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Communication of monetary policy in unconventional times

Discussion Papers

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Discussion papers

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Abstract

Monetary policy communication is particularly important during unconventional times, because high uncertainty about the economy, the introduction of new policy tools and possible limits to the central bank's toolkit could hamper the predictability of policy actions. We study how monetary policy communication should and has worked under such circumstances. Our main results relate to announcements of asset purchase programmes and the use of forward guidance. We show that announcements of asset purchase programmes have lowered market uncertainty, particularly when accompanied by a contextual release of implementation details such as the envisaged size of the programme. We also show that forward guidance reduces uncertainty more effectively when it is state-contingent or when it provides guidance about a long horizon than when it is open-ended or covers only a short horizon, and that the credibility of forward guidance is strengthened if the central bank also has embarked on an asset purchase programme.

JEL codes: E43, E52, E58

Keywords: central bank communication, unconventional monetary policy, asset purchase programme, forward guidance

Non-technical summary

Communication can help making central banks transparent and thereby contribute to their accountability and to the management of expectations of economic agents. While these roles are generally important, they become even more relevant in unconventional times, when central banks need to explain the rationale and the workings of the various new policy tools that they employ, when the public will want to understand how the central bank will use the new tools, and how the central bank will eventually want to exit from using these tools. Managing expectations of economic agents about the future course of monetary policy is therefore essential in such circumstances, also because under a situation of elevated uncertainty, the central bank should strive to minimize any uncertainty about its own behaviour, to the extent possible.

Looking back at several years of experience with unconventional monetary policies in several economies, this paper provides an assessment of the effects and effectiveness of central bank communication during unconventional times. The focus of the paper is on the role of clarity in central bank communication, both when it comes to announcing new policy tools and when using forward guidance. The paper shows that communication about new policy tools reduces market uncertainty in particular when the announcements provide information about the envisaged size of a programme. With regard to forward guidance, clarity can be achieved by stressing the state-dependency of the central bank's reaction function. In line with this reasoning, the paper shows that forward guidance is more effective in managing expectations when it is state-contingent or when it provides guidance about a long horizon than when it is open-ended or covers only a short horizon. In addition, the credibility of forward guidance seems to be considerably enhanced if the central bank simultaneously has an asset purchase programme in place.

The findings of this paper have implications for monetary policy communication going forward. They suggest that when the central bank resorts to (new) unconventional monetary policy tools or forward-looking guidance, it is important to communicate the expected workings of the tools and the central bank reaction function, and to provide as much detail about their implementation as possible. Because central bank reaction functions are relating central bank actions to the evolution of the economy, central bank communication about its future actions is naturally state-dependent. In line with this, the ECB's forward guidance has placed increasing emphasis on its state-dependent nature. The formulation of the asset purchase program makes it contingent on the achievement of a "sustained adjustment in the path of inflation consistent with [the ECB's] inflation aim". To facilitate predictability of the ECB's future policy actions, clarity in this definition of state dependency is desirable. This encompasses the definition of the ECB's inflation aim, and the specific indicators that the ECB is looking at when assessing whether or not such a sustained adjustment has been achieved. The paper's findings also have implications for communicating the envisaged path towards monetary normalization. To provide appropriate guidance and to avoid unsettling financial markets, it is important to clarify in advance the ECB's reaction function and the state-dependencies that are involved.

1 Introduction

Communication can help making central banks transparent and thereby contribute to their accountability and to the management of expectations of economic agents. For independent central banks in democratic societies, there is a need to explain their actions and the underlying reasoning for their actions to the public. Accordingly, central banks have become remarkably more transparent over the last decades. In addition, communication has become a key instrument in the toolkit of central banks because monetary policy works not only through the current setting of policy instruments, but also through expectations about the future course of policy. As argued by Blinder et al. (2008), such management of expectations can be achieved on the one hand by "creating news" - implying, for instance, that central bank communication has the ability to move financial markets. On the other hand, it can be achieved by "reducing noise" – leading, for instance, to an enhanced predictability of monetary policy decisions.

In unconventional times, communication about the central bank's policy is even more important. Being accountable to the public is even more important when central banks rely on unconventional measures, for at least two reasons. First, because some of these measures are quasi-fiscal and therefore impose a risk on the taxpayer, and second, because some unconventional tools have more tangible distributional effects, therefore leading to a more prominent discussion of central bank policies in the public discourse and requiring a greater degree of accountability.[1] Greater transparency is also warranted, given that the central bank needs to explain the rationale and the workings of the various new policy tools that it employs. Related to this, there is a larger desire by the public to understand how the central bank will use the new tools, given that there is no established track record that would allow an inference of the central bank's reaction function. Managing expectations of economic agents about the future course of monetary policy by creating news is therefore essential – effectively, the central bank cannot avoid such communication, given that in the absence of central bank signals, economic agents will still form their expectations, but base these on an inferior information set. Finally, under a situation of elevated uncertainty, the central bank should reduce noise, i.e. strive to minimize any uncertainty about its own behaviour, to the extent possible.[2]

With policy rates being constrained at the effective lower bound (ELB), communication in the form of forward guidance (FG) about policy rates has become a policy tool in itself. Once the central bank has lowered short-term interest rates to their ELB, an additional easing of monetary policy can potentially still be achieved by managing expectations about the future course of policy. This is what happens under FG, where the central bank goes beyond statements about the current setting of monetary policy and also makes explicit statements about the future path of policy. Such FG has been used by several central banks following the global financial crisis.

Looking back at several years of experience with unconventional monetary policies in several economies, this paper provides an assessment of the effects and effectiveness of central bank communication during unconventional times. The focus of the paper is on the role of clarity in

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[1] The Bank of England, for instance, has been asked by the UK treasury committee to improve its efforts to explain the distributional effects of its asset purchases, see Bank of England (2012).

[2] Of course, it is important to keep in mind that central banks themselves had been confronted with large uncertainty following the global financial crisis, not only about the evolution of the economy but also about the effectiveness of their own policies. Accordingly, some uncertainty about central bank policies has been unavoidable.

central bank communication, both when it comes to announcing new policy tools and when using FG.[3] The paper argues that communications about new policy tools do not only generate news, but can also reduce noise (i.e. can help reducing uncertainty) when the announcements provide details on the implementation plans, e.g. about the envisaged size of an asset purchase programme (APP). With regard to FG, clarity can be achieved by stressing the state-dependency of the central bank's reaction function. As a matter of fact, the paper shows that FG is more effective in managing expectations when it is state-contingent or when it provides guidance over a long horizon than when it is open-ended or covers only a short horizon. In addition, the credibility of FG seems to be considerably enhanced if the central bank simultaneously has an APP in place.

The findings of this paper have implications for monetary policy communication going forward. They suggest that when the central bank resorts to (new) unconventional monetary policy tools or forward-looking guidance, it is important to communicate the expected workings of the tools and the central bank reaction function, and to provide as much detail about their implementation as possible. Because central bank reaction functions are relating central bank actions to the evolution of the economy, central bank communication about its future actions is naturally state-dependent. In line with this, the ECB's FG has placed increasing emphasis on its state-contingent nature.[4] The state-dependent aspect relates to the asset purchases and is formulated with regard to a "sustained adjustment in the path of inflation consistent with [the ECB's] inflation aim". To facilitate predictability of the ECB's future policy actions, clarity in the definition of the state dependency is desirable. This relates to the definition of the ECB's inflation aim, and to the ECB's preferred indicators for assessing whether or not such a sustained adjustment has been achieved. The paper's findings also have implications for communicating about the envisaged path towards removing monetary accommodation. To provide appropriate guidance to the public and to thereby also avoid unsettling financial markets, it is important to clarify in advance the ECB's reaction function and the various state-dependencies that are involved.

The paper proceeds as follows. Section 2 provides more detail on the particular challenges of central bank communication in unconventional times. Section 3 reports the main findings regarding the effectiveness of such communication. It starts by providing an overview of how communication has changed since the global financial crisis, before it studies the announcement of new policies (by looking at APPs in particular) and discusses the workings of FG. Section 4 concludes and draws lessons for the ECB's current monetary policy communications.

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[3] The paper's focus is on the role of central bank communication in managing expectations. It does not cover the importance of central bank communication in making central banks accountable. This aspect is beyond the scope of this paper, but it is important to note that a central bank which manages to be predictable in its actions simultaneously enhances its accountability.

[4] At the time of writing this paper, the ECB's FG combines open-ended, time-dependent and state-dependent elements. Its APP is "intended to continue [...] until the end of December 2017, or beyond, if necessary, and in any case until the Governing Council sees a sustained adjustment in the path of inflation consistent with its inflation aim"; the key ECB interest rates are expected "to remain at present or lower levels for an extended period of time, and well past the horizon of the net asset purchases", and the principal payments on the securities purchased under the APP will be reinvested as they mature, "for as long as necessary".

2 Challenges for Central Bank Communication in Unconventional Times

Managing expectations and enhancing the predictability of central bank actions is particularly important in unconventional times, but at the same time considerably more challenging. As we will argue in this section, there are several factors why in unconventional times a central bank might want to strive even harder to ensure the predictability of monetary policy than otherwise. In addition, given that the central bank is operating in an environment of elevated uncertainty (about the economic outlook, about the effectiveness of its policy tools and presumably also about its own reaction function), clarity is even more precious than otherwise.

2.1 Enhancing the Predictability of Monetary Policy

Communication can help agents predicting *future* policy actions, which is key to the stabilization of the *current* economic outlook. In fact, monetary policy works not only through the current setting of policy instruments, but also through expectations about the future course of policy. If economic agents understand how policy makers react to incoming information, future policy actions would be predictable for a given path of the economy, and expectations would be pinned down.

In normal times, the central bank reaction function can be sufficiently well understood that little (or in the extreme no) central bank communication would be required for predictability. According to the principle that "actions speak louder than words", there would be no need of any verbal communication when a sufficiently large number of repetitions of analogous cases were to make future policy actions predictable. Such a level of predictability would allow agents to fully incorporate future policy actions into their expectations, enhancing the stabilization power of policy actions.

Enhancing the predictability of policy (re-)actions is essential during unconventional times. In particular, there are three elements that may otherwise hamper predictability:

- ***High economic uncertainty* may impair the ability of the public to identify the information on which monetary actions are based.** When the central bank takes decisions in situations of high uncertainty, agents may not be in a position to understand its reaction function, thereby preventing a mutual understanding of the future evolution of monetary policy. Good communication mitigates these asymmetries by disclosing the policy maker's available information, its assessment of the economic outlook and its reaction function.
- ***Constrained policy instruments* may harm trust in policy effectiveness and disrupt the ability of the public to predict future central bank's actions.** Policy instruments can reach limits. The most prominent example is the case when policy rates are constrained at the ELB, but central banks have also been facing constraints on other tools. For instance, purchases under the ECB's public sector purchase programme were for some time limited to assets with yields above the ECB's deposit facility rate, and to purchases of assets from different jurisdictions according to the ECB's capital key. Due to the reduced effectiveness of a constrained policy instrument, agents may be unable to discern the central bank's guiding principles applying to such situations from historical patterns, thereby preventing predictability.

- **The introduction of _new policy instruments_ requires additional central bank communication, because neither the set of potential instruments nor their effectiveness is known to the public.** The central bank needs to be transparent about the various tools it has at hand, and provide clarity as to their possible deployment, especially once some of its policy tools are constrained. Clear communication is crucial for agents to fully and correctly evaluate when and how the new tools will be used, what their likely effects will be and how the new tools will interact with the established ones.

2.2   Increased Importance of Clarity

If statements by the central bank are not sufficiently clear, this can generate noise in communication.[5] Common noise (when all agents suffer from the same imperfect interpretation of an announcement) typically originates from a problem in the language used by the policy maker in relation to the regime in which communication occurs. Private noise (when interpretations differ across individuals) instead relates to the individual ability of agents to understand policy messages.

Public announcements that lead to common noise can be a source of excess market volatility. Noisy public announcements can have effects that are similar to sunspots, for instance when agents value public signals not only for their intrinsic information about the state of the economy, but mostly for their ability to act as a coordination device. In such a case, they will over-react to the announcement.[6]

By releasing more detailed information through different channels, the central bank could avoid that agents focus too much attention on a single release. This could reduce common noise, but at the cost of producing private noise. Sims (2005) suggested that providing agents with multiple sources of detailed information is a way to avoid common noise, as individual misunderstandings would cancel out in the aggregate – as long as agents are not overwhelmed by too many signals, reducing their incentives to acquire information precisely because signals are no longer that useful to coordinate (Chahrour, 2014).

However, also private noise can create excess market volatility as agents may interpret market movements as a signal of how others understand the announcement's content. This insight has been recently formalized by Gaballo (2016). By updating their interpretation of the content of an announcement based on observed price movements, agents unintendedly also react to random or exogenous price disturbances, thereby amplifying their importance. While agents, as individuals, have an incentive to condition their expectations on market prices, their collective behaviour exacerbates the noisiness of these market prices. Because of this general-equilibrium externality, a release of news liable to subjective interpretation may _increase_ rather than decrease agents' uncertainty about the future course of the economy.

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[5] Our starting point is that the central bank does not want to surprise markets with its actions. The alternative case has been subject to an earlier literature, which has shown that then ambiguity in central bank communication might be optimal (see, e.g., Stein 1989).
[6] These effects have been the object of a large literature dating back to Morris and Shin (2002, 2005, 2008). They have been systematically explored by Angeletos and Pavan (2007) who emphasize that inefficiencies are due to mis-alignments of public and private incentives in the use of information. An application of these findings in the context of central bank communication and financial markets is provided by Morris and Shin (2005, 2008) and Allen et al. (2006). Svensson (2006) has argued, however, that in reality the precision of central bank communication is likely to be sufficiently high to avoid situations where issuing a signal lowers welfare.

To avoid triggering such inefficient market externalities, the central bank should communicate in the most precise way possible. In fact, by reducing the scope for private interpretations of its signals, the central bank reduces the incentive of agents to learn from prices. This principle also applies in settings where agents learn from markets and announcements are commonly but imperfectly understood. For example, Amador and Weill (2010) show that, when agents learn from prices, a public announcement may paradoxically lead to an increase in uncertainty. As prices reflect more public information, agents learn less from prices. In fact, what agents learn from prices is the result of the aggregation of private information, which is crowded out by the presence of public information. However, a sufficiently precise public release eliminates this inefficiency.

Precision is particularly important in periods of elevated uncertainty, such as times of unconventional monetary policy. If uncertainty is high, markets are typically more volatile. The mechanism modelled by Gaballo (2016) is therefore even more powerful: in response to imprecise central bank communication, agents look at market prices for cues about the proper interpretation of the content of the announcement. If markets are relatively volatile, chances are much larger that agents react to random price disturbances, such that their uncertainty about the future course of the economy is more likely to increase.

