billion. The two forward auctions for 2008 year-end are also boosted to USD 150 billion each, to bring the amount outstanding in the TAF over year-end to USD 900 billion (Board of Governors (2008o)).
6. 6 October 2008: An exemption is granted to section 23A of the Federal Reserve Act and the Board's Regulation W to allow a depository institution to "purchase assets from affiliated money market mutual funds under certain circumstances" (Board of Governors (2008n)).
7. 7 October 2008: The CPFF is announced and set to begin on 27 October 2008. "The CPFF will provide a liquidity backstop to U.S. issuers of commercial paper through a special purpose vehicle (SPV) that will purchase three-month unsecured and asset-backed commercial paper directly from eligible issuers… The Treasury believes this facility is necessary to prevent substantial disruptions to the financial markets and the economy and will make a special deposit at the Federal Reserve Bank of New York in support of this facility." (Board of Governors (2008p)).

iii. The height of the crisis:

1. 8 October 2008: In an unscheduled meeting, the target rate is lowered by 50 basis points to 1.5%. "The Bank of Canada, the Bank of England, the European Central Bank, the Federal Reserve, Sveriges Riksbank, and the Swiss National Bank are today announcing reductions in policy interest rates. The Bank of Japan expresses its strong support of these policy actions." (Board of Governors (2009b, 2008q)).
2. 13 October 2008: Swap line quantities with the Bank of England, ECB and Swiss National Bank are uncapped (Board of Governors (2008r)).
3. 21 October 2008: The Board announces the creation of the Money Market Investor Funding Facility (Board of Governors (2008s)). It is never used.
4. 22 October 2008: The Board changes the IOER rate to the lowest target over a maintenance period less 35 basis points. "The Board judged that a narrower spread between the target funds rate and the rate on excess balances at this time would help foster trading in the funds market at rates closer to the target rate." (Board of Governors (2008t)).
5. 29 October 2008: The FOMC cuts the target by 50 basis points to 1% (Board of Governors (2008u)).
6. 5 November 2008: The Board changes the IOR rate to the average target over the maintenance period and changes the IOER rate to the lowest target over the maintenance period, both effective as of 6 November 2008 (Board of Governors (2008v)).

7. 25 November 2008: "The Federal Reserve Board on Tuesday announced the creation of the Term Asset-Backed Securities Loan Facility (TALF), a facility that will help market participants meet the credit needs of households and small businesses by supporting the issuance of asset-backed securities (ABS) collateralized by student loans, auto loans, credit card loans, and loans guaranteed by the Small Business Administration (SBA)." (Board of Governors (2008w))

b. LSAPs
   i. Zero-bound:
      1. 25 November 2008: The Federal Reserve announces the intention to purchase up to USD 100 billion in agency debt and up to USD 500 billion in agency mortgage-backed securities, taking place over several quarters. "This action is being taken to reduce the cost and increase the availability of credit for the purchase of houses, which in turn should support housing markets and foster improved conditions in financial markets more generally." (Board of Governors (2008x)).
      2. 16 December 2008: The target is set by the FOMC at a range of 0-0.25%, with Board setting IOR and IOER rates at 25 basis points. The FOMC reiterates plans to purchase agency debt and agency mortgage-backed securities and "is also evaluating the potential benefits of purchasing longer-term Treasury securities." "The Federal Reserve will employ all available tools to promote the resumption of sustainable economic growth and to preserve price stability. In particular, the Committee anticipates that weak economic conditions are likely to warrant exceptionally low levels of the federal funds rate for some time. The focus of the Committee's policy going forward will be to support the functioning of financial markets and stimulate the economy through open market operations and other measures that sustain the size of the Federal Reserve's balance sheet at a high level." (Board of Governors (2008y)).
      3. 28 January 2009: The target is kept at a range of 0-0.25%. "The Federal Reserve continues to purchase large quantities of agency debt and mortgage-backed securities to provide support to the mortgage and housing markets, and it stands ready to expand the quantity of such purchases and the duration of the purchase program as conditions warrant. The Committee also is prepared to purchase longer-term Treasury securities if evolving circumstances indicate that such transactions would be particularly effective in improving conditions in private credit markets." (Board of Governors (2009a)).
      4. 7 February 2009: The FOMC and Board agree in a conference call to expand the TALF using capital from the Treasury's TARP (Board of Governors (2009e)).
      5. 3 March 2009: The Treasury and Federal Reserve Board announce the TALF. "The TALF has the potential to generate up to $1 trillion of lending for businesses and households. The TALF is designed to catalyze the securitization markets by providing financing to investors to support their purchases of certain AAA-rated asset-

backed securities (ABS). These markets have historically been a critical component of lending in our financial system, but they have been virtually shuttered since the worsening of the financial crisis in October. By reopening these markets, the TALF will assist lenders in meeting the borrowing needs of consumers and small businesses, helping to stimulate the broader economy." (Board of Governors (2009c)).

6. 18 March 2009: The target range is kept at 0-0.25%. The FOMC increases the 2009 target for purchases of agency mortgage-backed securities up to USD 1.25 trillion and agency debt up to USD 200 billion. In addition, it commits to purchase USD 300 billion in Treasuries over the next six months (Board of Governors (2009e)).
7. 23 March 2009: The Treasury and Federal Reserve release a joint statement to the effect that the Treasury will respect the Federal Reserve's independence and its ability to carry out its monetary policy objectives (Board of Governors (h2009e)).

ii. Gradual normalisation:

1. 25 June 2009: The Board of Governors extends the AMLF, CPFF, PDCF and TSLF (which also required FOMC approval) until 1 February 2010. The FOMC approves an extension of the swap lines to 1 February 2010. The Board reduced TAF auction sizes from USD 150 billion to USD 125 billion starting 13 July 2009, tightened the criteria for use of the AMLF, and decided not to extend the MMIFF beyond 30 October 2009. The Board and FOMC discontinued the TSLF Schedule 1 auctions and Options programme while halving the frequency of the Schedule 2 auctions (Board of Governors (2009d)).
2. 12 August 2009: The target range is kept at 0-0.25%. "The Federal Reserve is in the process of buying $300 billion of Treasury securities. To promote a smooth transition in markets as these purchases of Treasury securities are completed, the Committee has decided to gradually slow the pace of these transactions and anticipates that the full amount will be purchased by the end of October." (Board of Governors (2009f)).
3. 23 September 2009: The target range is kept at 0-0.25%. "To promote a smooth transition in markets as these programs concluded, the Committee decided to gradually slow the pace of both its agency MBS and agency debt purchases and to extend their completion through the end of the first quarter of 2010. To keep inflation expectations well anchored, policymakers agreed on the importance of the Federal Reserve continuing to communicate that it has the tools and willingness to begin withdrawing monetary policy accommodation at the appropriate time and pace to prevent any persistent increase in inflation." (Board of Governors (2010a)).
4. 24 September 2009: The Board of Governors announces a gradual curtailing of the TAF programme (Board of Governors (2010a)).
5. 4 November 2009: The target range is kept at 0-0.25%. "Because of the limited availability of agency debt and concerns that larger purchases could impair market functioning, the Committee also

agreed to specify that its agency debt purchases would cumulate to about $175 billion by the end of the first quarter, $25 billion less than the previously announced maximum for these purchases." (Board of Governors (2010a)).