In bad states of the economy, central bank communication should provide positive signals about the effectiveness of monetary policy, rather than solely stressing the negative outlook. Recent theoretical studies (Angeletos et al., 2016) have shown that communication can lead the economy further away from its first best when it concerns states of the economy that trigger coordination failures. For example, Wiederholt (2016) emphasizes the perverse effect of releasing information about the severity of the crisis when the economy is stuck at the ELB. In such a case more information exacerbates the perils of a deflationary spirals triggered by a liquidity trap, and communication about policy action (e.g. in the form of FG) is required to overcome this effect.

3 Evidence on the Effectiveness of Central Bank Communication in Unconventional Times

Central bank communications have changed considerably since the global financial crisis. Central banks have generally communicated more, for instance in order to explain the new policy tools, or because they resorted to FG as a policy tool. In this section, we first document recent trends in central bank communication, before we analyse how communications about asset purchases and FG were received by financial markets, and how clarity has helped improving their effectiveness.

3.1 Recent Trends in Central Bank Communication

Many central banks, including the ECB, have stepped up their communication efforts once they had resorted to unconventional policies. The intention of the central banks has been to publicly define the scope and implementation of these unconventional policies, as well as to build a common understanding of their effectiveness. While there had already been a trend towards more communication prior to the crisis, this has intensified considerably since.[7] The ECB has not been an

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[7] In their survey among central bank heads and academic economists, Blinder et al. (2017) find that more than 90% of governors in advanced economies and more than 90% of academics feel that communication had intensified since the crisis, and 60% and 75%, respectively, expect these changes to remain, or to go even further.

exception to this rule. To give just one example of its increased communication efforts, since January 2015 it has released regular accounts of the monetary policy discussions of its Governing Council.

As economic uncertainty rose, policy making has become more complex, and disagreement among central bank committee members has increased, leading to a more dispersed communication. Figure 1 shows how the increasing complexity of monetary policy decisions is reflected in the minutes of the central bank committee meetings. Since the crisis, these minutes have become considerably longer, for all central banks that we study (note that the ECB started releasing its accounts in January 2015, such that no pre-crisis comparison is available). The case of the Swedish Riksbank is particularly striking, and in line with an increase in disagreement among the members of its Executive Board.[8] Given the complexity of policy making, it is not surprising that disagreement has risen more generally across central banks. Meade et al. (2015) measure disagreement as expressed in the minutes of the Federal Open Market Committee (FOMC) and report that the diversity of views has increased over time, and particularly so since the financial crisis. The ECB has been no exception: it has become considerably more difficult to implement the one-voice policy of its Governing Council. This raises the question whether more dispersed communication is conducive to "creating news" which help the public better understand how the discussion in the committee and therefore the future course of monetary policy evolve, or whether this could "increase noise" and therefore be counterproductive.[9]

Figure 1: Length of monetary policy minutes
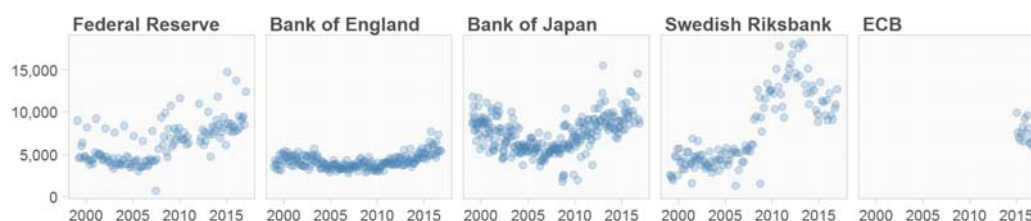
Note: The figure shows the length of the minutes of the meetings of the monetary policy committees of different central banks, measured by the number of words. For the ECB, it measures the length of the accounts of the monetary policy meetings of its Governing Council, which have been released since January 2015.

**The "readability" of central bank statements has varied over time, with the ECB's statements having become somewhat easier to understand.** Figure 2 shows how the introductory statements of the ECB's press conferences (which are used to explain the monetary policy decisions) have evolved over time, both in length and in difficulty of the language employed (proxied by the Flesch-Kincaid reading grade level statistic, which measures the years of formal education that are required to understand the statement, based on the length of its sentences and words). It also provides equivalent figures for the monetary policy statements of the Federal Reserve. A number of points stand out. First, without putting too much emphasis on the exact numbers provided in the figure, it is apparent that central bank statements are rather complex, given an average reading grade level of

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[8] See, e.g., a blog by Lars E.O. Svensson on this issue at http://larseosvensson.se/2014/11/24/major-differences-between-the-majority-and-minority-of-the-riksbank-executive-board/.
[9] There are different views on this, which are nicely summarised by Blinder (2007, p. 114) on the one hand, who states "A central bank that speaks with a cacophony of voices may, in effect, have no voice at all" and by Bernanke (2004) on the other hand, who argues that "the willingness of FOMC members to present their individual perspectives in speeches and other public forums provides the public with useful information about the diversity of views and the balance of opinion on the Committee."

around 13-15 for both central banks.[10] Second, for the case of the FOMC, statements have become considerably longer since the financial crisis, and remarkably more difficult to read, even though that trend has reversed more recently. This is different for the ECB, which might be surprising at first sight. However, it is important to note that the ECB's introductory statements are substantially longer than the FOMC statements and furthermore relatively standardised. This might have led to less variation in length, and possibly also might have helped sustaining the level of readability of the statement.

**Figure 2: Length of ECB/FOMC monetary policy statements and difficulty of language employed**
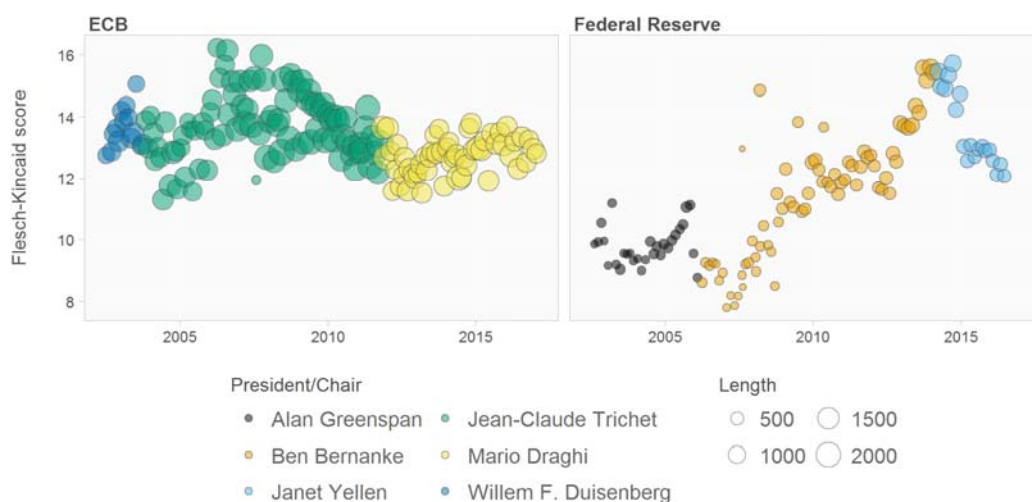
Note: The figure depicts the length of the ECB's introductory statements and the FOMC monetary policy statements, measured by the number of words, through the size of the circles. The difficulty of the language employed is measured by the Flesch-Kincaid reading grade level statistic (which indicates how many years of formal training are required to understand the text, based on the length of its sentences and words). Last observation: March 2017.

Central bank statements have on average become more forward-looking. As central banks have been resorting to FG, one would expect that their communication has become more forward-looking. Figure 3 shows the degree of forward-lookingness of the ECB's and the FOMC's communications, measured following the approach by Galardo and Guerrieri (2017). While the time series for the ECB's accounts does not allow for a pre-crisis comparison, the plot for the introductory statement shows that the post-crisis communications have on average been more forward-looking than the statements just prior to the crisis. However, there remains considerable variation over time also during the FG period, which is in contrast to the Federal Reserve, where the increase in forward-lookingness of the monetary policy statements is more consistent over time. For the Federal Reserve, comparisons over longer time periods are possible, with the minutes reaching back to the late 1930s. Forward-lookingness dropped to historical lows in the 1970s during the Great Inflation, then recovered, but took another dip during the Great Moderation, to rise strongly following the global financial crisis and the Great Recession.

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[10] While these statements are addressed to a specialised audience (which presumably mostly have 13-15 years of formal education), Haldane (2016) has pointed out that the same is true for speeches by policy makers.

Figure 3: The use of forward-looking terms by the ECB and the Federal Reserve
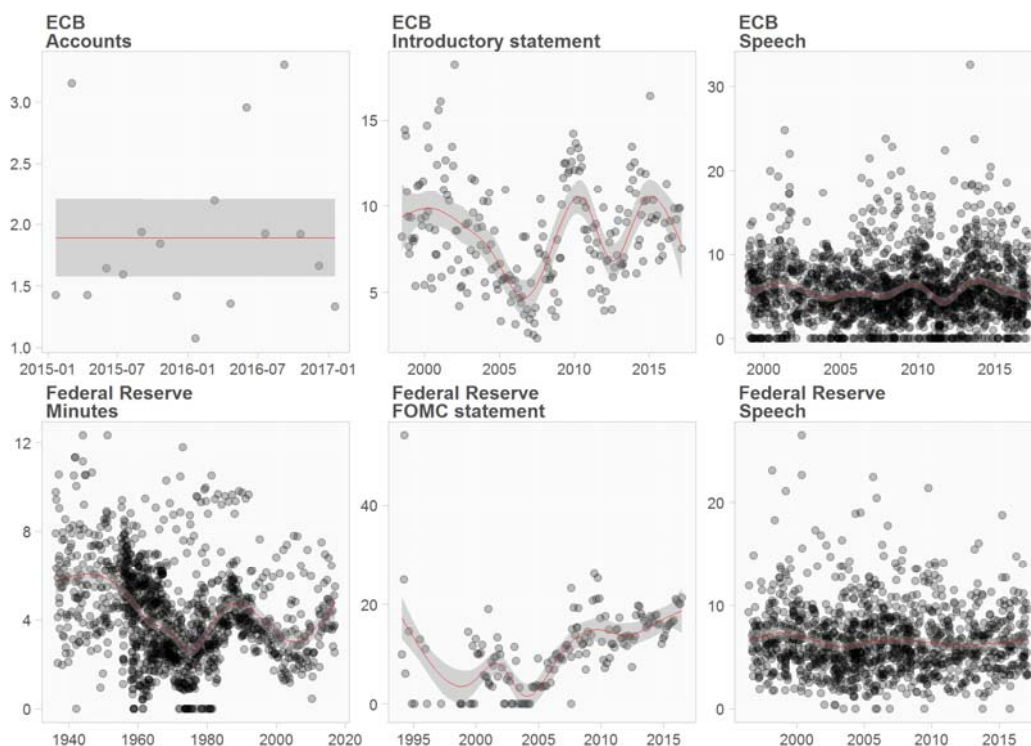
Note: This figure shows the share of forward-looking terms (expect, going to, may, might, shall, will) per 1,000 words in the ECB's accounts, introductory statements and speeches by its Executive Board members and in the Federal Reserve's minutes, policy statements and speeches by the Governors of the Board of Governors. The red lines denote Loess curves (which describe the deterministic part of variation in the data by fitting low-degree polynomials to localized subsets of the data, observation by observation, giving higher weights to observations near the observation concerned), the grey shaded areas show the 95% confidence interval. Last observation: March 2017.

Very recently, the ECB has again commented on the evolution of core inflation in its policy statements. By studying the evolution of core inflation, policy makers can look through transitory price changes when setting monetary policy. Core inflation is used as an operational guide to monetary policy, and regularly commented upon by some central banks (see, e.g., Schembri (2017) for the Bank of Canada). Given the importance of core inflation for the deliberations of policy makers, it is not surprising that it is mentioned regularly and frequently in the minutes. In contrast, both the ECB and the Federal Reserve have referred to core inflation only infrequently in their monetary policy statements (see Figure 4). References to core inflation are clustered, they are made repeatedly for some time before they drop out of the statements for extended periods of time. In the most recent ECB statements, core inflation has been mentioned again, given the divergent movements in core and headline inflation. For instance, the January 2017 introductory statement refers to underlying inflation three times and stresses that the "Governing Council will continue to look through changes in HICP inflation if judged to be transient and to have no implication for the medium-term outlook for price stability."

Figure 4: References to (core) inflation by the ECB and the Federal Reserve
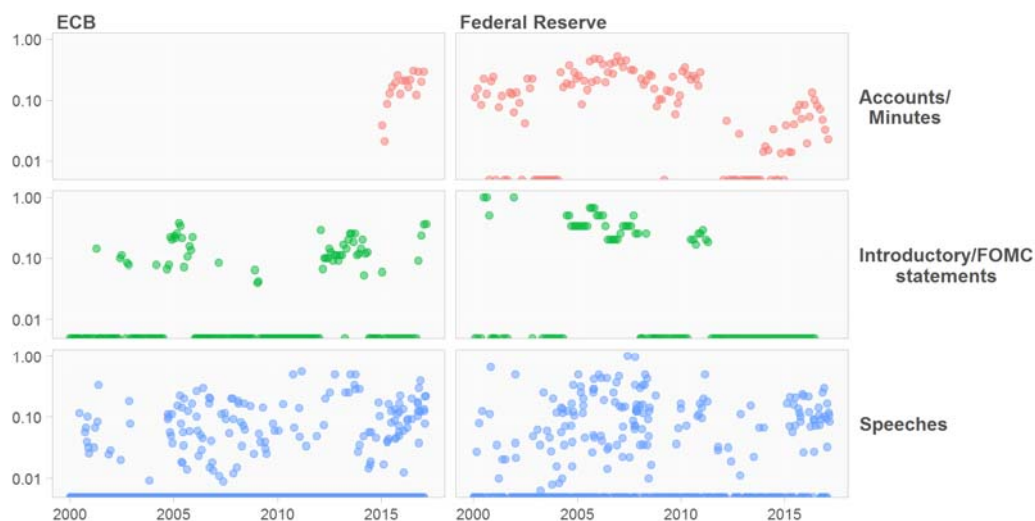
Note: This figure shows the share of references to core inflation in the overall references to inflation in the ECB's accounts, introductory statements and speeches by its Executive Board members and in the Federal Reserve's minutes, policy statements and speeches by the Governors of the Board of Governors. Core inflation is captured by the terms "core inflation", "HICP excluding", "underlying inflation", "underlying price pressures" and "headline inflation". The latter term is included under the assumption that a reference to headline inflation is made in order to distinguish it from core inflation. For the overall references to inflation, we count the terms "inflation" and "HICP". In all instances, it is ensured that references are not double counted. Last observation: March 2017.