6. 17 November 2009: The Board reduces the maximum maturity of primary credit to 28 days.
7. 1 February 2010: The PDCF, TSLF, CPFF and AMLF expire. Swap lines are also closed (Board of Governors (2010a)).
8. 18 February 2010: The primary credit rate is increased to 0.75%, effective as of 19 February 2010. The maximum maturity is shortened to overnight, effective as of 18 March 2010. The TAF minimum bid rate on the final 8 March auction is raised to 50 basis points (Board of Governors (2010a)).

Chart I Timeline of the Federal Reserve's policy actions and balance sheet

(January 2007 – February 2010)

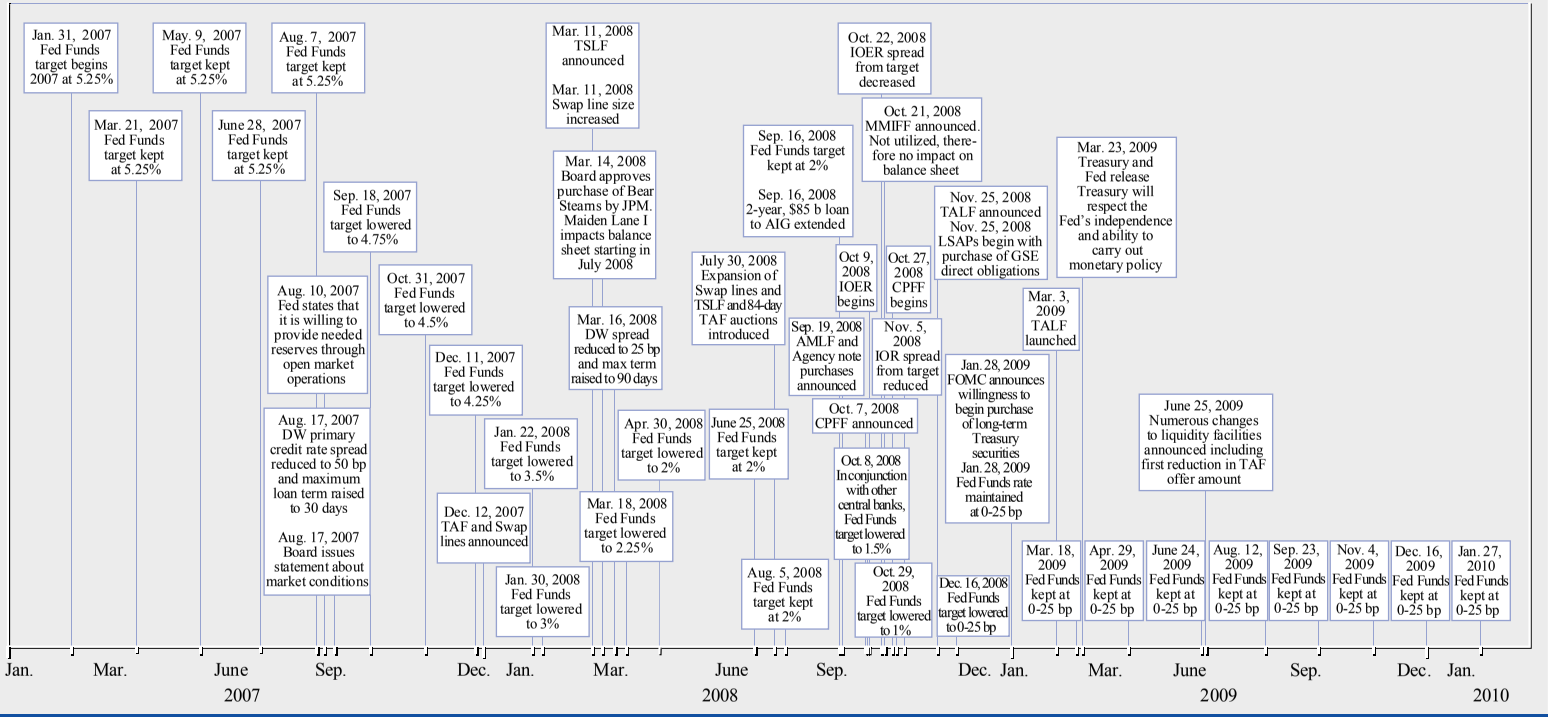


Chart I Timeline of the Federal Reserve's policy actions and balance sheet (Cont'd)

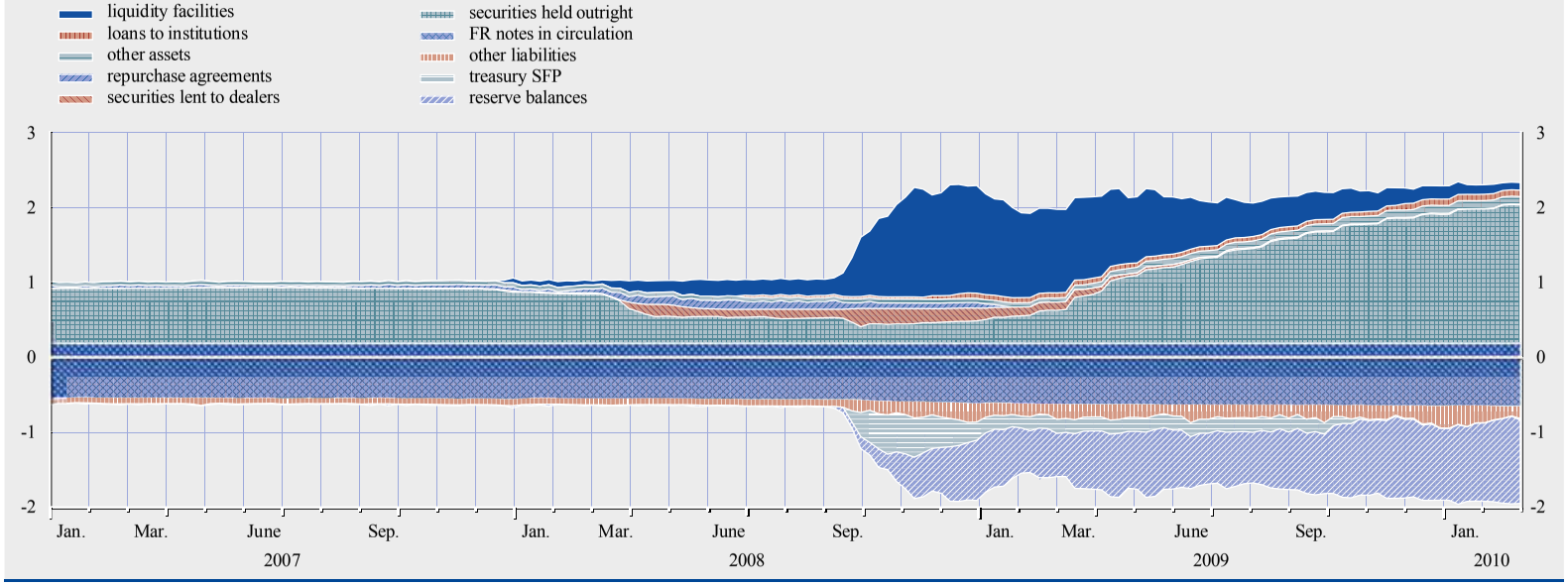
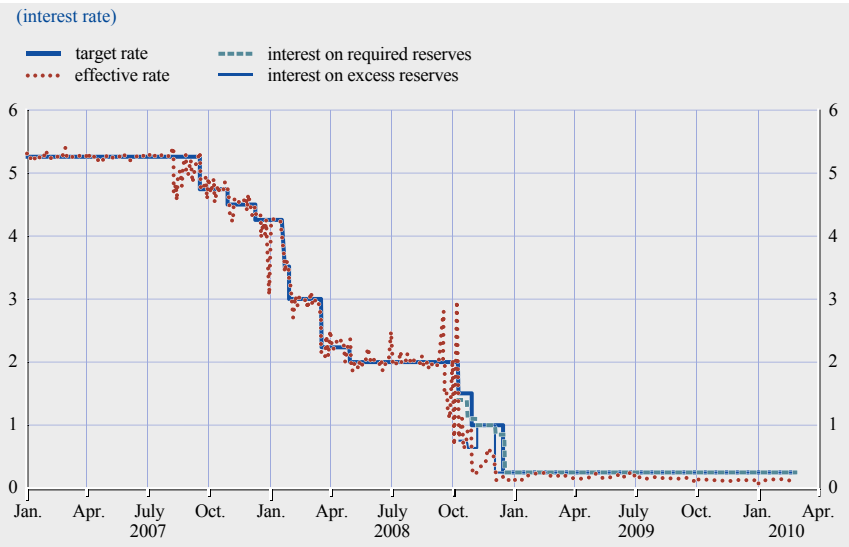


Chart 2 Time series of the federal funds rate



COMMENT

BY MARVIN GOODFRIEND, CARNEGIE MELLON UNIVERSITY

1 INTRODUCTION

Operating procedures are often treated as an afterthought at central banking conferences. Operational matters rarely get the attention they deserve, relegated instead to specialists instructed to make interest rate policy decisions effective in markets. This is like plumbers and electricians fitting a home for water and electrical service based on narrow engineering considerations alone, with only the vague direction of architects and builders.

The credit turmoil put operational matters at the heart of central banking. Central bank officials around the world worked closely with operational specialists to create and manage an extraordinary array of new initiatives designed to stabilise credit markets. The papers by Cassola, Durre and Holthausen and Hilton and McAndrews provide a valuable overview of a variety of extraordinary operational initiatives undertaken by the Eurosystem and the Federal Reserve System during the credit turmoil.

This comment classifies central bank operations broadly into "monetary policy" and "credit policy" in order to explain the nature of these extraordinary operational initiatives in terms of their fundamental money and credit components. It explains that "expansive credit policy" invades the territory of the fiscal authorities and puts central bank independence in jeopardy. It observes that an ambiguous boundary of support for the financial system between the central bank and the fiscal authorities helped destabilise the US economy in the autumn of 2008, and that a similar "no man's land" of responsibility for stabilising financial markets exits in the euro area today.[1]

2 FISCAL ASPECTS OF MONETARY AND CREDIT POLICY

Pure monetary policy consists of open market operations that expand or contract bank reserves or currency by buying or selling Treasury securities. Pure monetary policy works by varying the scarcity of bank reserves to manage the spread between the interbank interest rate and interest paid on reserves, whether or not interest is paid on (excess) reserves. In the United States, the Federal Reserve chooses the scarcity of bank reserves to manage the spread between the federal funds rate and interest on reserves; in the euro area, the Eurosystem chooses the scarcity of reserves to manage the spread between EONIA and the deposit rate.

Until the recent credit turmoil the Federal Reserve satisfied virtually all of its asset acquisition needs in support of monetary policy by purchasing US

1 The analysis employed throughout this comment draws heavily on Goodfriend (2011).

Treasuries, a policy known as "Treasuries only". The Federal Reserve followed this policy to avoid carrying credit risk on its balance sheet.

"Treasuries only" has had two important virtues in relation to fiscal policy. First, it has transferred Federal Reserve interest earnings (net of expenses) directly to the US fiscal authorities to allocate as they see fit. Second, US Treasury securities held by the Federal Reserve disappear on the consolidated balance sheet of the Federal Reserve and the US fiscal authorities, leaving only bank reserves and currency. In other words, US monetary policy has been implemented without the acquisition by the public sector of private liabilities or those of sub-national government entities. Hence, the Federal Reserve's expansion of bank reserves or currency by acquiring US Treasuries is pure monetary policy.

Pure credit policy involves lending to private sector entities or acquiring private or sub-national government securities with funds obtained by selling Treasury securities from the central bank portfolio. In contrast to monetary policy, credit policy does not change currency or bank reserves outstanding and so has no effect on the spread between the interbank rate and interest on reserves.

In an expansionary credit policy action executed by a central bank, the fiscal authorities receive interest on the credit assets acquired by the central bank in place of interest on the Treasuries sold by the central bank to fund its credit initiative. Thus, credit policy involves the allocation of public funds in a way that monetary policy does not. For instance, credit assets acquired by the Federal Reserve do not disappear in the consolidated balance sheet of the Federal Reserve and the US fiscal authorities. Credit policy involves the acquisition by the Federal Reserve and the US fiscal authorities taken together of private sector liabilities or those of sub-national government entities.

Fiscal policy involves the use for any purpose of public funds acquired with current taxes or by borrowing against future taxes, including the lending of public funds to particular borrowers financed by selling Treasuries against future taxes. Therefore, credit policy executed by a central bank is **debt-financed fiscal policy**.

Unlike monetary policy, credit policy interposes taxpayers between private borrowers and lenders and exploits the government's power to borrow against future taxes to facilitate flows to distressed or favoured borrowers. Doing so involves a fiscal policy decision to put taxpayer funds at risk.

3 CENTRAL BANK INDEPENDENCE

Independent central banks such as the Eurosystem and the Federal Reserve are not authorised to make fiscal policy decisions. A healthy democracy requires full public disclosure and discussion of the expenditure of public funds. The legislative appropriations process enables society to evaluate competing budgetary programmes and to establish priorities for the allocation of public resources. Hence, the Eurosystem and the Federal Reserve − precisely because

they are exempted from the appropriations process − should avoid, to the fullest extent possible, taking actions that can properly be regarded as within the domain of fiscal policy and the fiscal authorities.

That said, credit policy as "last resort lending" has long been a valued part of independent central banking around the world. Moreover, there are no equivalents to US Treasury securities in the euro area because there is no euro area-wide fiscal authority. Of necessity, loans to depositories have accounted for virtually all assets acquired by the Eurosystem in the management of monetary policy. In other words, the Eurosystem has pursued **monetary policy in combination with credit policy**.

Credit policies are reasonably compatible with independent central banking if they are well-protected against losses. For instance, short-term lending to supervised, solvent depositories against good collateral carries multiple layers of protection against ex ante distortions and ex post fiscal losses.

It is important to appreciate the problems that a central bank incurs when it engages in **expansive credit policy** beyond supervised, solvent depositories at longer term and against weaker collateral. A central bank must decide how widely to extend its lending reach. Lending farther afield creates an implied promise in the future with its moral hazard implications. Central bank presence in one credit market can drain funds from nearby credit channels and prompt calls for support in nearby credit classes. The central bank must determine relative pricing, eligible collateral and haircuts. Above all, expansive credit policies put taxpayer funds at increasing risk, properly draw the scrutiny of the fiscal authorities and jeopardise central bank independence.

4 THE FEDERAL RESERVE'S TERM AUCTION FACILITY

Consider the Federal Reserve's Term Auction Facility (TAF) as described by Hilton and McAndrews. The Federal Reserve financed TAF credit at 28 and 84 days with the proceeds from the sale of Treasuries from its portfolio with no effect on bank reserves. In effect, the TAF interposed the US government's creditworthiness between lenders and borrowers in the dollar term interbank market to improve the flow and reduce the cost of dollar term credit to persistent borrowers in the United States and abroad. Hence, the TAF was a pure credit policy.