The Federal Reserve is one of the few central banks that have started to exit from their unconventional measures, and in so doing has encountered communication challenges. The Federal Reserve has engineered a large-scale easing of monetary policy after the global financial crisis. As soon as there was a first sign that this easing might be coming to an end, volatility in financial markets rose drastically. In the adjacent box "Lessons from the 'taper tantrum'", we study this particular period in more detail. It is important to note that the remarks triggering the taper tantrum suggested that tapering could happen "in the next few meetings" (i.e. gave a very concrete guidance about the envisaged timing), but also had a conditionality attached to it (namely that this would happen "if the labour market is strong"). When the FOMC decided a few months later to delay tapering, the Federal Reserve removed any references to concrete timing, and made it even more explicit how the FOMC would react to incoming data, i.e. clarifying the state-dependency of its actions (see, e.g., Bernanke (2013)).

Box: Lessons from the "taper tantrum"

Remarks by Fed chairman Ben Bernanke on 22 May 2013 that the Fed "could take a step down" in the pace of its asset purchases pushed up market volatility across the globe for several months. On the background of improved economic prospects, these remarks on a tapering of QE3 and their re-affirmation a few weeks later led to the "taper tantrum," a pronounced episode of increased market volatility, particularly in the bond market. Some commentators attribute the market reaction to ineffective communication by the Fed.[11] However, others have argued that at least part of the

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[11] This view is supported by the observed sharp increase in the volatility of market-based measures of expected future policy rates, and a pronounced change in the way asset prices reacted to macroeconomic news (see Kurov and Stan, 2016).

reaction was an unavoidable, because the decision to taper marked a turning point that naturally implies a reversion of previous market developments driven by monetary easing.

In the following, we provide empirical evidence on the role of turning points for the transmission of U.S. monetary policy surprises on term interest rates.[12] More formally, we estimate

$$\Delta R_t^m = \alpha + \beta \Delta MP_t + \gamma TP_t + \delta \Delta MP_t \times TP_t + \varepsilon_t \tag{4}$$

where ΔMP_t is the monetary policy surprise based on the change in Fed Funds Futures in a window of +/- 30 minutes around the relevant FOMC news release, and ΔR_t^m is the contemporaneous change in the treasury bill/bond yield with residual maturity m.[13] Finally, TP_t is a dummy variable that is equal to one on days that are turning points.

Table B1: The effects of monetary policy shocks on interest rates around turning points

	3m	*6m*	*2y*	*5y*	*10y*
β	0.400***	0.436***	0.422***	0.217**	0.076
	(0.110)	(0.116)	(0.118)	(0.108)	(0.080)
$\beta + \delta$	**0.750*****	**0.972*****	**0.894*****	**0.646*****	0.353
	(0.159)	**(0.140)**	**(0.190)**	**(0.226)**	(0.226)
N	210	210	210	210	210

Note: This table depicts the relevant coefficient (sum) estimates for regression equation (4), based on monetary policy shocks and yield changes measured in a +/- 30 minute window around relevant announcements. See Gürkaynak, Sack, and Swanson (2005) for details. Robust standard errors are given in parentheses. The sample period is July 1991 – June 2015. Bold letters for β+δ indicate that the coefficient estimate for δ is statistically significantly difference from zero at the 10% level or better. ***/**/* denote statistical significance at the 1%/5%/10% level.

Our findings confirm that turning points are indeed associated with a stronger financial market reaction to monetary policy shocks. Table B1 contains the estimated effects of "regular" monetary policy shocks (β) as well as shocks associated with turning points ($\beta + \delta$) for various maturities. First, we observe that the effects of "regular" monetary policy surprises are concentrated in shorter maturities up to two years, in line with previous literature (e.g. Gürkanyak, Sack and Swanson, 2005). Second, monetary policy shocks around turning points in monetary policy have a significantly larger impact, in line with the argument that these shocks are predicting a series of future policy changes into the same direction. In particular, we observe that the relative importance of turning points, measured by the ratio $(\beta + \delta)/\beta$, is increasing in maturity. While the extra effect is around 70% for

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[12] Turning points are defined as changes in the policy rate with a sign different from the sign of the previous policy change. As noted by Rudebusch (1995), monetary policy rates are usually changed gradually, so that turning points are likely to signal a number of future changes in the same direction. While our approach closely follows Demiralp and Jorda (2004), we do not restrict our analysis to events where the Fed Funds target was changed, but instead consider all FOMC decisions. Following Demiralp and Jorda (2004), we discard the policy shocks associated with the rate changes in January and September 2001. Our results remain unchanged when restricting the set of policy shocks to dates with changes in the Fed Funds target, and are robust to various definitions of the turning point dummy variable, e.g., including one or two decision dates prior to the actual turning point, thus allowing the Fed to "prepare the market".

[13] We are grateful to Refet Gürkanyak for providing the data.

3-month bills, this increases to around 180% for 5-year bonds. The effect is even stronger for 10-year yields, but statistically insignificant.[14]

Our analysis highlights the importance of clear and effective central bank communication, especially in times when the monetary policy stance is shifting. Naturally, the phasing-out of large-scale asset purchases will inevitably affect financial markets, with disproportionate effects on long-term bond yields. Accordingly, it is important that the effects of such fundamental policy changes are not amplified by unnecessary uncertainty concerning the central bank's reaction function. The central bank might therefore want to be very explicit about the state-contingency of its plans, which is precisely what the Federal Reserve re-emphasised in September 2013, when it decided to delay the tapering of QE.

3.2   Communication of New Policies

Like other central banks, the ECB has made substantial efforts to enhance its communication during the crisis in order to explain the rationale for its unconventional policies, the implementation details and the way the ECB expects the measures to contribute to the transmission of monetary policy. For instance, as part of its unconventional monetary policy, the ECB has embarked on several APPs.[15] Given the novelty of this tool, new announcements were always accompanied by several communication initiatives. One example is the launch of an APP in January 2015, which was *inter alia* explained in the accompanying press conference, in the subsequent ECB's Economic Bulletin and in a speech by Vítor Constâncio, Vice-President of the ECB, in the same month. It is also explained on the educational section of the ECB's website.[16] Furthermore, Draghi (2014) laid out the ECB's reaction function with regard to the usage of its non-standard measures.

APP announcements can be powerful tools to reduce market uncertainty. Figure 5 graphs the daily change in market uncertainty (measured by the VSTOXX index) on each ECB press conference day since 2012. The figure shows that, on average, stock market uncertainty was falling on these days.[17] In particular, volatility decreased markedly following the announcements about the Outright Monetary Transactions (OMT) programme on 6 September 2012, the Public Sector Purchase Programme (PSPP) on 22 January 2015, the Asset-backed Securities Purchase Programme (ABSPP) on 5 June 2014 and about the extension of the Asset Purchase Programme (APP) on 3 September 2015. In contrast, following the announcement of the modalities of the ABSPP and the third Covered Bond Purchase Programme (CBPP3) on 2 October 2014, volatility increased substantially. Figure 6 plots the intraday evolution of the VSTOXX index around the time of the ECB press conference on that day as well as on 22 January 2015, and confirms that the daily effects shown in Figure 5 are indeed due to market movements during the ECB press conference. These stark differences call for an explanation. In order to see what led to the respective market reactions, we will now study the various press conferences in more detail.

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[14] We note that the magnitude of our results is smaller than the effects estimates by Demiralp and Jorda (2004), which suggests that the effects of turning points have become more muted in recent years (their sample spans 1989-2002). Importantly, we show in the Appendix that our results also hold in a panel of 6 advanced economies (excluding the U.S.).

[15] For an assessment of these programmes, see, e.g., Andrade et al. (2016).

[16] The speech is available at http://www.ecb.europa.eu/press/key/date/2015/html/sp150131_1.en.html, the explanation of the APP on the website at http://www.ecb.europa.eu/explainers/show-me/html/app_infographic.en.html.

[17] This has not always been the case. In the period 2002-2006, the average change on ECB press conference days amounted to +0.2%; it was +0.7% in the period 2007-2011, whereas it fell to -3.1% in the period 2012-2016.

Figure 5: Daily change in stock market uncertainty on ECB press conference days
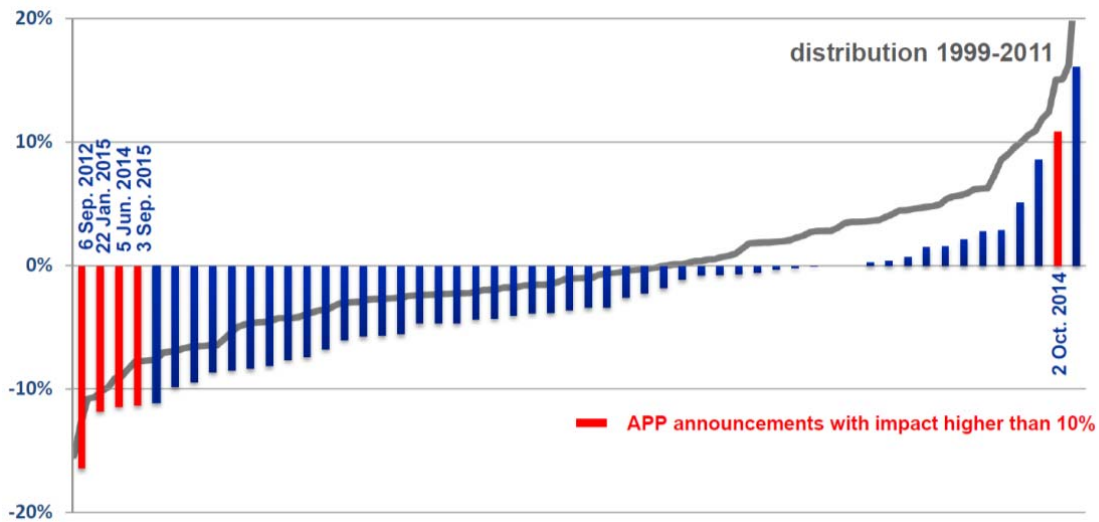
Note: The figure shows the daily change in stock market uncertainty measured by the growth rate of the 30-day VSTOXX index on ECB press conference days since 2012, sorted by size. The black line plots the distribution for the press conference days in 1999-2011. Last observation: March 2017.

Figure 6: Intraday evolution of stock market uncertainty on selected ECB press conference days
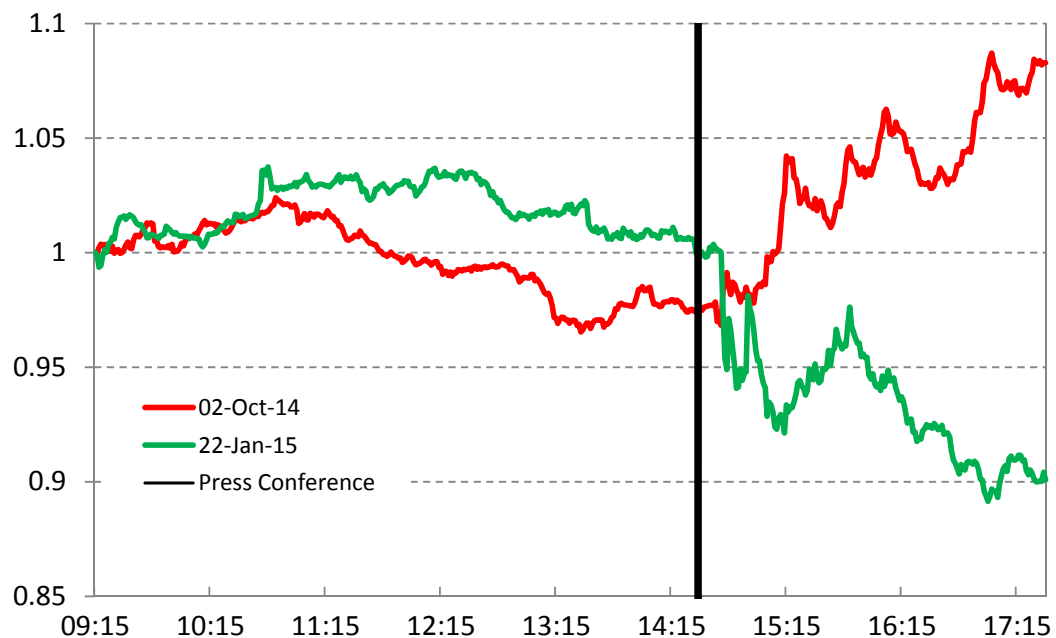
Note: The figure shows the intraday evolution in stock market uncertainty measured by the 30-day VSTOXX index (V2TX, ISIN DE000A0C3QF1), value at 9:15:00 on the respective day standardized to 1. The vertical line shows the beginning of the press conference.

Statements that use a more difficult language raise stock market uncertainty. This finding results from a more formal econometric analysis, results of which are presented in Table 1. Our analysis is based on variants of the regression

$$\Delta V_t = \beta_0 + \beta_1 D_t + \beta_2 FK_t + \beta_3 L_t + \beta_4 \left| s_t^{mp} \right| + \beta_5 \left| \Delta r_t^{DE} \right| + \beta_6 \left| s_t^{jc} \right| + \beta_7 V_{t-1} + \beta_8 V_{t-2} + \varepsilon_t \quad (1)$$

where ΔV_t denotes the daily percentage changes of the euro VSTOXX index, a measure of expected stock market uncertainty, on ECB press conference days. D_t is a set of dummy variables capturing the content of the press conference. FK_t and L_t denote the Flesch Kincaid grade level statistic and the length of the introductory statement, $\left| s_t^{mp} \right|$ and $\left| s_t^{jc} \right|$ the absolute surprise components in the monetary policy decision and the release of the U.S. jobless claims, $\left| \Delta r_t^{DE} \right|$ the absolute change in Germany 2-year government bond yields (which is meant to capture the absolute surprise component in decisions about unconventional monetary policy tools) and V_{t-j} the *j-th* lag of the VSTOXX index.[18] Our results show that the change in the VSTOXX on days with an ECB press conference is considerably larger if the introductory statement is more complex, whereas the length of the statement itself does not seem to matter. This finding is in line with recent literature. Jansen (2011) has shown that the readability of statements by the FOMC chair matter for their reception in financial markets, with clearer statements leading to lower volatility. The same pattern has also been established for the monetary policy statements of the Bank of Canada in Ehrmann and Talmi (2016).

Releasing a clear indication of the envisaged size of monthly purchases is key for APP announcements to reduce uncertainty. Column (2) of Table 1 demonstrates that the announcement of APP measures has produced on average a significant daily reduction of stock market uncertainty of about 3.5%. Distinguishing announcements by the type of information provided, we find that APP announcements with a clear indication of the size of monthly purchases[19] led to a large reduction of expected stock market uncertainty, by about 8% on average. In contrast, announcements with no or only a vague indication of the envisaged size may have only mild effect on stock market uncertainty (see Column 3 and 4 of Table 1).