The TAF was fully collateralised and well protected against losses from the Federal Reserve's point of view. Nevertheless, the TAF exposed US taxpayers to losses as follows. If TAF lending financed the exit of uninsured or unsecured lenders to a bank that failed with TAF loans outstanding, the Federal Reserve would get its collateral and strip the failed bank of collateral that would have been available otherwise to cover the cost of insured deposits or other government guarantees if the bank had been closed more promptly. Extending TAF credit to 28 and especially to 84-day terms in the midst of the credit turmoil thereby significantly elevated risk to US taxpayers.

5 THE EUROSYSTEM'S LONG-TERM, FIXED-RATE REFINANCING OPERATIONS WITH FULL ALLOTMENT

At the peak of the credit turmoil the Eurosystem announced refinancing operations in which it would accommodate whatever funding banks asked at various fixed interest rates and terms up to one full year. For instance, by offering banks unlimited credit for one year at 1% together with a 0.25% rate at the deposit facility, the Eurosystem set the "term spread" between liquid reserves and one-year credit. A bank could acquire whatever euro reserves it demanded for a year at a net pecuniary cost of 0.75%. The Eurosystem presented banks with an arbitrage opportunity – subject to meeting collateral requirements, banks could borrow reserves until they drove their marginal implicit liquidity convenience yield on reserves down to 0.75%.

Panel B of Chart 6 in the paper by Cassola, Durre and Holthausen shows that EONIA was pressed nearly down to the deposit rate (interest on reserves) floor throughout the first period of long-term, fixed-rate, full allotment refinancing operations. The perfectly elastic demand for reserves was fully accommodated at just above the 0.25% deposit rate floor during the period. In other words, banks took advantage of the arbitrage opportunity offered by the Eurosystem to satiate themselves with reserves.

The Eurosystem's long-term, fixed-rate refinancing operations with full allotment combined credit and monetary policies because they financed loans to banks with newly created reserves. These initiatives satisfied two important policy objectives: they pulled down term premia in interbank markets and satisfied the demand for reserves. However, because such refinancing operations were partly credit policies, they achieved these aims at an elevated risk to euro area taxpayers. Specifically, any losses on lending to banks owing to defaults and impaired collateral would deprive euro area fiscal authorities of interest earnings (net of expenses) that would have been transferred on a pro rata basis otherwise. Moreover, if long-term refinancing operations financed the exit of uninsured or unsecured lenders to a bank that failed with long-term refinancing operation loans outstanding, the Eurosystem could get its collateral but strip the failed bank of collateral that would have been available otherwise to cover the cost of insured deposits or other government guarantees if the bank had been closed more promptly.

6 THE "NO MAN'S LAND" OF CREDIT/FISCAL RESPONSIBILITY FOR FINANCIAL STABILITY

In May 2010 euro area governments announced a package of measures including the European Financial Stability Facility (EFSF) to help stabilise financial markets. Among other things, the Eurosystem launched the Securities Market Programme, under which it has purchased sovereign bonds of euro area member states to help stabilise markets.

In recent months, businesses and other institutions are reported to have pulled deposits out of banks in peripheral euro area countries deemed at financial risk to place them with safer-seeming banks in the United Kingdom and continental Europe. The Eurosystem is reported to have stepped in to recycle funding to peripheral banks. The 16 November 2010 *Wall Street Journal* reported that Ireland accounted for 24% of borrowing from the Eurosystem, Greece accounted for 17% and Portugal accounted for 7.5%, even though each of these countries accounts for only around 2% of euro area GDP.

The evidence suggests that expansive Eurosystem credit policies are providing fiscal support for banks in the euro area periphery having difficulty funding themselves in interbank markets and otherwise.

To sum up, the paper by Hilton and McAndrews documents how the Federal Reserve was drawn into expansive credit policy in 2007 to facilitate private credit flows in the wake of the collapse of the shadow banking system in the United States. Likewise, the paper by Cassola, Durre and Holthausen documents how the Eurosystem expanded its initiatives as the credit turmoil spread to Europe. More recently, expansive Eurosystem credit policy has facilitated the flow of credit to weak banks in peripheral countries in the euro area.

The credit turmoil has unearthed a problem with expansive credit policy initiatives undertaken by the Eurosystem and the Federal Reserve. There is a limit to what an independent central bank is authorised to provide in credit/fiscal policy support for the financial system. At some point, the fiscal authorities must take responsibility for authorising such support.

The Federal Reserve reached its limit with the support of AIG in the autumn of 2008. The US Congress then took the lead with the Troubled Assets Relief Program (TARP). The lack of clarity in the boundary of credit/fiscal policy support for the financial system created a "no man's land" of responsibility between the Federal Reserve and the US Congress in the autumn of 2008 that then contributed to the destabilisation of financial markets in the United States.

Likewise, at some point the Eurosystem may be pushed to its limit. One hopes that the boundary of responsibility for credit/fiscal policy support of the financial system in the euro area today can be clarified before too long.

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COMMENT

BY RAFAEL REPULLO, CENTRO DE ESTUDIOS MONETARIOS Y FINANCIEROS (CEMFI)

MONETARY POLICY OPERATIONS EXPERIENCES DURING THE CRISIS AND LESSONS LEARNT

1 INTRODUCTION

The papers by Cassola, Durré and Holthausen and Hilton and McAndrews offer two complementary perspectives on how the ECB and the Federal Reserve responded to the crisis, and the lessons that these experiences provide for the future design of the operational framework of monetary policy on both sides of the Atlantic.

I would like to start by noting that both central banks shared the same fundamental structure, based on a separation between the decisions on the policy rate – taken by the Governing Council of the ECB and the Federal Open Market Committee (FOMC) of the Federal Reserve respectively – and the decisions on liquidity provision designed to keep very short-term interest rates, such as EONIA and the Federal Funds rate, close to the policy rate. In the case of the ECB, this *separation principle* has its institutional correspondence in the allocation of tasks between the Governing Council, which is responsible for the formulation of the monetary policy of the Eurosystem, and the Executive Board, which is responsible for its implementation. In the case of the Federal Reserve, it corresponds to the allocation of tasks between the FOMC and the Federal Reserve Bank of New York.

However, prior to the crisis there were very important differences between the ECB and the Federal Reserve in terms of implementation of monetary policy. First, the open market operations of the ECB were conducted in a decentralised manner, through the national central banks of the Eurosystem, normally once a week and with a large number of counterparties, whereas the Federal Reserve Bank of New York traded every day with a few primary dealers. Second, minimum reserves were fairly small in the United States, and until October 2008 they were not remunerated,[1] while the Eurosystem had large reserve requirements remunerated at market rates. Third, until January 2003 the Federal Reserve's discount window rate was below the policy rate, and using the window carried a stigma that made it a last-resort source of liquidity. In contrast, the ECB's marginal lending facility rate had always been above the policy rate and carried no stigma. Finally, the ECB had a deposit facility, whereas the Federal Reserve had none.

1 The 2006 *Financial Services Regulatory Relief Act* contemplated the payment of interest on reserves from October 2011, but the 2008 *Emergency Economic Stabilization Act* advanced this date to October 2008.

The changes adopted by the Federal Reserve in January 2003 and October 2008 moved the US framework toward the Eurosystem framework in two important respects: first, a lending facility was introduced with a discount rate (renamed the primary credit rate) set initially at 100 basis points above the policy rate, and second, an "automatic" deposit facility was introduced as a result of the decision to pay interest on excess reserves.

Still some important differences remained. First, working with a very small number of counterparties meant that when the normal functioning of the money markets broke down, it was much more difficult for the Federal Reserve to get the liquidity flowing to the banks that needed it, as compared to a system where these banks could directly access the central bank. Second, using a restricted set of collateral assets – basically US Treasury securities – meant that when the primary dealers ran out of these assets the Federal Reserve did not have the instruments to inject the required liquidity into the system. Finally, despite the changes in the US discount window policy, the stigma problem lingered, so many banks were reluctant to use the window.[2] These differences help to explain how in many of its operational decisions the Federal Reserve seemed to be a more "innovative" central bank, but the fact is that the ECB had at its disposal a better set of tools to handle a liquidity crisis.

During the crisis, investors withdrew large amounts of funds from some financial institutions and placed them in other institutions, and/or purchased financial assets such as government securities. Thus, some institutions had liquidity deficits and others had liquidity surpluses. In normal conditions, such portfolio shifts could have been managed by deficit institutions either by selling assets to, or by borrowing from, surplus institutions. The problem was that deficit institutions ran out of government securities and credit markets stopped functioning, owing to a lemons problem, so there was a major problem in redistributing liquidity from surplus to deficit institutions. In response to this situation, central banks stepped in as intermediaries (or market makers) of last resort, taking funds from surplus institutions (via excess reserves in the United States and via the use of the deposit facility in the euro area) and lending them to deficit institutions (via the Term Auction Facility in the United States and via the various extensions of the refinancing operations in the euro area).

As a result of these actions, both central banks significantly increased their balance sheets. In particular, the balance sheet of the Federal Reserve System grew from 6.5% of the US GDP at the end of 2006 to 15.8% at the end of 2009, while the balance sheet of the Eurosystem grew from 13.6% of the euro area GDP at the end of 2006 to 21.2% at the end of 2009. The increase in the relative size of the Federal Reserve over these three years was of 9.3 percentage points, whereas that of the Eurosystem was of 7.6 percentage points. Although this corresponds

2 As noted by Ben Bernanke in a speech on 3 April 2009, "Banks were reluctant to rely on discount window credit to address their funding needs. The banks' concern was that their recourse to the discount window, if it became known, might lead market participants to infer weakness. (…) The perceived stigma of borrowing at the discount window threatened to prevent the Federal Reserve from getting much-needed liquidity into the system."

to the widespread perception that the Federal Reserve has been a more "active" central bank, the difference in terms of the increase in their balance sheets was not that large (and the relative size of the Federal Reserve at the end of 2009 was still 5.4 percentage points below that of the Eurosystem).

In the next two sections I will provide some specific comments on the two papers, which I will refer to as the ECB paper and the Federal Reserve paper, before going on to conclude in Section 4 with some preliminary thoughts about monetary policy implementation after the crisis.

2 COMMENTS ON THE ECB PAPER

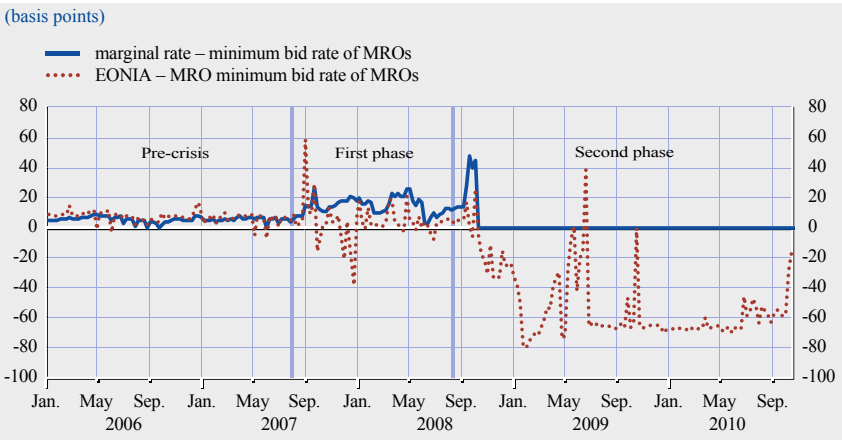
The paper by Cassola, Durré and Holthausen has three main sections. It starts with a description of the three phases of the crisis, then it presents a theoretical model of the interbank market that tries to capture the main trade-offs faced by the ECB, and finally it provides some econometric evidence on the effect of the refinancing operations.

From the perspective of the monetary policy operations of the ECB, the first phase of the crisis, from August 2007 to September 2008, was characterised by the frontloading of liquidity provision and the increase in the amount of longer-term refinancing. The second phase, from September 2008 to October 2009, was characterised by the implementation of non-standard monetary policy measures and the abandonment of the separation principle. The third phase started with the decision to gradually phase out the non-standard measures, which was reversed by the arrival of the European sovereign debt crisis in the spring of 2010.

My first comment on this part of the paper is that the decisions before September 2008, and in particular the frontloading of liquidity provision, represented a straightforward application of the separation principle in light of the change in banks' bidding behaviour. In fact, this principle was not fully followed, since the ECB allowed the marginal rate of the main refinancing operations to increase above the policy rate (the minimum bid rate) – see the blue line in Chart 1. This was a signal of tighter liquidity provision, and it would be interesting to know why the ECB did it. Was it perhaps to tighten the monetary policy stance through the back door (i.e. without moving the policy rate) in a situation in which inflation in the euro area was heading towards a level significantly above the 2% target?

My second comment is that I do not understand why from September 2008 interbank rates such as EONIA were allowed to fall way below the policy rate – see the red dotted line in Chart 1. If the ECB wanted to lower rates by 50 basis points, why did it not lower the rate of the main refinancing operations by this amount? Why abandon the separation principle and introduce this element of confusion in the stance of monetary policy at this critical stage of the crisis?

Chart 1 Euro interest rate spreads, 2006-2010



Source: ECB Monthly Bulletin.

The official justification referred to the preservation of the functioning of the interbank markets. In the words of Bini Smaghi (2009), "bringing the main policy rate too close to zero would risk hampering the functioning of the money markets". And this is what the theoretical model in the paper is supposed to illuminate.

The model has four dates (t=0, 1, 2, 3) and a large number of risk-neutral banks that are identical ex ante but are different ex post in that they may suffer idiosyncratic liquidity and solvency shocks at t=1 and t=2. In addition, the system may experience an aggregate liquidity shock at t=2. Apart from the private banks, the model has a central bank that offers a deposit and a lending facility. The main issue analysed in the paper is this: under what conditions would there be an active interbank market in which banks that do not suffer a liquidity shock (surplus banks) lend their excess liquidity to those that do (deficit banks)? The alternative would be that surplus banks place their excess liquidity at the central bank's deposit facililty and deficit banks borrow from the central bank's lending facility.