Not releasing information about the size of a policy intervention may increase market uncertainty. As already discussed, the press conference of 2 October 2014 is a statistical outlier in the sample of APP announcements in that it generated a sizeable *increase* in market uncertainty of about +12% (the sum of the two coefficients -0.031 and 0.153; see column (4) of Table 1). In fact, the ECB had prepared markets for an announcement regarding the modalities of the APP programme on that day. Even though many implementation details were included, the announcement did not provide information on the envisaged size of the programme, disappointing markets.[20] Our analysis

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[18] In line with the announcement effect literature, we interpret our results in a causal manner, which assumes that the ECB's announcements dominate all other events on that specific day.

[19] Our focus is on announcements of the size of monthly purchases, which is why we did not include announcements that kept monthly purchases stable, but announced a new duration of an APP, even though such announcements change the overall size of the programme (such as the announcement of 18 December 2015). We acknowledge that different classifications are possible, but find that our results are robust to a reclassification of a few ambiguous cases.

[20] Following this particular press conference, the Financial Times titled "Draghi's lack of detail on measures disappoints" and writes: "The ECB has cast its net wide in terms of the assets it will consider buying. But the lack of a hard figure from the ECB for the size of the purchases […] fuelled disappointment. Information on the size of the programme was vague, the central bank saying only that it would have a 'sizeable' effect on its balance sheet." See

therefore indicates that the size of a purchase programme is such an essential characteristic of its effectiveness that an announcement that does not provide this information could actually raise uncertainty.

Table 1: Expected Stock Market Uncertainty and the ECB's press conferences

	(1)	(2)	(3)	(4)
Flesch Kincaid reading grade level	0.013***	0.011**	0.011**	0.010**
	(0.005)	(0.005)	(0.005)	(0.004)
Length of statement (1000 words)	0.010	0.008	0.009	0.011
	(0.013)	(0.015)	(0.015)	(0.015)
APP announcement		-0.035**		
		(0.017)		
APP announcement with size			-0.075***	-0.077***
			(0.026)	(0.026)
APP announcement without size			-0.018	-0.031**
			(0.018)	(0.015)
APP outlier 2/10/2014				0.153***
				(0.016)
Observations	191	191	191	191
R^2	0.089	0.114	0.130	0.157

Notes: The table shows results of OLS regressions of daily percentage changes of the euro VSTOXX index on ECB press conference days on the Flesch-Kincaid readability statistic, the length of the introductory statement (in 1000 words) and on APP announcement dummies. The regressions furthermore control for the announcement of "Other UMPs" (a dummy variable that takes the value 1 for announcements of fix-rate tenders with full allotment, long-term refinancing operations, targeted long-term refinancing operations and extensions of the collateral framework), the absolute surprise component in the ECB's decision on policy rates (measured as the difference between the announcement and the mean expectation in a corresponding Bloomberg survey), the absolute surprise component in the release of U.S. jobless claims (measured as the difference between the announcement and the median expectation in a corresponding Bloomberg survey), the absolute change in Germany 2-year government bond yields and the level of the euro VSTOXX index one and two days before the press conference. The dummy variable "APP announcement" covers the CBPP, the OMT, the ABSPP, the extended APP and the Corporate Sector Purchase Programme (CSPP). This dummy is subsequently split into announcements which have been accompanied by information about the envisaged size of monthly purchases ("with size"), those without ("without size") and an outlier on 2/10/2014. Asterisks indicate the level of significance, (*) at the 10%, (**) at the 5%, and (***) at the 1% level. Robust standard errors are shown in brackets.

3.3   Forward Guidance - Communication in Presence of Constrained Policies

After lowering its policy rates to unprecedented levels, the ECB has, like several other central banks, provided FG about its future course of policy. With interest rates at or near the ELB, the public was lacking proper reference points on how monetary policy could possibly evolve, risking that monetary policy would become less predictable. Through their FG, central banks helped managing expectations, thereby fostering predictability and engineering additional stimulus by lowering interest rates at longer horizons.

The form of FG matters for its effectiveness. In this section, we will discuss why FG can be effective, distinguish between the concept of "Odyssean" and "Delphic" FG and provide an overview of how FG has been implemented in practice, namely in the form of open-ended, time-dependent and

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https://www.ft.com/content/66aca742-4a50-11e4-b8bc-00144feab7de. In a Bloomberg survey after the press conference, 67% of respondents express dissatisfaction with the information provided.

state-dependent FG. For the latter type of FG, we will illustrate its workings in a model-based counterfactual analysis for the euro area. Finally, we will report cross-country evidence about the impact of different FG types on the reactiveness of markets to macroeconomic news and on disagreement among forecasters.

3.3.1 Two Concepts of FG: Odyssean vs. Delphic

FG is communication about the future conduct of monetary policy. Its emphasis is on the management of expectations, as opposed to the current setting of a monetary policy instrument. Note that FG can be applied for guidance about different policy instruments. Most frequently, it has been related to the future course of policy rates, but the ECB has also provided FG in relation to its asset purchases.[21]

"Odyssean" FG represents a *commitment* about the future conduct of monetary policy. The central bank will follow through on its (state-contingent) plan even if conditions at a later date might warrant re-optimization.[22] By binding itself in such a way the central bank is able to affect private sector expectations ex-ante (Woodford (2003); Galí (2008)). This allows the central bank to keep inflation close to the target throughout a typical liquidity trap episode, and even in the face of strong and persistent deflationary headwinds.

In standard monetary policy models, credible Odyssean FG constitutes a powerful tool in the context of the ELB, even though the magnitude of its effect is debated. In standard models, anticipated monetary policy can generate very large changes in prices and activity, a property that has been called the "forward guidance puzzle" (Del Negro et al. (2015)). If the private sector was less forward-looking than standard models assume, e.g. due to "bounded rationality", promises about keeping the interest rate low in the future would have less of an effect on price setting, demand and output today (Gabaix (2016)). Also, the promise needs to be credible. The private sector might perceive a time-inconsistency of the policy and assume that the central bank will be reneging on its promise and start raising the interest rate sooner than promised. In such a case, long-term interest rates will not fall as desired.

Odyssean FG implies no sizable inflation overshoot once the interest rate recovers from the ELB. The commitment is only for a mild and transitory overshoot of inflation, even in the face of sizable and persistent deflationary forces. The reason is that inflation above the target is just as costly to the central bank as inflation below the target. There is, however, a commitment to a non-negligible (though relatively short-lived) output boom upon exit from the ELB, which translates into higher demand, output, and inflation earlier on in the liquidity trap episode.

Odyssean FG entails a state-dependent commitment. Figure 7 shows that lift-off of the nominal interest rate depends on the value of the natural real interest, regardless of the exact past commitment policy of the central bank. The more severe the recession that the central bank has been facing in previous periods, the more binding the ELB, and the more the inflation target was undershot, the stronger the commitment that the central bank will have expressed (modelled by

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[21] Indeed, optimal policy typically involves an interior solution using a "mix" of all available instruments. Thus, an APP may be backed by FG about the policy interest rate. At the same time, asset purchases may serve as a commitment device to enhance the effectiveness of FG on policy rates.

[22] The distinction between Odyssean and Delphic FG goes back to Campbell (2013).

increasing values of ϕ_{t-1} in the figure). However, in all cases is lift-off a function of the natural real interest.

Figure 7: State-contingency of Odyssean FG
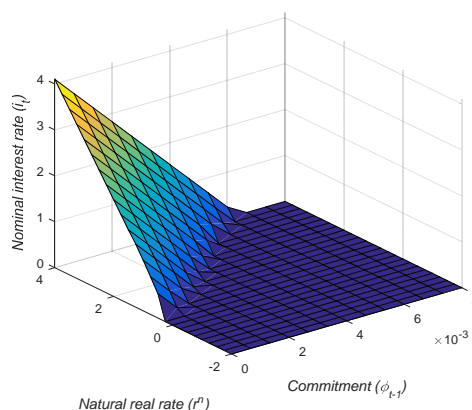
Note: This figure illustrates the state-contingency of Odyssean FG. It shows how the central bank will set the nominal interest rate (i_t) in time period t depending on its *past* commitment policy, summarized by the variable ϕ_{t-1}, and the natural real interest rate in time period t, denoted by r^n_t. The more severe the recession that the central bank has been facing in previous periods, the more binding the ELB, and the more the inflation target was undershot, the stronger the commitment that the central bank will have expressed (leading to a larger ϕ_{t-1}), implying that lift-off of the nominal interest rate occurs only at higher values of the natural real interest rate.

"Delphic" FG, in contrast, is guidance about the *likely* future course of policy instruments, and exerts smaller effects. With Delphic FG, the central bank only communicates its forecast, reserving the right to re-optimize its plan in every future period. Hence it *need not* follow the predicted path of interest rates should circumstances change. In standard model-based analysis there is a substantial difference between Odyssean FG and Delphic FG in terms of outcomes (see Figure 8).[23] At the ELB, under Delphic FG, inflation undershoots the target substantially and for an extended period of time, even if the central bank is able to set policy optimally under discretion.

Figure 8: Odyssean vs. Delphic FG in a simulated liquidity trap episode
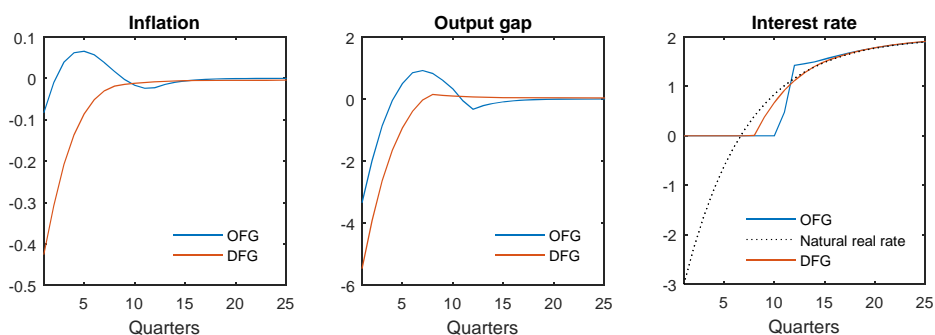
Note: The figure shows the evolution of inflation, the output gap and the nominal interest rate in response to a shock that takes the natural real interest rate initially to -3%. Under Delphic FG (red lines) this shock generates a substantial undershooting of inflation and output with respect to target inflation and potential output. In contrast, under Odyssean FG (blue lines) the output gap and especially inflation are much better stabilized due to the benefits of commitment. In this particular case the nominal interest rate is held at the zero lower bound for a few quarters longer under Odyssean FG.

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[23] Eggertsson, G.B. and M. Woodford (2004); Nakov, A. (2008); Adam, K. and R. Billi (2006); Adam, K. and R. Billi (2007).

In practice, and especially if economic agents have incomplete information, it is hard to tell the difference between Odyssean and Delphic FG. Even in the absence of commitment, the central bank may forecast an extended period of low interest rates because fundamentals are expected to be weak for a long time or because there is great uncertainty surrounding the recovery (Nakov (2008); Schmidt (2013)). Statements that the central bank "expects interest rates to remain low" do therefore not necessarily imply commitment and may instead be interpreted as a forecast. This Delphic interpretation, however, would preclude the benefits of Odyssean FG and may even be counter-productive (namely if agents adjust their inflation expectations downward in response to what is perceived to be a pessimistic central bank forecast, see Andrade et al. (2015)).

3.3.2 Open-ended, Time-dependent or State-dependent?

In practice, central banks have used different specifications of FG. The specification of FG used can signal different degrees of commitment and therefore have implications for its benefits.

Open-ended FG is likely to have only small effects. Open-ended, or purely qualitative FG takes the form of the publication of official policy rate projections or the release of qualitative statements about the future course of monetary policy. An example of this is the ECB's statements "we expect the key ECB interest rates to remain at present or lower levels for an extended period of time", used until January 2016. While such projections or statements on the *expected* rate path imply less of a risk for the credibility of the central bank, they might also be less effective, as they can easily be interpreted as Delphic and therefore not containing any commitment.

Time-dependent FG can be designed to contain different degrees of commitment, depending on the exact wording. Time-dependent (or "calendar-based") FG expresses the likely future path of the policy instrument as a function of calendar time. The Bank of Canada, from April 2009 until April 2010, used a relatively strong formulation by stating that "conditional on the inflation outlook, it commits to hold the current policy rate until the end of the second quarter of 2010". In contrast, in its statements between August and December 2011, the FOMC said "The Committee […] currently anticipates that economic conditions […] are likely to warrant exceptionally low levels for the federal funds rate at least through mid-2013". Whereas the Canadian communication explicitly refers to a commitment, the U.S. example resembles a Delphic FG, due to the words "currently anticipates" and "conditions are likely to warrant".

State-dependent FG is closest in spirit to Odyssean FG and is less rigid than time-dependent FG, as economic agents endogenously adjust their expectations in light of new economic developments. State-dependent (or "data-based") FG states how future changes to the policy instrument depend on specific new economic information. For example, in its December 2012 statement the FOMC communicated that its low policy rates were appropriate "at least as long as the unemployment rate remains above 6-1/2 percent, inflation between one and two years ahead is projected to be no more than a half percentage point above the Committee's 2 percent longer-run goal, and longer-term inflation expectations continue to be well anchored." The spirit of such statements is closest to Odyssean FG, which (as shown above) itself also is state-contingent. It can be expected that economic agents endogenously adjust their expectations about the future path of the policy instrument in light of new economic developments.

State-dependent FG creates a trade-off between simplicity and accuracy. If the central bank provides a relatively simple state contingency that is easy to communicate, its message might turn out to be too simple in the end, requiring the bank to "renege". This was the case for the FOMC, which saw unemployment rates drop below 6.5%, but partly for the wrong reason (namely an unexpectedly large decrease in labour force participation), leading the FOMC to remove the unemployment threshold from its FG. On the other hand, if it lists a multitude of indicators to be considered, accurate and intelligible communication of the contingency might prove impossible, especially if the different indicators point in opposite directions.

State-dependent FG can generate additional accommodation and also fewer surprises. To achieve this, the contingency should be in line with several principles:

- Consistent with the central bank's mandate
- Based on a set of indicators that delivers robust results
- Based on a set of indicators that is reliable and available in real time
- Based on a set of indicators that is easy to communicate
- Based on a set of indicators that is independently verifiable

For the ECB, consistency with the central bank's mandate implies that state-dependencies should relate to inflation, possibly in the form of an inflation threshold. Inflation threshold-based FG has some distinct advantages over the threshold-based policies followed by other major central banks. The Federal Reserve and the Bank of England both relied on thresholds for a real variable, namely the unemployment rate, which ex post proved unreliable as a comprehensive measure of labour market slack. By contrast, a threshold for inflation respects the ECB's mandate and provides a direct link to its primary price stability objective. Furthermore, inflation is a reliable indicator that is available with short lags and that is also independently verifiable.