To review the analysis in the paper, consider a (type A) bank that has a unit of liquidity surplus at t=1 and a unit of liquidity deficit at t=2. Let r_t denote the interbank rate at date t, d_t the deposit facility rate at date t, l_t the lending facility rate at date t and q_t the probability that an interbank loan will not be repaid at date t+1. At t=1 the bank can either use the deposit facility, which yields $1+d_1$ at t=2, or lend the unit of liquidity surplus in the market, which yields $1+r_1$ with probability $1-q_1$ or 0 with probability q_1 at t=2. On the one hand, if the bank uses the deposit facility, it will have the principal to meet the payment due at t=2 and the interest d_1 to invest (say, in the interbank market) which will yield $d_1(1+r_2)$ at t=3. On the other hand, if the bank goes to the market and the interbank loan is not repaid, it will have to borrow one unit of liquidity (say, in the interbank market) at t=2, and if the loan is repaid it will have the principal

to meet the payment due at t=2 and the interest r_1 to invest (say, in the interbank market). Then its net expected payoff at t=3 will be $r_1(1+r_2)(1-q_1) - (1+r_2)q_1$. The bank will lend its surplus liquidity in the interbank market at t=1 if the net expected payoff of lending exceeds the net payoff from using the deposit facility, that is if

$$r_1(1+r_2)(1-q_1) - (1+r_2)q_1 \geq d_1(1+r_2),$$

which simplifies to

$$1+r_1 \geq \frac{1+d_1}{1-q_1}.$$

Since borrowing (type B) banks will go to the interbank market at t=1 if it is cheaper than using the central bank's lending facility, that is if $l_1 \geq r_1$, we conclude that the condition for having an active interbank market at t=1 is

$$1+l_1 \geq \frac{1+d_1}{1-q_1},$$

which simplifies to

$$l_1 - d_1 \geq q_1(1+l_1) \approx q_1.$$

In other words, the spread between the central bank's lending and deposit facilities must be large relative to the credit risk in interbank lending.

It should be noted that this condition does not depend on the interbank rate at t=2, so contrary to what is stated in the paper *there is no interaction between credit risk and liquidity risk* (the risk that there is an aggregate liquidity shock at t=2). This shows that there is a problem with lemma 2 in the paper.

Apart from this, it is important to note that if the condition for having an active interbank market were to be violated, that is if $l_1 - d_1 < q_1$, the central bank would be losing money with its intermediation activity, because it would be charging a spread over the deposit facility rate that would not cover the credit risk of its lending. In other words, we have an active interbank market if the central bank does not provide a subsidy to the borrowing banks. Could this be why the ECB cared about "not hampering the functioning of the money markets"?

However, it should be noted that in models in which banks have either structural liquidity surpluses or structural liquidity deficits, such as the model presented in Bruche and Suarez (2010), central bank intermediation may be an efficient way to deal with money market freezes. In such situations, narrowing the spread between the lending and the deposit facility rates could be desirable.

The conclusion to be drawn from this discussion is that more work needs to be done in order to provide a rationale for abandoning the separation principle in terms of "not hampering the functioning of the money markets".

The ECB paper concludes with an econometric estimation of a VARX model with seven endogenous variables, in which changes in the policy rate are taken to be exogenous. The model is estimated using daily data for the period August 2007 to October 2010. The results show that shocks to the outstanding volume of refinancing operations decrease trading and spreads in the interbank market. Although the results are interesting, there is some concern regarding the empirical strategy, which is based on a model that has too many endogenous variables, some of which have a trend, and which takes as exogenous a variable like changes in the policy rate that is clearly endogenous. The question is: why not estimate a standard structural VAR, with a proper discussion of the identification restrictions?

3 COMMENTS ON THE FEDERAL RESERVE PAPER

The paper by Hilton and McAndrews is divided into two parts: challenges in responding to the crisis and lessons for the future. The three key challenges were how to increase the size of the Federal Reserve's balance sheet in order to tackle the liquidity crisis, how to deal with the stigma of discount window borrowing, and how to arrange collateral requirements for lending to an expanded set of counterparties.

With respect to balance sheet constraints, the obvious thing to note is that liquidity injections increase reserves, so maintaining a policy rate above the zero lower bound requires either mopping up reserves via open market operations or paying positive interest on excess reserves. In fact both avenues were taken by the Federal Reserve, by means of the creation of the Supplementary Financing Program in September 2008 and the provisions in the *Emergency Economic Stabilization Act* of October 2008 respectively.

The problem of the stigma attached to discount window borrowing was inherited from a long tradition of setting the discount rate below the policy rate and adding non-pecuniary penalties (in the form of stigma) to restrict its use. Interestingly, no stigma was attached to borrowing from the ECB, neither in the refinancing operations nor at the lending facility. The way out found by the Federal Reserve was to resort to a liquidity auction system, the Term Auction Facility, in which a potentially large number of banks bid simultaneously on the date of the auction.

In conducting these operations the Federal Reserve had to set up new lending arrangements with banks without Treasury securities to be posted as collateral, as well as with other key institutions such as money market mutual funds. In doing this the Federal Reserve assumed an unprecedented amount of credit risk, which was justified by the need to address unprecedented disruptions in financial markets and institutions.

The three lessons for the future operating framework for monetary policy discussed in the paper by Hilton and McAndrews relate to the payment of interest on reserves, the structure of the Federal Reserve's securities portfolio, and the size of reserve requirements.

The payment of interest on (excess) reserves solves the balance sheet problem noted above, and allows the running of monetary policy with a structural liquidity surplus. It also facilitates acting on the term premium, via quantitative easing (QE), even outside the zero lower bound. However, it naturally reduces the level of trading activity in the federal funds market, which may (or may not) be a source of concern.

In dealing with the crisis, the Federal Reserve acquired a large amount of non-Treasury securities. This will eventually be reversed, since there should be no need to buy or take as collateral such securities in normal times. However, the Federal Reserve should be ready to act in future crises by, among other things, lending for terms longer than overnight, against non-Treasury securities, and possibly on a non-recourse basis – so the authors argue for an expanded credit risk management approach in normal times.

Finally, the third lesson is to note the potential value for the wholesale payment system (Fedwire) of operating with higher reserve balances. This would not only improve the efficiency of payments, but also reduce the risks posed by daylight overdrafts. Achieving this would require much higher reserve requirements, which should be remunerated at market rates to avoid any distortions. It should be noted that for this purpose, and as the case of the ECB illustrates, there is no need to pay interest on excess reserves, only on required reserves.

Summing up, this paper contains a very good summary of the challenges faced by the Federal Reserve during the crisis, but I think that it is somewhat weaker on the lessons for the future. In particular, the paper takes a piecemeal approach focusing on three specific issues, when a more systematic approach would have been desirable. Ideally, this would require a description of the relevant environment, a specification of the central bank's objectives, a list of the possible instruments, and, to conclude, an analysis of the optimal implementation of monetary policy. This should be the subject of an ambitious research project for the next few years.

4 MONETARY POLICY IMPLEMENTATION AFTER THE CRISIS

In broad terms, there are three ways in which monetary policy can be implemented. First, as in the case of the Eurosystem, one may have a *structural liquidity deficit*, and operate monetary policy with a regime under which the central bank lends reserves to the private banks. In this case, the policy rate would be the central bank's lending rate (like the ECB's minimum bid rate in the main refinancing operations). Second, as in the case of the Federal Reserve prior to the crisis, one may have an *approximate liquidity balance*, and operate monetary policy by conducting open market operations designed to compensate the daily movements in the autonomous liquidity creation factors. In this case, the policy rate would be the target short-term money market (Federal funds) rate. Finally, as perhaps in the case of the Federal Reserve after the crisis, one may have a *structural liquidity surplus*, and operate monetary policy with a regime under which the private banks lend reserves to the central bank. In this case, the policy rate would be the interest rate paid by the central bank on excess reserves.