A robust implementation of state-dependent FG could be achieved by relying on a set of inflation-related indicators that also cover measures of core inflation. While being well aligned with the ECB's quantitative definition of its price stability objective, focusing exclusively on annual HICP inflation to define the state-contingency would make the FG vulnerable to transient factors such as energy and food price fluctuations. Including measures of underlying inflation would better capture the medium-term orientation of the ECB's monetary policy strategy, while also mitigating concerns about the undue influence of transient factors. An exclusive focus on inflation expectations would give rise to a number of other critical implementation issues. For example, using inflation projections by ECB staff would not enable the private sector to independently verify the fulfilment of the contingency. Relying on survey or market-based measures of inflation expectations would instead entail the risk of inflation expectations becoming self-fulfilling and monetary policy being indeterminate.[24] Further to these considerations, and in order to remove monetary accommodation only once inflation developments are sustained, it is important to define a threshold variable that does not react to short-term developments, which could be achieved by defining the relevant threshold as an average over some consecutive quarters. This has the additional advantage of bringing the conditionality closer in spirit to the concept of Odyssean FG, which entails history-

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[24] For the pitfalls of orienting monetary policy towards private sector expectations, see Bernanke and Woodford (1997).

dependence and does not let bygones be bygones as in a purely forward-looking inflation targeting regime. Weighing these factors suggests that a state-dependent FG should give prominence to measures of core inflation, such as annual HICP inflation excluding energy and food, while not neglecting the information contained in other inflation indicators.

Risks that inflation threshold-based FG may create higher inflationary momentum than desired – through its impact on inflation expectations – can be held in check by suitable "knock-out" conditions. For example, the inflation threshold defined in terms of reaching a certain level for average core inflation could be complemented by an upper threshold for the ECB's two-year-ahead staff projection of HICP inflation or for private sector inflation expectations two years ahead with a view to providing insurance against the risk of an undue overshooting of inflation developments over the medium term.[25] Such an additional knock-out element featured also prominently in the threshold-based FG policies of the Federal Reserve and of the Bank of England. However, the before-mentioned caveats of lack of verifiability in the case of using the ECB's own staff projection and of circularity in the case of relying on private sector expectations would apply again.

3.3.3 Illustrating the Workings of State-dependent FG

Counterfactual simulations of the hypothetical adoption of an inflation threshold-based FG policy by the ECB can illustrate how state-dependent FG could work in the euro area context. The simulations are conducted with the ECB's New Area-Wide Model (NAWM), which is regularly used in the quarterly macroeconomic projection exercises undertaken by ECB staff.[26] The simulations are carried out around the baseline of the March 2016 ECB staff Macroeconomic Projection Exercise (MPE), which foresaw consumer price inflation to hover at levels close to zero at the start of the projection horizon and to only very gradually adjust towards levels closer to 2%.[27] In the counterfactual simulations, the short-term nominal interest rate is assumed to follow its MPE baseline path, but to remain at a lower bound as long as the annual inflation rate stays below the threshold value. Once inflation has crossed the threshold level, the interest rate is lifted with a one-quarter delay and set in accordance with a simple Taylor-type interest rate rule. Throughout the simulations, it is assumed that the FG policy is fully understood by the private sector and perfectly credible, so that the effects in the simulations are likely to provide an upper bound for the potency of state-dependent FG.
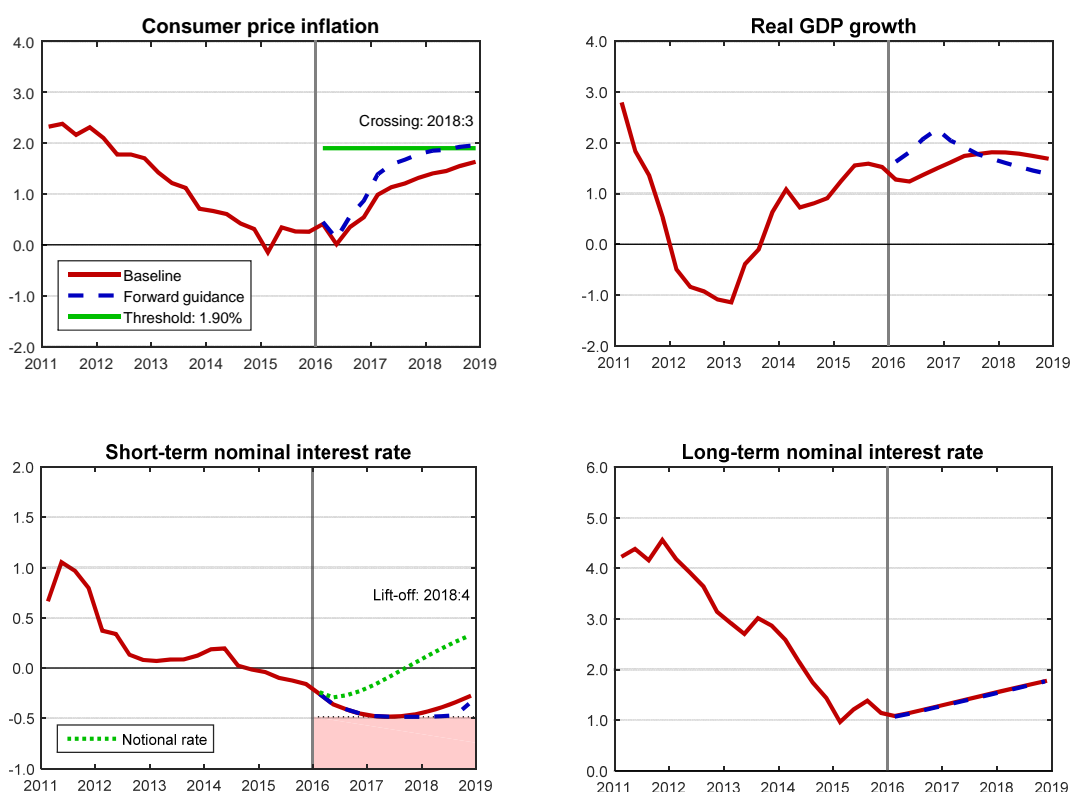
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[25] For an illustration and quantitative assessment of such an insurance strategy, see Coenen and Warne (2014).

[26] For a description of the NAWM, see Christoffel et al. (2008). To account for the portfolio balance effects of the ECB's asset purchases and their transmission via the financial intermediary sector, the NAWM has been augmented with a long-term interest rate variable and an implicit lending rate. The long-term interest rate is determined according to the expectations hypothesis of the term structure as the sum of current and expected future short-term rates, plus a term premium depending on the (exogenous) stock of assets purchased. The implicit lending rate is equal to a weighted average of the short and the long-term interest rate, plus an exogenous risk premium. Furthermore, in an attempt to capture the impairment of the interest rate channel of monetary policy transmission and the observed flattening of the Phillips curve in the aftermath of the financial crisis, the interest rate sensitivity of private spending has been lowered and the inertia in firms' price adjustment decisions has been increased in the current application, respectively.

[27] For details, including on the effects of the ECB's asset purchases, see ECB (2016) and Praet (2016).

Figure 9: Effects of inflation threshold-based FG

Consumer price inflation

Crossing: 2018:3

Baseline
Forward guidance
Threshold: 1.90%

Real GDP growth

Short-term nominal interest rate

Lift-off: 2018:4

Notional rate

Long-term nominal interest rate

Note: Counterfactual simulation based on the NAWM. The vertical lines indicate the starting date of the March 2016 MPE. Consumer price inflation and real GDP growth are reported as annual rates of change, in percentages, whereas the short-term interest rate (corresponding to the three-month EONIA) and the long-term nominal interest rate (corresponding to the average euro area ten-year nominal government bond yield) are reported as annualised percentages. Once annual consumer price inflation crosses the threshold level of 1.9% and the short-term nominal interest rate is lifted with a one-quarter delay, the short-term rate follows the prescriptions of a Taylor rule: $r_t = 0.9\, r_{t-1} + 0.1\,(1.5\, \pi_t + 0.5\, y_t)$, where r_t and π_t denote percentage-point deviations of the annualised short-term interest rate and the annualised quarterly inflation rate from their respective steady-state values, and y_t represents the output gap.

The counterfactual simulations suggest that the adoption of inflation threshold-based FG would shift the inflation path upwards and bring forward the adjustment of inflation towards levels close to 2%. In a first counterfactual simulation the inflation threshold relates to annual consumer price inflation and is set equal to 1.9%. Figure 9 shows the March 2016 MPE baseline paths (red solid lines) for consumer price inflation (measured in terms of the private consumption deflator), real GDP growth, and the short and the long-term nominal interest rate. In the counterfactual simulation (blue dashed lines), inflation crosses the threshold level of 1.9% (green solid line in the top-left panel of the chart) in 2018:3. Accordingly, the short-term nominal interest rate is lifted from its lower bound (marked by the pink-shaded area in the bottom-left panel) in 2018:4. The slightly lower short-term interest rate towards the end of 2018 and expectations of higher inflation lead – via the implied fall in the ex-ante real interest rate – to an increase in current private spending at the expense of future spending.[28] As a result, real GDP growth is temporarily boosted above its baseline

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[28] Keeping the short-term nominal interest rate at the ELB for longer in a state-dependent manner leads to different responses of macroeconomic variables than doing so in a non-state-dependent and purely time-dependent manner. In

path, and the output gap is closing at a faster pace. This gives rise to heightened cost pressures which, along with a moderate depreciation of the nominal effective exchange rate of the euro, further accelerates the adjustment in inflation.

Comparing the distance between the baseline interest rate path and a "notional" interest rate path provides intuition for the appreciable macroeconomic impact of adopting inflation threshold-based FG. The green dotted line in the bottom-left panel of Figure 9 shows how interest rates would normally be set according to the assumed Taylor rule if inflation and the output gap were to evolve as calculated in the counterfactual simulation. The path of this "notional" interest rate is considerably higher than the path implied by the threshold-based FG policy. Hence, the short-term interest rate path in the counterfactual simulation implies a sizeable effective easing of monetary policy against the more favourable ex-post outcomes for inflation and the output gap.

At a more fundamental level, the stimulus of the inflation threshold-based FG rests on the mobilisation of the expectations channel of monetary policy. To the extent that the announced inflation threshold is fully credible, the central bank is able to engineer a rise in inflation expectations. As long as private sector price and wage-setting behaviour is at least moderately forward looking, this rise in expectations shifts the actual inflation path upwards, while the short-term interest rate remains at the ELB for longer. In so doing, adopting an inflation threshold causes a marked easing of the monetary policy stance through the implied decline in ex ante real interest rates, over and above the stimulus coming from lower nominal interest rates themselves.

Figure 10: Effects of FG based on alternative threshold variables and alternative specifications
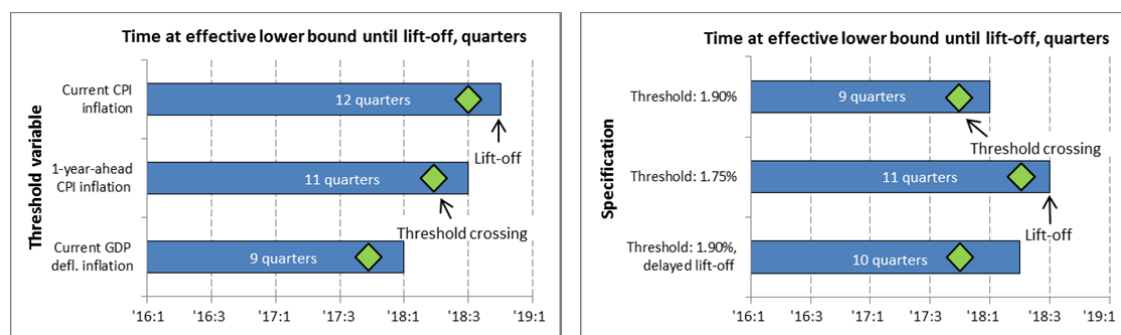
Note: Counterfactual simulations based on the NAWM. The blue bars represent the time period from the starting date of the March 2016 MPE to the lift-off date for the short-term nominal interest rate in the counterfactual simulations of inflation threshold-based FG. The green diamonds indicate the date of crossing the threshold level by the threshold variable. The left panel shows simulations with the threshold variable being specified in terms of alternative inflation measures, whereas the right panel shows simulations for alternative specifications related to a GDP deflator-based threshold.

The choice of the threshold variable matters for the effects of inflation threshold-based FG. The benchmark simulation in which the threshold variable is defined in terms of current consumer price inflation is compared to two alternative counterfactual simulations where the threshold is defined either in terms of current GDP deflator inflation or in terms of one-year-ahead consumer price inflation. GDP deflator inflation can be considered as a measure of underlying inflationary pressures,

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particular, state dependency helps to attenuate the "forward-guidance puzzle" documented for New-Keynesian macroeconomic models like the NAWM (Del Negro et al. 2015).

or of core inflation, that is more resilient to transient factors than headline consumer price inflation and therefore helps focusing the threshold-based FG policy on the shocks driving inflation developments over the medium term. In a similar vein, using projections, or expectations, of future consumer price inflation as the threshold variable, as opposed to current inflation, helps ensuring the medium-term orientation of the FG policy. The left panel in Figure 10 shows the timings of the threshold crossing and interest rate lift-off events in the three different simulations. Under the two alternative simulations, lift-off is brought forward: to 2018:3 when the threshold is defined in terms of one-year-ahead consumer price inflation; and, even more so, to 2018:1 when the threshold is defined in terms of current GDP deflator inflation. This comes along with somewhat smaller (larger) peak effects on both consumer price inflation and real GDP growth for the case of one-year-ahead consumer price inflation (current GDP deflator inflation).[29]

The effects of threshold-based FG are also influenced by pertinent specification details, including the choice of the threshold level and the conditions for interest rate lift-off. For the GDP deflator-based threshold, the right panel of Figure 10 shows how the timings of the threshold crossing and interest rate lift-off vary when the threshold level is lowered from 1.9% to 1.75%, and when lift-off is further delayed from one to two periods after the inflation threshold has been initially crossed. In the case of the reduced threshold level, the dates of crossing the threshold and lift-off are shifted backwards by two quarters to 2018:2 and 2018:3, respectively, whereas the peak effects on both consumer price inflation and real GDP growth are smaller. In contrast, in the case the threshold level needs to be surpassed for one more quarter, monetary stimulus is provided for longer, resulting in somewhat stronger peak effects on both consumer price inflation and real GDP growth, with the threshold crossing and interest-rate lift-off events occurring in 2017:4 and 2018:2, respectively.[30]

3.3.4 The Track Record of FG

The track record of FG as implemented in recent years is mixed. Many FG statements avoided explicit commitment, resembling Delphic FG. Furthermore, given the limited experience with this policy tool, central banks and the public, and in particular markets, had to converge to a joint assessment on what information (and commitment) these statements actually entailed.

There is evidence that FG can be an effective tool for influencing medium- and long-term interest rates through expectations on the future policy path. Evidence from the time before the current near-zero rate environment shows that the long end of the term structure is generally more affected by communication via FOMC statements than by changes in current policy rates. A number of event studies pertaining to more recent policy communications using more explicit FG largely corroborate these effects, although the effects on long-term rates are estimated to be more modest.[31]

In contrast to the effects on interest rates, the adjustment of professional forecasts appears sometimes inconsistent with the additional accommodation. There is evidence that professional forecasters adjust their forecasts downward in response to the issuance of FG (Campbell et al.

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[29] For details regarding the quantitative effects on consumer price inflation and real GDP growth, see the left panel in Figure A.4 and panels A and B in Figure A.5 in the appendix.

[30] For further details, see the right panel in Figure A.4 and panels B to D in Figure A.5 in the appendix.

[31] See Gürkaynak, Sack, and Swanson (2005). Additional evidence is provided e.g. in Bernanke, Reinhart, and Sack (2004).

(2012)). This "paradox" is attributed to most FG being "Delphic" and thus providing negative news about the future state of the economy.

The specification of FG affects its effectiveness. To show this empirically, we distinguish the three types of FG: state-dependent FG, open-ended FG, and time-dependent FG.[32] We further distinguish time-dependent FG regimes by their (remaining) horizon of guidance at each point in time, and test how the responsiveness of bond yields to macroeconomic surprises and the disagreement among economic forecasters depend on the specification of FG.

3.3.4.1 The responsiveness of bond yields to macroeconomic surprises

If FG is effective in managing expectations about the future course of monetary policy, markets should generally be less responsive to macroeconomic news. This has been documented by Swanson and Williams (2014a) and Feroli et al. (2016) for the United States, and by Swanson and Williams (2014b) for the UK and Germany.

The responsiveness should also differ depending on the FG specification in place. Open-ended and time-dependent FG would dampen the response of bond yields to macroeconomic news surprises, whereas state-dependent FG would maintain it to some extent. These hypotheses would be applicable if the FG was indeed perceived as Odyssean. Of course, this condition need not hold, complicating the interpretation of the results of any corresponding empirical test. For this purpose, we estimate the fixed-effects model

$$\Delta R_t^{c,i} = \alpha^{c,i} + \alpha_{SG} SG_t^c + \alpha_{OG} OG_t^c + \alpha_{LTG} LTG_t^c + \alpha_{STG} STG_t^c +$$

$$\beta s_t^{c,i} + \beta_{SG} SG_t^c s_t^{c,i} + \beta_{OG} OG_t^c s_t^{c,i} + \beta_{LTG} LTG_t^c s_t^{c,i} + \beta_{STG} STG_t^c s_t^{c,i} + \varepsilon_t^{c,i}, \qquad (2)$$

where $\Delta R_t^{c,i}$ is the contemporaneous change in the two-year sovereign bond yield in country c around the release time t of indicator i.[33] The surprise $s_t^{c,i}$ is the difference between the expected and the released value of the macroeconomic indicator i for country c at time t. The dummy variables for the different FG regimes equal unity if the central bank of country c in period t follows state-dependent (SG_t^c), open-ended (OG_t^c) or time-dependent FG with a remaining horizon of more than 1.5 years (LTG_t^c) or less than 1.5 years (STG_t^c), respectively. We restrict the sample to ELB periods (which we define to be periods where the policy rate is at or below 1%), because the impact of macroeconomic surprises on bond yields is expected to be muted if interest rates are at the lower bound.[34]

The types of FG differ systematically in how effectively they break the link between macroeconomic news and bond yields. As columns (1) and (3) of Table 2 show, long-horizon time-

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[32] For details about the criteria of our classification, see Appendix A.1.

[33] In contrast to typical event studies (e.g. Balduzzi, Elton, and Green, 2001) we pool a set of indicators from multiple countries in a single regression. See appendix A.2 for details. We use daily sovereign bond returns from Datastream with two years to maturity available for Canada, Czech Republic, Germany, Italy, Japan, Norway, Sweden, UK, and USA. Further, we use intraday returns during a symmetric 120 minute window around the announcement event. For this, we obtain tick-by-tick data for sovereign bonds with two-year time to maturity for the countries Canada, Germany, Italy, Japan, Sweden, UK, and USA.

[34] Swanson and Williams document this decline in responsiveness for Eurodollar futures and US Treasury (Swanson and Williams, 2014a) and for UK Gilts and German Bunds (Swanson and Williams, 2014b). They study each country separately, without an explicit distinction between FG and ELB episodes. In our sample, the surprise impact of the announcements shrinks by about two-thirds during ELB periods.

dependent FG mutes the market responsiveness to macroeconomic news almost completely. State-dependent FG lowers it, but does not fully eliminate it. Open-ended FG has no effect, whereas short-horizon time-dependent FG amplifies the responsiveness. This suggests that time-dependent FG with long horizons has been sufficiently credible to shift market perceptions about the central bank's reaction function, a finding that is in line with the evidence provided by Femia et al. (2013) for the United States. State-dependency seems to have gone some way in this direction: it muted the market impact of macroeconomic news, but not fully. This is plausible, because markets should still be responsive to those macroeconomic news that relate to the state-contingency (e.g. unemployment in the case of the Federal Reserve and the Bank of England), but might not be responsive to news that are unrelated to the state contingency, thereby leading to an overall muted, but not insignificant responsiveness. Open-ended FG, in contrast, retains the original market responsiveness, which can be interpreted as markets perceiving the FG to be Delphic (i.e., the regular central bank reaction applies). Finally, the increased market responsiveness under short-horizon time-dependent FG is somewhat puzzling: the central bank announces that it will keep short-term rates stable for a while, yet already at a two-year maturity, interest rates are highly responsive to incoming news about the economy. This suggests that at such short FG horizons, markets see through the FG and already try to form expectations about the future conduct of monetary policy beyond this horizon.

Table 2: Net market impact of macroeconomic news under different types of FG

	Daily data			Intraday data		
	Overall (1)	No APP (2a)	With APP (2b)	Overall (3)	No APP (4a)	With APP (4b)
STG ($\beta + \beta_{STG}$)	**1.25***** (**0.26**)	**1.91***** (**0.29**)	0.25 (0.30)	**1.08***** (**0.14**)	**1.44***** (**0.16**)	0.51*** (0.18)
OG ($\beta + \beta_{OG}$)	0.44** (0.18)	0.33* (0.18)	0.51* (0.26)	0.51*** (0.16)	0.38** (0.17)	0.56*** (0.20)
No FG (β)	0.41** (0.18)	0.41 (0.25)	0.41** (0.18)	0.47*** (0.14)	0.45** (0.18)	0.51** (0.21)
SG ($\beta + \beta_{SG}$)	0.22* (0.12)	n.a.	0.22* (0.12)	**0.11** (**0.07**)	n.a.	**0.11** (**0.07**)
LTG ($\beta + \beta_{LTG}$)	**0.08** (**0.09**)	0.19 (0.21)	**0.05** (**0.09**)	**0.13*** (**0.07**)	0.25 (0.24)	**0.12*** (**0.07**)
Observations	5120	5120		4739	4739	
R^2	0.01	0.02		0.03	0.03	

Note: This table shows net surprise impact based on the coefficient estimates of the fixed effects model. The dependent variable in columns 1 and 2a/2b is the daily change, in columns 3 and 4a/4b the intraday (symmetric 120 minute window around event) change in two-year sovereign bond yields in basis points. Sample covers Canada, Germany, Italy, Japan, Sweden, UK and US for intraday, and additionally Czech Republic and Norway for daily frequency. Surprises cover business confidence, consumer confidence, CPI inflation, GDP growth, industrial production, nonfarm payrolls, purchasing manager index, retail sales, unemployment. Only periods at or below the ELB of 1%. Therefore, observations for most countries are only at or after the year 2009, with two exceptions Japan (earliest observation in the year 2000) and USA (earliest observation in the year 2003). State-contingent FG only observed during APP periods. Country-indicator fixed effects, FG and APP effects and their interactions, and constant not reported. Standard errors clustered at the country-indicator level in parentheses. Bold numbers indicate that the coefficient estimate of a given FG regime, β_X, is significant at a 10% level. Asterisks indicate the level of significance, (*) at the 10%, (**) at the 5%, and (***) at the 1% level.

The existence of an APP mutes the perverse effect of short-horizon time-dependent FG and strengthens the effect of long-horizon time-dependent FG. Some authors argue that if the central bank embarks on an APP, this can act as a commitment device to keep interest rates low for an

extended period, thereby adding credibility to the FG about policy rates (Clouse et. al. 2003, Eggertsson and Woodford 2003). To test this hypothesis, we distinguish the effects during and outside of APP periods. We do so by interacting every term in regression (2) with an APP indicator variable.[35] Table 2 reports the coefficients on the triple-interactions of FG regime with the APP indicator and the surprise for periods without an APP in columns (2a) and (4a) and for periods with an APP in columns (2b) and (4b). While markets are looking through short-horizon FG and are highly responsive to news, this is much less the case in the presence of an APP, suggesting that the APP lends credibility to the FG regime. At the other end of the spectrum, the existence of an APP also appears to strengthen the effect of long-horizon time-dependent FG. If both an APP and a long-horizon time-dependent FG point in the same direction, this sends a very clear signal. Open-ended FG, however, remains as ineffective during an APP as it is otherwise.

Overall, the results suggest that time-dependent FG over a short horizon and open-ended FG can add (Delphic) uncertainty rather than assuring markets of a policy path. FG is therefore not a universal policy tool, but is effective if contingent on explicit, verifiable criteria, with its credibility being aided by the existence of an APP.

3.3.4.2 Disagreement across forecasters in the presence of FG

Another way to test the effectiveness of FG in managing expectations is to study its impact on forecaster disagreement. Andrade et al. (2015) have shown that under FG, forecaster disagreement about future interest rates is reduced, although disagreement about the future macroeconomic outlook has increased. We will now extend their analysis to see whether these effects differ depending on the type of FG. For this purpose, we follow Ehrmann (2015) and estimate variants of the model

$$\Omega_t^{c,i} = \alpha^{c,i} + \alpha_t + \alpha_{SG}SG_t^c + \alpha_{OG}OG_t^c + \alpha_{LTG}LTG_t^c + \alpha_{STG}STG_t^c + +\varepsilon_t^{c,i} \tag{3}$$

where $\Omega_t^{c,i}$ is the interdecile range of one-year ahead forecasts of macroeconomic variable i in country c, as provided in the Consensus Economics forecast conducted in month t. We cover forecasts for three-month interest rates, 10-year government bond yields, consumer price inflation (percent change per annum) and real GDP growth (percent change per annum). $\alpha^{c,i}$ denotes country-variable fixed effects, and α_t time fixed effects.[36] All other variables denote FG dummies and are defined as in the previous section. We estimate separate regressions for the different macroeconomic variables i. As before, we restrict the sample to ELB periods (which we define to be periods where the policy rate is at or below 1%), because the disagreement and the impact of FG could well be different if interest rates are at the lower bound.

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[35] The APP indicator variable is unity if country c has an active APP at time t and is zero otherwise. Among the economies in our sample, Canada, the Czech Republic, and Norway never adopted an APP. APP in the euro area started on 22/01/2015, in Japan on 05/10/2010, in Sweden on 11/02/2015, in the UK on 19/01/2009 and in the USA on 25/11/2008. We consider APP as active as long as any principal is reinvested at maturity; therefore all five APP programs are active at the time of writing this paper.

[36] We cover Canada, the Czech Republic, the euro area, Japan, Norway, Sweden, the UK and the United States. The models are estimated by ordinary least squares. We calculate Driscoll and Kraay (1998) standard errors, which allow for heteroskedasticity, autocorrelation up to a maximum lag order of 12, and cross-sectional correlation. The one-year-ahead forecasts for inflation and real GDP are calculated from calendar-year forecasts following Dovern et al. (2012).

Table 3: FG and forecaster disagreement

	3-month rates			10-year rates		
	Overall	*No APP*	*With APP*	*Overall*	*No APP*	*With APP*
SG (α_{SG})	-0.270***	n.a.	-0.389***	-0.097*	n.a.	-0.149**
	(0.093)		(0.088)	(0.051)		(0.061)
OG (α_{OG})	-0.099	0.133*	-0.290***	0.012	0.160***	-0.091
	(0.085)	(0.070)	(0.106)	(0.070)	(0.037)	(0.085)
LTG (α_{LTG})	-0.565***	0.070	-0.883***	0.034	-0.172*	0.023
	(0.138)	(0.123)	(0.151)	(0.097)	(0.092)	(0.099)
STG (α_{STG})	0.009	0.194**	-0.260**	-0.071	-0.087	-0.128
	(0.100)	(0.090)	(0.109)	(0.063)	(0.086)	(0.099)
Observations	755	755		755	755	
R^2	0.777	0.804		0.775	0.775	
$\overline{\Omega}$	0.541			0.650		

	Inflation			GDP growth		
	Overall	*No APP*	*With APP*	*Overall*	*No APP*	*With APP*
SG (α_{SG})	-0.180**	n.a.	-0.283***	-0.108**	n.a.	-0.084
	(0.086)		(0.083)	(0.042)		(0.053)
OG (α_{OG})	-0.119***	-0.029	-0.234***	-0.003	-0.092	0.053
	(0.042)	(0.044)	(0.077)	(0.060)	(0.064)	(0.088)
LTG (α_{LTG})	-0.094*	-0.037	-0.199**	-0.067	0.013	-0.054
	(0.049)	(0.089)	(0.082)	(0.086)	(0.165)	(0.112)
STG (α_{STG})	-0.065	-0.058	-0.212***	-0.068	-0.075	-0.032
	(0.050)	(0.081)	(0.080)	(0.064)	(0.078)	(0.135)
Observations	755	755		755	755	
R^2	0.715	0.754		0.758	0.760	
$\overline{\Omega}$	0.652			0.910		

Note: The table shows the effect of different FG types on Consensus forecaster disagreement regarding one-year-ahead forecasts for the different variables reported in the column headers, as measured by the interdecile range. Country and time fixed effects not reported for brevity. SG denotes state-dependent FG, OG open-ended FG, LTG time-dependent FG with a remaining guidance horizon of more than 1.5 years, STG time-dependent FG with a remaining guidance horizon of less than 1.5 years. State-contingent FG only observed during APP periods. $\overline{\Omega}$ denotes the sample average of the interquartile range in the absence of FG. Driscoll and Kraay (1998) standard errors are given in parentheses. Asterisks indicate the level of significance, (*) at the 10%, (**) at the 5%, and (***) at the 1% level.