Since it is unclear which system is best, studying this issue should be a high priority for all central banks. I would like to conclude with some preliminary thoughts on these alternatives.

First, having a structural liquidity deficit is good for distributing liquidity broadly, since there is no stigma attached to borrowing from the central bank (everybody does it). However, if the deficit is too large, the central bank has to be willing to take non-government paper as collateral. Thus, a large structural liquidity deficit requires some careful management of credit risk, which in principle is not the comparative advantage of the central bank. Also, a system with a structural liquidity deficit will penalise banks under the future Basel III regime,[3] since the Liquidity Coverage Ratio will require them to hold additional liquid assets to back their short-term borrowing from the central bank.

Second, having a structural liquidity surplus is bad for distributing liquidity broadly, since the stigma of having to borrow from the central bank may remain. It also requires that there is a large pool of suitable assets that the central bank can hold (something that should not be a problem in the foreseeable future). However, if the central bank were forced to hold longer-term government securities (or private securities) in its portfolio, it could incur losses that might endanger its independence.[4] Insofar as this is would be anticipated, it could imply an undesirable constraint on monetary policy decisions.

3 See Basel Committee on Banking Supervision (2010).

4 In particular, the situation of the central bank could resemble that of the US Savings and Loans institutions in the 1980s, with a combination of low-return, long-term assets and high-cost, short-term liabilities. The difference, of course, is that the central bank could control the cost of its liabilities via the setting of the policy rate.

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GENERAL DISCUSSION

Charles Goodhart (London School of Economics) supported Repullo's view that more research is needed on the optimal spread between central bank deposit and lending rates. He asked why Holthausen was taking for granted that it is good to have more activity in the interbank market. He also questioned the rationale for keeping the interest rate corridor symmetric.

Holthausen argued that an active interbank market is important for aggregating information and for maintaining banks' incentives to engage in peer monitoring, both in good times and bad. As stressed by Goodfriend, too great a degree of central bank intermediation in the interbank market presents a further disadvantage: it implies that the central bank is assuming more credit risk, even with an appropriate collateral framework in place. Therefore, to the extent that the central bank can continue to control interest rates, the optimal move is for it to step back from the market.

According to **McAndrews**, the most important reason for having a symmetric corridor is that the middle of the corridor is the most elastic portion of the demand curve. Therefore, placing the target rate in the middle of the corridor diminishes interest rate variability.

Francesco Papadia (ECB) distinguished between two variants of monetary policy implementation: the ECB's broad variant and the Federal Reserve's narrow variant. The ECB deals with many counterparties and accepts many different categories of collateral, while the reverse applied to the pre-crisis Federal Reserve. Before the crisis it was difficult to tell which variant was better. They were both equally successful in controlling the short-term rate. During the crisis, however, the broad approach performed better. Thus the Federal Reserve substantially broadened its framework, and the ECB also further broadened its framework somewhat. This broadening was necessary because central banks took over part of the financial intermediation that the private sector was no longer able to perform. Papadia asked if the speakers agreed with characterising one framework as broad and the other as narrow. Second, he asked if the broad frameworks will be retained after the crisis ends.

In **Hilton**'s view, what is important is not whether the framework is permanently broad or narrow, but whether it can be broadened in the event of a crisis. The Federal Reserve has built on its experience of responding to a crisis and has developed tools with which to respond to future similar crises. But in normal times there is no need to operate with such a broad framework.

Repullo remarked that Papadia's classification of operational frameworks into broad and narrow is not exhaustive. In addition, the narrow framework could be accompanied by flooding the market with reserves so that the interest rate on excess reserves becomes the policy rate.

For welfare reasons, **Goodfriend** favoured satiating the financial system with reserves, so that the interbank rate falls to the interest-on-reserves floor. Electronic reserves can be produced for free so they should be supplied without limit. Therefore, central banks should seriously consider the floor system. In this system, the central bank can hedge its interest rate risk by holding short-term securities such as Treasury bills, since Treasury bill rates will fluctuate with the interest rate that the central bank pays on reserves.

McAndrews remarked that Goodfriend's "no man's land" of responsibility for stabilising financial markets was, in his view, navigated well by the Federal Reserve, especially in light of the severe difficulties in the real economy.

Jean-Claude Trichet

CONCLUDING REMARKS

CONCLUDING REMARKS

BY JEAN-CLAUDE TRICHET, PRESIDENT OF THE ECB

Ladies and gentlemen,

Hosting all of you has been a great privilege for us – and I am speaking on behalf of my colleagues on the Executive Board of the ECB and the Governing Council. I think that at a certain point, the majority of the Governing Council and the majority of the "team" from the Global Economy Meeting in Basel were here. So thanks to all those colleagues who accepted our invitation. The presentations have been outstanding, and I wish to extend my thanks to all of the speakers. I have learnt a lot during these two days.

I am very grateful to Ben Bernanke, Henrique Meirelles and Dominique Strauss-Kahn for being open to your questions, remarks and observations. We have always believed in a frank and candid exchange of views. We trust in the benefits of being totally open. At times in the past we were considered too open in accepting all kinds of criticism. But it is essential that we exchange views and maintain this openness.

I have the feeling that, especially with hindsight, much of our monetary policy concept, which we have followed from the very beginning, has proven its worth. I am speaking particularly of our attention to the information contained in monetary aggregates. As has been explained, we take into account the dynamics of all of the various components and counterparts of monetary aggregates. The issue of the dynamics of credit has come up again and again during this conference and is an issue that is an absolutely essential part of our monetary analysis.

During this conference I have been struck by the importance of some of the luminaries of economics – Charles Kindleberger, Milton Friedman, Hyman Minsky, Frank Knight. We have once again been reminded in this crisis that we not only have to live with risk, but also with significant Knightian uncertainty.

One thing we lacked in this crisis was a good analytical understanding of the unfolding sequence of events. Therefore, in this conference, I was particularly interested in the perspectives on exploring non-linear, highly complex, transitory phenomena. This seems to be an immense field for research – both academic research as well as applied research in central banks. However, we should not underestimate the analytical difficulty of this research. Even in the natural sciences we are still lacking a complete understanding of the phase transition in physics, of the modelling of turbulence itself, of the transition from laminar flow to turbulent flow. Dannie Heineman, one of the greatest luminaries in physics who made incredible progress in the quantum theories, once said that turbulence is much more complicated than quantum physics. I think that we have to work on this area much more than we had imagined before the crisis. I am saying this because, again, I was fascinated by the wealth of discussion that we have had here.

I again extend my warm thanks to you all. We have benefited a lot from your presence here. This conference is our flagship event and in two years' time the ECB will again hold this conference. Thank you for having spent these last two days with us.

ECB President Jean-Claude Trichet and Christian Thimann with 30 graduate students from across Europe

MEDIA COVERAGE

A REVIEW OF THE MEDIA COVERAGE

The proceedings of the Sixth ECB Central Banking Conference were covered extensively by media across Europe and beyond. International newspapers, including the Financial Times, the Wall Street Journal and the International Herald Tribune, reported on the conference, as did national media in more than a dozen countries. Frankfurter Allgemeine Zeitung and Handelsblatt (Germany), Les Echos (France), Il Sole 24 Ore (Italy), Expansión (Spain) and many others followed the two-day event closely. The reporting focused primarily on the policy panel discussion entitled "Emerging from the crisis: where do we stand?", and, in particular, on the comments made by ECB President Jean-Claude Trichet, US Federal Reserve Chairman Ben Bernanke and IMF Managing Director Dominique Strauss-Kahn.