Disagreement about short-term interest rates is lower under state-dependent FG, and even more so under time-dependent FG with a long remaining horizon. These results (reported in Table 3, with more detailed results provided in the appendix) are consistent with those reported in the previous section, whereby the largest effects arise under long-horizon time-dependent FG, and some, albeit smaller effects (in this case of only half the magnitude), are triggered by state-dependent FG. The effects are not only of statistical, but also of economic significance. In our sample, the average interdecile range of three-month interest rate forecasts at the ELB in the *absence* of FG amounts to 0.54. The coefficient of -0.57 estimated for long-horizon FG implies that disagreement is effectively eliminated; the coefficient of -0.27 on state-dependent FG suggests that disagreement is reduced by half. Open-ended FG and time-dependent FG with a short horizon, in contrast, do not reduce forecaster disagreement. State-dependent FG does furthermore lower disagreement about long term rates, inflation and GDP growth. State-dependent FG is the only type of FG which, beyond

affecting forecast disagreement about three-month rates, has systematic effects on all other variables to be forecasted.

FG is considerably strengthened in the presence of an APP. Differentiating the results across periods where the central bank has embarked on an APP and periods without an APP, we can strongly confirm the Clouse et. al. (2003) hypothesis that asset purchases add credibility to FG about policy rates: with an APP, disagreement about the future course of short-term rates is significantly reduced for all types of FG, whereas there is no reduction for any type of FG in the absence of an APP. The same is true for disagreement about the future path of inflation, which is significantly reduced in the presence of an APP, regardless of the type of FG employed, whereas any such effect is absent if no APP is in place.

Taken together, these results suggest that FG has affected the way markets respond to news and the disagreement among economic forecasters. Time-dependent FG appears to have been interpreted by markets as a credible commitment and to have helped forecasters to agree on their future development, but only if the guidance was provided over relatively long horizons. State-dependent FG also seems to have "worked" as expected. It lowered disagreement among forecasters, not only about short-term rates, but also about several other variables, and muted (but did not eliminate) the responsiveness of markets. This is consistent with the notion that central bank watchers understood the conditionality contained in the state-dependent FG. In addition, the credibility of FG seems to be considerably enhanced if the central bank simultaneously has an APP in place.

Still, the implementation of FG is subject to substantial risks and implementation challenges. First and foremost, credibility of the FG is essential. The analysis above has shown that the existence of an APP enhances the credibility of FG, but the reverse also holds – in the absence of an APP, the effectiveness of FG seems harder to prove. In part, this is due to the inherent time inconsistency of FG. Even if the central bank commits to keeping policy accommodation for long(er), it might be tempted to re-optimise once conditions have improved. This incentive inherently casts doubts on the credibility of the central bank's promises. In addition, as shown in section 3.3.3, FG relies heavily on the expectations channel, which makes an alignment of the expectations by the public with those of the central bank essential. Such an alignment is inherently difficult to achieve given that the future course of monetary policy depends on many more factors than can possibly be communicated.[37] Another implementation challenge specific to state-dependent forward guidance lies in defining a contingency that is both easy to communicate and at the same time able to deliver robust results. The experiences of the Bank of England and the FOMC with their unemployment-related contingencies illustrate this very prominently. Our analysis suggests that from an ex ante perspective, the state-dependent FG has been highly credible, reducing uncertainty. While it is true that both central banks had to change their FG subsequently, this does not invalidate our results. Rather, it emphasises the importance to have a well-defined contingency in place, an issue that we will turn to in the next section.

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[37] For a more extensive discussion of the risks and implementation challenges, see Williams (2011).

4 Conclusions and Implications for the ECB's Communication

In this paper, we have argued that central bank communication is of particular importance during unconventional times.

When the central bank resorts to (new) unconventional monetary policy tools or forward-looking guidance, it is important to communicate the expected workings of the tools and the central bank reaction function, and to provide as much detail about their implementation as possible. Given the novelty of these tools, their deployment, their effectiveness and their interaction with the existing tools unavoidably remain unpredictable to some degree. In the light of this, it is even more important for the central bank to be as clear as possible. Specifying the central bank's reaction function with regard to these tools, as for instance done by Draghi (2014), is instrumental in achieving a common understanding among central bank watchers, in managing expectations, and thus in making the central bank predictable. The empirical evidence provided in this paper has shown that APP announcements by the ECB have generally reduced uncertainty, especially if they contained information about the envisaged size of the programme (whereas the lack thereof has at times raised uncertainty).

Central bank reaction functions relate central bank actions to the evolution of the economy. Accordingly, central bank communication about its future actions is naturally state-dependent. Furthermore, state-contingent FG allows economic agents to endogenously adjust their expectations in light of new economic developments, thereby requiring fewer re-adjustments of central bank communication if these developments differ from the original expectations. The empirical evidence provided in this paper suggests that forecasters and markets understand the conditionality contained in the state-dependent FG. For example, recent state-dependent FG episodes lowered disagreement among forecasters about short-term rates and other key macroeconomic indicators and muted the responsiveness of markets to macroeconomic news.

The ECB has resorted to FG, which has evolved over time, and placed increasing emphasis on its state-contingent nature. Following its meeting on 4 July 2013, the Governing Council of the ECB initially communicated that it "expects the key ECB interest rates to remain at present or lower levels for an extended period of time." The expectation was based on the overall subdued outlook for inflation extending into the medium term, given the broad-based weakness in the real economy and subdued monetary dynamics prevailing at that time. Following its meeting on 10 March 2016, and complementing the announcement of a comprehensive package of measures, including the expansion of the ECB's monthly asset purchases, the Governing Council clarified its *qualitative* FG on future policy rates, stating that it "expects the key ECB interest rates to remain at present or lower levels for an extended period of time, and well past the horizon of our net asset purchases." Thus, a new interconnected element in the ECB's FG was introduced linking the future path of policy rates to the ECB's APP, which, at that time, was "intended to run until the end of March 2017, or beyond, if necessary, and in any case until the Governing Council sees a sustained adjustment in the path of inflation consistent with its inflation aim", i.e. was subject to a mix of time-dependent and state-dependent FG itself. Finally, a third leg of the ECB's FG has been introduced in December 2015, when it was announced that the principal payments on the securities purchased under the APP will be reinvested as they mature, "for as long as necessary", constituting a case of open-ended FG.

For the ECB, consistency with the central bank's mandate implies that state-dependencies should relate to inflation, possibly in the form of an inflation threshold. A robust implementation of state-dependent FG could be achieved by relying on a set of inflation-related indicators that prominently includes measures of core inflation. The ECB's current state contingency of asset purchases is already defined in terms of inflation, and the requirement of a "sustained adjustment in the path of inflation consistent with its inflation aim" goes a long way towards ensuring robustness. To facilitate predictability of the ECB's future policy actions, clarity in the definition of the state dependency is desirable. This relates to the definition of the ECB's inflation aim and to the specific indicators that the ECB is looking at when assessing whether or not such an adjustment has been achieved. While not explicit about the role of core inflation, the recent clarifications[38] and references to core inflation in the ECB's communication suggest that the ECB's assessment will indeed be conducted based on a set of indicators that are geared towards achieving a robust outcome.

Providing guidance to the public about the envisaged path towards removing monetary accommodation will be a key communication task for the ECB going forward. To some extent, this is not different from communicating any turning point in monetary policy, when the central bank shifts from an easing stance to a tightening stance. However, given the complexity of the exit process in the presence of multiple tools, it is important to lay out the central bank's reaction function in this different environment well in advance. (This would be in analogy to Draghi (2014), which provided details on ECB's reaction function related to the *introduction* of new measures.) While only few central banks have exited from their nonstandard measures so far, the Federal Reserve in 2013 provides an interesting example: after providing explicit time-dependent guidance on the expected timing of tapering in May and June 2013, the FOMC subsequently decided to delay the start of tapering, and in its further communication removed any references to calendar dates, re-emphasising the state contingency of its actions. This corroborates the findings in this paper which suggest that forward guidance is best done in a state-dependent manner, because it reduces uncertainty among economic agents, allows them to adjust their expectations about the process endogenously in response to the arrival of new information, and furthermore does not bind the central bank to take measures according to a pre-set calendar schedule and is therefore more credible. This paper highlights the interdependency of the unconventional measures: with an APP in place, FG reduces uncertainty more effectively. Such interdependencies need to be considered when deciding on the path towards normalisation.

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[38] In the press conference in January 2017, ECB president Draghi clarified that the ECB defines its objective over a medium-term horizon, that the adjustment is required to be durable, that it has to be self-sustained (i.e. is not dependent on monetary stimulus) and that it has to be defined for the euro area as a whole.

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Appendix

A.1 Classification of FG Regimes

Our empirical analysis of FG regimes covers 8 different currency areas: Canada, the Czech Republic, the euro area, Japan, Norway, Sweden, the UK and the United States. These are very heterogeneous experiences and any comparison, ours included, must acknowledge the specificity of each. Our approach is to define three different types of FG based on the wording in the official public press releases on monetary policy decisions.

In line with our definition in section 3.3.2., we refer to *open-ended* FG whenever policy makers disclose their expected path of policy rates through the release of rate projections, or put forward any qualitative statement on the expected lasting of exceptionally low rates (e.g. the common reference to "extended period of time"). Outside this definition remains any reference to a future evolution of policy rates that is not supported by official projections or that does not refer explicitly to the envisaged duration of exceptionally low rates. We instead refer to *time-dependent* FG when there is an explicit reference to a date for the expected lift-off of policy rates, independently on whether or not this is accompanied by a contextual release of projections.[39] Finally, we refer to *state-dependent* FG when there is an explicit statement that conditions the path of future rates to the evolution of business cycle indicators, like unemployment and/or inflation.

Figure A.1: Horizon of Time-Dependent FG
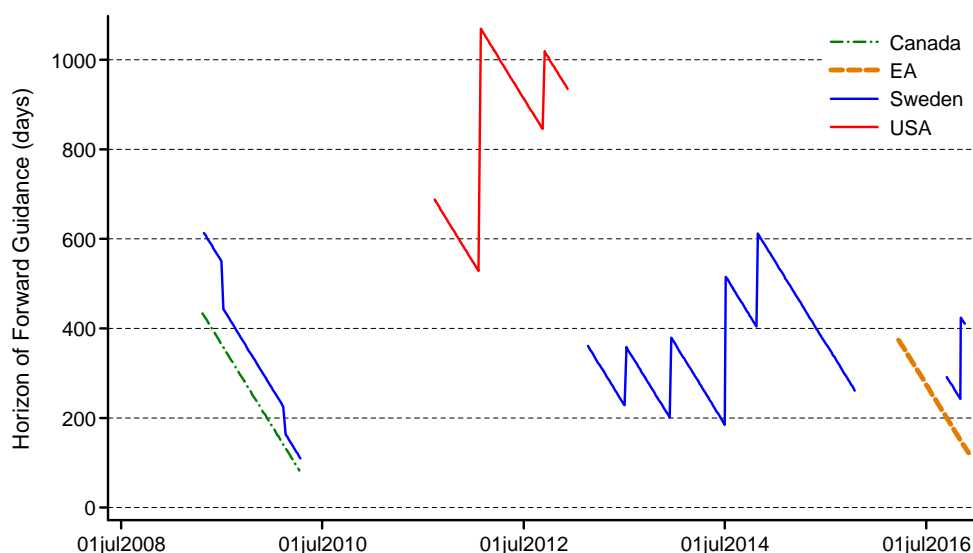
Note: The graph shows the remaining horizon of the most recent time-dependent FG announcement. If explicit time-dependent FG was discontinued, then no line is shown.

We distinguish further between *long time-dependent* FG and *short time-dependent* FG, which is time-dependent FG with more than 1.5 years and less than 1.5 years, respectively. The relevance of this distinction can be better appreciated visually. Figure A.1 shows the use of time-dependent FG by four central banks in recent years, measured as the number of days left until the announced end

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[39] According to our classification, the ECB had been using open-ended forward guidance starting 4 July 2013. Since 10 March 2016, the ECB's FG has been explicitly referring to the duration of the APP. Because the APP itself has an explicitly stated expected minimum duration, we classified the ECB's FG since then to be short-horizon time-dependent.

date. Most date-based FG experiences are captured by our definition of *short time-dependent* FG. The main exception is the United States, whose guidance had a horizon of over two years for most of the time, which therefore qualifies as *long time-dependent* FG.

A.2 The effect of FG on macroeconomic surprises – additional results

We select macroeconomic indicators *i* which are available in many countries *c*. Our sample consists of business confidence indices, consumer confidence indices, consumer price indices, GDP growth, industrial production, nonfarm payroll employment, purchasing manager indices, retail sales, and unemployment rates. This selection is guided by the availability of expectations data, by the long-time coverage of the series of our sample and their asset price impact during our sample period.

The initially released values of macroeconomic indicators $a_t^{c,i}$ as well as the market expectations $e_t^{c,i}$ at time *t* are available from Bloomberg. We define the surprise $s_t^{c,i}$ as the difference between actual and expected values, divided by the standard deviation of the time series for the respective country *c* and indicator *i*. We choose the sign of the surprise so that a positive surprise is good news about the economy, which via a more restrictive monetary policy is likely to imply higher yields. For this reason we invert the sign of the surprise in the unemployment report.

As sovereign bond returns $\Delta R_t^{c,i}$ we use both at daily as well as intraday data. Our daily sovereign bond returns come from Datastream. They refer to bonds with two years to maturity and are available for Canada, Czech Republic, Germany, Italy, Japan, Norway, Sweden, UK, and USA. Further, we use intraday returns during a symmetric 120 minute window around the announcement event. For this, we obtain tick-by-tick data for sovereign bonds with two-year time to maturity for the countries Canada, Germany, Italy, Japan, Sweden, UK, and USA.