Mr Trichet's opening remarks were the main focus of press reports on the first day of the conference. Several newspapers quoted Mr Trichet's call for political decisions to strengthen the Stability and Growth Pact, emphasising his "grave concerns" about the path that economic and fiscal governance of the euro area was taking. In this regard, Mr Trichet's comment that "the situation is very difficult" and his call to governments to pay attention to "preserving and strengthening their credit merit" were widely quoted by many newspapers. "Taking into account the lessons of the global crisis, in particular as regards its impact on the European single market and in the single currency area, we have called, and are still calling, for a quantum leap of governance." This was another of Mr Trichet's statements that featured prominently. The newspapers also had extensive coverage of the President's warning regarding the risk of an increased reliance by over-indebted countries on ECB support measures put in place during the crisis. "The central bank must guard against the danger that the necessary measures in a crisis period would evolve into a dependency as conditions normalise", Mr Trichet concluded.

News coverage of the second day of the conference was largely dominated by reports on Mr Bernanke's remarks made during the panel discussion with Mr Trichet and Mr Strauss-Kahn. In particular, the Federal Reserve Chairman explained that the Federal Reserve deemed a second round of quantitative easing necessary in order to keep the US economy growing and to fuel the global recovery. Mr Bernanke was quoted as saying "the best way to continue to deliver the strong economic fundamentals that underpin the value of the dollar, as well as to support the global recovery, is through policies that lead to a resumption of robust growth in a context of price stability in the United States".

Another focal point was Mr Bernanke's warning that undervaluations of some emerging market currencies were at the root of "persistent imbalances" in trade and that these imbalances "represent a growing financial and economic risk". "Currency undervaluation by surplus countries is inhibiting needed international adjustment and creating spillover effects that would not exist if exchange rates better reflected market fundamentals", Mr Bernanke was reported as saying. Newspapers interpreted his remarks to the effect that unless countries like China allow their currencies to rise naturally to reflect their faster pace of growth, others

would suffer disproportionately from the imbalances that can be traced to the trade effect of undervalued currencies.

The media reported Mr Trichet's statement that "we strongly share the view that a strong dollar, credible vis-à-vis the major floating currencies, is very important". They also reflected on the ECB President's point that some economies with current account surpluses have exchange rates "that are not sufficiently flexible" and warned that failure to solve global imbalances would "pave the way for future major difficulties". IMF Managing Director Dominique Strauss-Kahn was quoted as saying that he believed that "wherever it's possible…the support to growth is still something which is absolutely necessary" and he called upon Europe to adopt "a strategy of common growth". He was furthermore cited as saying that "the currency question is only part of the problem" and that, in general, there was a need to "restore confidence" by tackling debt problems. Media coverage of this topic also included remarks made by Henrique Meirelles, the Governor of Brazil's central bank, who said that "it's simply a fact that there are global imbalances" and appealed to his counterparts that "we should work toward global coordination".

Several media reported Jürgen Stark's remarks made during his keynote address entitled "In search of a robust monetary policy framework", in which he said that the financial crisis had bolstered the case for central banks taking a longer-term view when setting interest rates. Some articles used the occasion to highlight the ECB's medium-term orientation. In coverage of Mr Stark's closing remarks, newspapers reported his emphasis on the importance of some fundamental features of central banking, namely the overriding task of maintaining price stability, the independence of central banks in pursuing their mandate and the prohibition of monetary financing of government expenditure. Mr Stark's statement that the ECB's monetary policy strategy embodies elements which provide "a suitable and robust framework for an occasional, but appropriate 'leaning-against-the-wind'" type of monetary policy was also widely mentioned by the media as a concluding element of their reporting of the event.

PROGRAMME

THURSDAY, 18 NOVEMBER 2010

1.30 p.m. -2.30 p.m.	Registration and welcome coffee
2.30 p.m. -3 p.m.	**Introductory speech** Jean-Claude Trichet, President, European Central Bank
3 p.m. -5.45 p.m.	**Session I** **Monetary policy strategies: experiences during the crisis and lessons learnt** Chair: José Manuel González-Páramo, Member of the Executive Board, European Central Bank **Paper: Lessons for monetary policy strategy from the recent past** Stephan Fahr, Roberto Motto, Massimo Rostagno, Frank Smets and Oreste Tristani, European Central Bank **Paper: Monetary policy strategy: lessons from the crisis** Frederic Mishkin, Professor, Columbia University Discussants: Jean Pisani-Ferry, Director, Bruegel; Guido Tabellini, Rector, Bocconi University; and William White, Chair of the Economic and Development Review Committee, OECD
5.45 p.m. -7.15 p.m.	**Session II** **Panel -The financial crisis: what did central bankers forget and what did they learn? A historical perspective** Chair: Lorenzo Bini Smaghi, Member of the Executive Board, European Central Bank Panellists: Marc Flandreau, Professor, Graduate Institute of International and Development Studies; Carl-Ludwig Holtfrerich, Professor, Freie Universität Berlin; and Harold James, Professor, Princeton University
7.15 p.m.	Transfer to the dinner venue
8 p.m.	**Reception and Conference dinner** **Dinner address** **Personal reflections on EMU by the President of the EMI** Alexandre Lamfalussy Capitol Theater, Konzert-und Veranstaltungshaus, Offenbach am Main

FRIDAY, 19 NOVEMBER 2010

8 a.m. -8.45 a.m.	Registration and welcome coffee
8.45 a.m. -9.15 a.m.	**Keynote speech** **In search of a robust monetary policy framework** Jürgen Stark, Member of the Executive Board, European Central Bank
9.15 a.m. -10.45 a.m.	**Session III** **Panel -What shortcomings in macroeconomic and finance theory has the financial crisis revealed, and how should they be addressed?** Chair: Gertrude Tumpel-Gugerell, Member of the Executive Board, European Central Bank Panellists: Jean-Philippe Bouchaud, Professor, École Polytechnique; Martin Eichenbaum, Professor, Northwestern University and John Geanakoplos, Professor, Yale University
10.45 a.m. -11.15 a.m.	Coffee break
11.15 a.m. -11.45 a.m.	**Keynote speech** Speaker: Ben Bernanke, Chairman, Federal Reserve Board
11.45 a.m. -1.15 p.m.	**Session IV** **Policy panel -Emerging from the crisis: where do we stand?** Panellists: Jean-Claude Trichet, President, European Central Bank; Dominique Strauss-Kahn, Managing Director, IMF; Henrique Meirelles, Governor, Central Bank of Brazil and Ben Bernanke, Chairman, Federal Reserve Board
1.15 p.m. -2.45 p.m.	**Buffet lunch**
2.45 p.m. -4.45 p.m.	**Session V** **Monetary policy operations: experiences during the crisis and lessons learnt** Chair: Jürgen Stark, Member of the Executive Board, European Central Bank **Paper: Implementing monetary policy in crisis times: the case of the ECB** Nuno Cassola, Alain Durré and Cornelia Holthausen, European Central Bank **Paper: Challenges and lessons of the Federal Reserve's monetary policy operations during the financial crisis** Spence Hilton and James McAndrews, Federal Reserve Bank of New York Discussants: Marvin Goodfriend, Professor, Carnegie Mellon and Rafael Repullo, Professor, Center for Monetary and Financial Studies
4.45 p.m. -5 p.m.	**Concluding remarks** Jean-Claude Trichet


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