Table A.1: Net market impact of macroeconomic news under different types of FG (Sweden, UK, US)

	Daily			Intraday		
	Overall	*No APP*	*APP active*	*Overall*	*No APP*	*APP active*
	(1)	*(2a)*	*(2b)*	*(3)*	*(4a)*	*(4b)*
STG ($\beta + \beta_{STG}$)	1.37***	1.62***	0.82*	1.15***	1.37***	0.65**
	(0.27)	(0.25)	(0.43)	(0.16)	(0.16)	(0.32)
OG ($\beta + \beta_{OG}$)	0.73**	1.83***	0.60*	0.74***	1.11***	0.69***
	(0.29)	(0.39)	(0.32)	(0.22)	(0.19)	(0.24)
No FG (β)	0.90**	1.89	0.59**	1.12***	2.16*	0.79**
	(0.36)	(1.35)	(0.26)	(0.37)	(1.17)	(0.29)
SG ($\beta + \beta_{SG}$)	0.47*	n.a.	0.46*	**0.21**	n.a.	**0.21**
	(0.25)		(0.25)	**(0.15)**		**(0.16)**
LTG ($\beta + \beta_{LTG}$)	**0.08**	0.19	**0.05**	**0.13***	0.25	**0.13***
	(0.08)	(0.21)	**(0.09)**	**(0.07)**	(0.24)	**(0.07)**
Observations	2164	2164		2166	2166	
R^2	0.04	0.06		0.09	0.11	

Note: This table shows net surprise impact based on the coefficient estimates of the fixed effects model. The dependent variable in columns 1 and 2a/2b is the daily change, in columns 3 and 4a/4b the intraday (symmetric 120 minute window around event) change in two-year sovereign bond yields in basis points. Sample covers Sweden, UK, US. Surprises cover business confidence, consumer confidence, CPI inflation, GDP growth, industrial production, nonfarm payrolls, purchasing manager index, retail sales, unemployment. Only periods at or below the ELB of 1%. Therefore, observations for most countries are only at or after the year 2009, with the exception USA (earliest observation in the year 2003). State-

contingent FG only observed during APP periods. Country-indicator fixed effects, FG and APP effects and their interactions, and constant not reported. Standard errors clustered at the country-indicator level in parentheses. Bold numbers indicate that the coefficient estimate of a given FG regime, β_X, is significant at a 10% level. Asterisks indicate the level of significance, (*) at the 10%, (**) at the 5%, and (***) at the 1% level.

In this appendix we first redo the analysis of section 3.3.4.1 for a subset of countries with pronounced FG episodes, namely Sweden, UK, and the US. The coefficients in Table A.1 for these three countries reaffirm the findings for all advanced economies presented in the main text. State-contingent guidance and long-term guidance reduce the surprise impact, whereas open-ended FG has barely any effect. The APPs drastically reduce the surprise impact. Once we account for the lower surprise impact in presence of an APP, the short-horizon time-dependent FG has no significant effect – no matter whether an APP is active or not.

Next, using the notation of section 3.3.4.1, we specify the fixed effects model

$$\Delta R_t^{c,i} = \alpha^{c,i} + \alpha_{SG} SG_t^c + \alpha_{OG} OG_t^c + \alpha_{TG} TG_t^c + \beta s_t^{c,i}$$
$$+ \beta_{SG} SG_t^c s_t^{c,i} + \beta_{OG} OG_t^c s_t^{c,i} + \beta_{TG} TG_t^c s_t^{c,i} + \gamma TG_t^c g_t^c s_t^{c,i} + \varepsilon_t^{c,i},$$

where TG_t^c is an indicator variable for time-dependent FG. Under time-dependent FG, the coverage ratio g_t^c measures the share of a two-year period covered by time-dependent FG, bounded from above by unity. This coverage ratio captures what percentage of the time-to-maturity is subject to time-dependent FG at any point in time. As in the main text, we restrict the sample to ELB periods (which we define to be periods where the policy rate is at or below 1%).

Table A.2: Effect of FG on Macroeconomic Surprises

	Daily		Intraday	
	Advanced Economies	Sweden, UK, US	Advanced Economies	Sweden, UK, US
Surprise (β)	0.41**	0.90**	0.47***	1.12***
	(0.18)	(0.36)	(0.14)	(0.37)
SG (β_{SG})	-0.19	-0.44	-0.36***	-0.91***
	(0.18)	(0.37)	(0.12)	(0.31)
OG (β_{OG})	0.03	-0.17	0.04	-0.38
	(0.20)	(0.28)	(0.14)	(0.25)
TG (β_{TG})	1.54***	1.33**	1.15***	0.76
	(0.48)	(0.60)	(0.26)	(0.47)
TTM coverage (γ)	-1.82***	-2.11***	-1.44***	-1.76***
	(0.58)	(0.50)	(0.30)	(0.29)
Observations	5120	2164	4739	2166
R^2	0.01	0.04	0.03	0.09

Note: The dependent variable in columns 1 and 2 is the daily change in two-year sovereign bond yields in basis points. The dependent variable in columns 3 and 4 is the intraday (symmetric 120 minute window around event) change in two-year sovereign bond yields in basis points. Advanced economies are Canada, Germany, Italy, Japan, Sweden, UK and US for intraday, and additionally Czech Republic and Norway for daily frequency. Surprises cover business confidence, consumer confidence, CPI inflation, GDP growth, industrial production, nonfarm payrolls, purchasing manager index, retail sales, unemployment. Only periods at or below the ELB of 1%. Therefore, observations for most countries are only at or after the year 2009, with two exceptions Japan (earliest observation in the year 2000) and USA (earliest observation in the year 2003). Country-indicator fixed effects, FG effects and constant not reported. Standard errors clustered at the country-indicator level in parentheses. Asterisks indicate the level of significance, (*) at the 10%, (**) at the 5%, and (***) at the 1% level.

The results in Table A.2 are complementary to the ones in the section 3.3.4.1. The table shows that open-end FG had barely any, and state-dependent FG had an ambiguous effect. Time-dependent FG over short horizons amplifies the surprise impact rather than muting it. Only long-term guidance ($g_t^c > 0.75$) reduces the response of yields to macroeconomic surprises.

A.3 The effects of turning points in monetary policy – Further evidence from an international panel

In the following, we provide an extension of the analysis of turning points from the box in the body of the paper to an international panel. To this end, we collect data on bond yields (with maturities of 1, 2, 5, and 10 years) and policy rates for seven jurisdictions (EA/DE, UK, CA, JP, NZ, AU and CH) from Datastream. Unlike for the U.S., a high-frequency identification of monetary policy shocks is difficult due to the lack of intraday data for financial instruments which are roughly comparable to the Fed Funds Futures.[40] Instead, we measure monetary policy surprises as the change in the 1-month LIBOR rate for the respective currency around the change in the policy rate.[41] Our sample is therefore dictated by availability of Libor rates.[42] In contrast to the analysis in the body of the paper, we restrict our sample to the monetary policy shocks associated with actual changes in the underlying policy rate. Table A.3 details the number of policy changes and turning points across jurisdictions.

Table A.3: Policy changes and turning points

	EA/DE	UK	CA	JP	NZ	AU	CH
Policy changes	58	88	31	20	21	54	32
Turning points	10	19	4	5	4	7	3
Sample period	1987-2012	1987-2012	2001-2012	1989-2012	2003-2012	1990-2012	1994-2012

Note: This table details the number of policy changes and turning points across jurisdictions. The sample period for each country, which is indicated in the last row, is based on the availability of data for policy rates and bond yields (obtained from Datastream), as well as 1-month Libor rates (obtained from www.econstats.com).

Our analysis is then based on the following fixed-effects regression

$$\Delta R_{i,t}^m = \alpha_i + \beta \Delta MP_{i,t} + \gamma TP_{i,t} + \delta \Delta MP_{i,t} \times TP_{i,t} + \varepsilon_{i,t}, \tag{A.1}$$

where i and t index country and time, respectively, and α_i is a country fixed effect. Moreover, $\Delta MP_{i,t}$ is the relevant change in monetary policy rates, $\Delta R_{i,t}^m$ denotes the contemporaneous change in the

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[40] For most countries, the closest substitutes would be data on overnight indexed swaps. However, reliable intraday data is rarely available before the mid 2000s, which would severely limit the sample and thus the number of turning points.

[41] Over time, central banks have changed their communication strategies in several ways. Among other things, this concerns the timing of announcement and effective dates, which important because the market reaction occurs at announcement, while Datastream reports the effective date. We manually search central bank websites for the announcement dates wherever possible. However, in many cases the intraday timing is not available, which is problematic because Libor rates are usually set at 11 am GMT. To ensure that our findings are robust to such (possibly time-varying) measurement errors, we compute changes in bonds yields and Libor rates in a window of ±1 days around the event.

[42] Libor started with 3 currencies (USD, GBP, DEM) in 1987, and then later expanded to other currencies.

government bond yield with a residual maturity of m years, and $TP_{i,t}$ is a dummy variable that marks turning points. Thus, β measures the effects of changes in monetary policy on bond yields, while the effects of changes in monetary policy at turning points is given by $\beta + \delta$.

Table A.4: Coefficient estimates of fixed-effects panel regression of changes in bond yields on changes in monetary policy.

	1 year	2 year	5 year	10 year
β	0.434*** (0.063)	0.238** (0.083)	0.148* (0.070)	0.083 (0.055)
$\beta + \delta$	0.362*** (0.066)	0.305*** (0.052)	**0.358*** (0.014)**	**0.198*** (0.005)**
N	274	303	316	304

Note: This table depicts the relevant coefficient (sum) estimates for regression equation (A.1), based on monetary policy shocks and yield changes measured in a +/- 1 day window around relevant announcements. Standard errors clustered at the country level are given in parentheses.

Table A.4 presents the regression results, which are qualitatively very similar to those in the body of the paper. First, the effects of monetary policy shocks are more pronounced for shorter maturities. In fact, the effects are statistically insignificant beyond the 2-year maturity. Second, turning points are associated with a stronger pass-through from policy rates to term rates. One exception is the 1-year maturity, for which the effect is slightly negative. Notice, however, that there are a number of missing observations for 1-year rates. And third, the relative importance of turning points increases in maturity, with the most pronounced effects obtained for 10-year yields. Overall, the results are slightly weaker than the ones obtained with U.S. data. Clearly, both the lack of good data for the proper identification of monetary policy shocks and cross-country heterogeneity in the conduct of monetary policy may be attenuating factors.

For robustness, we additionally repeat our analysis when using actual changes in policy rates instead of monetary policy surprises based on changes in Libor rates. The results, which we do not tabulate for brevity, are qualitatively very similar. Also, note that our results do not change qualitatively if we discard observations surrounding the breakdown of the ERM in 1992.

A.4 The effect of FG on forecaster disagreement – detailed results

Table A.5: FG and forecaster disagreement

	3-month rates						10-year rates					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
FG	-0.145***	--	--	--	--	--	-0.040	--	--	--	--	--
	(0.055)						(0.039)					
SG	--	-0.221**	-0.270***	-0.100***	-0.274***	-0.238***	--	-0.106**	-0.097*	-0.039	-0.103*	-0.131**
		(0.102)	(0.093)	(0.034)	(0.091)	(0.086)		(0.051)	(0.051)	(0.025)	(0.052)	(0.066)
OG	--	-0.084	-0.099	-0.037	-0.094	-0.055	--	0.009	0.012	0.017	0.014	0.094**
		(0.091)	(0.085)	(0.032)	(0.081)	(0.057)		(0.070)	(0.070)	(0.037)	(0.070)	(0.038)
TG	--	-0.153	--	--	--	--	--	-0.042	--	--	--	--
		(0.164)						(0.075)				
LTG	--	--	-0.565***	-0.225***	-0.557***	-0.576***	--	--	0.034	0.028	0.028	0.079
			(0.138)	(0.054)	(0.136)	(0.125)			(0.097)	(0.052)	(0.098)	(0.058)
STG	--	--	0.009	0.011	0.024	0.006	--	--	-0.071	-0.048	-0.066	0.093
			(0.100)	(0.040)	(0.082)	(0.079)			(0.063)	(0.043)	(0.065)	(0.076)
Lag	--	--	--	0.677***	--	--	--	--	--	0.521***	--	--
				(0.030)						(0.034)		
Observations	755	755	755	754	813	1,771	755	755	755	754	800	1,771
R²	0.754	0.757	0.777	0.886	0.775	0.670	0.771	0.774	0.775	0.836	0.765	0.613

	Inflation						GDP growth					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
FG	-0.130***	--	--	--	--	--	-0.052	--	--	--	--	--
	(0.037)						(0.042)					
SG	--	-0.177**	-0.180**	-0.084**	-0.175**	-0.108***	--	-0.108**	-0.108**	-0.065*	-0.107***	-0.135**
		(0.087)	(0.086)	(0.041)	(0.081)	(0.036)		(0.043)	(0.042)	(0.035)	(0.041)	(0.068)
OG	--	-0.119***	-0.119***	-0.063*	-0.113***	0.039	--	-0.003	-0.003	0.003	0.013	0.155***
		(0.041)	(0.042)	(0.035)	(0.036)	(0.044)		(0.059)	(0.060)	(0.042)	(0.054)	(0.054)
TG	--	-0.073*	--	--	--	--	--	-0.068	--	--	--	--
		(0.041)						(0.057)				
LTG	--	--	-0.094*	-0.033	-0.087**	-0.018	--	--	-0.067	-0.020	-0.054	0.025
			(0.049)	(0.028)	(0.043)	(0.052)			(0.086)	(0.069)	(0.083)	(0.103)
STG	--	--	-0.065	-0.023	-0.027	-0.029	--	--	-0.068	-0.049	-0.026	0.230***
			(0.050)	(0.028)	(0.038)	(0.077)			(0.064)	(0.054)	(0.046)	(0.067)
Lag	--	--	--	0.548***	--	--	--	--	--	0.354***	--	--
				(0.059)						(0.110)		
Observations	755	755	755	754	813	1,771	755	758	755	754	813	1,771
R²	0.713	0.715	0.715	0.805	0.704	0.525	0.755	0.758	0.758	0.787	0.757	0.532

Note: FG denotes a dummy variable for FG of any type, SG denoted state-dependent FG, OG open-ended FG, TG time-dependent FG, LTG time-dependent FG with a remaining guidance horizon of more than 1.5 years, STG time-dependent FG with a remaining guidance horizon of less than 1.5 years. Driscoll and Kraay (1998) standard errors are given in parentheses. ***/**/* denote statistical significance at the 1%/5%/10% level. Columns (1) to (4) vary the FG dummies as displayed. Columns (4) include lags of the forecaster disagreement. Columns (5) go beyond advanced economies and also include Chile, Hungary and Poland. Columns (6) extend the sample beyond the ELB periods, therefore also including New Zealand (which has not experienced policy rates at or below 1%).

A.5 The forward-lookingness of ECB and Fed communication – detailed results

Figure A.2: The use of forward-looking terms by the ECB

Note: This figure shows the share of different forward-looking terms (expect, going to, may, might, shall, will) per 1,000 words in the ECB's accounts, introductory statements and speeches by its Executive Board members.

**Figure A.3: The use of forward-looking terms by the Federal Reserve**
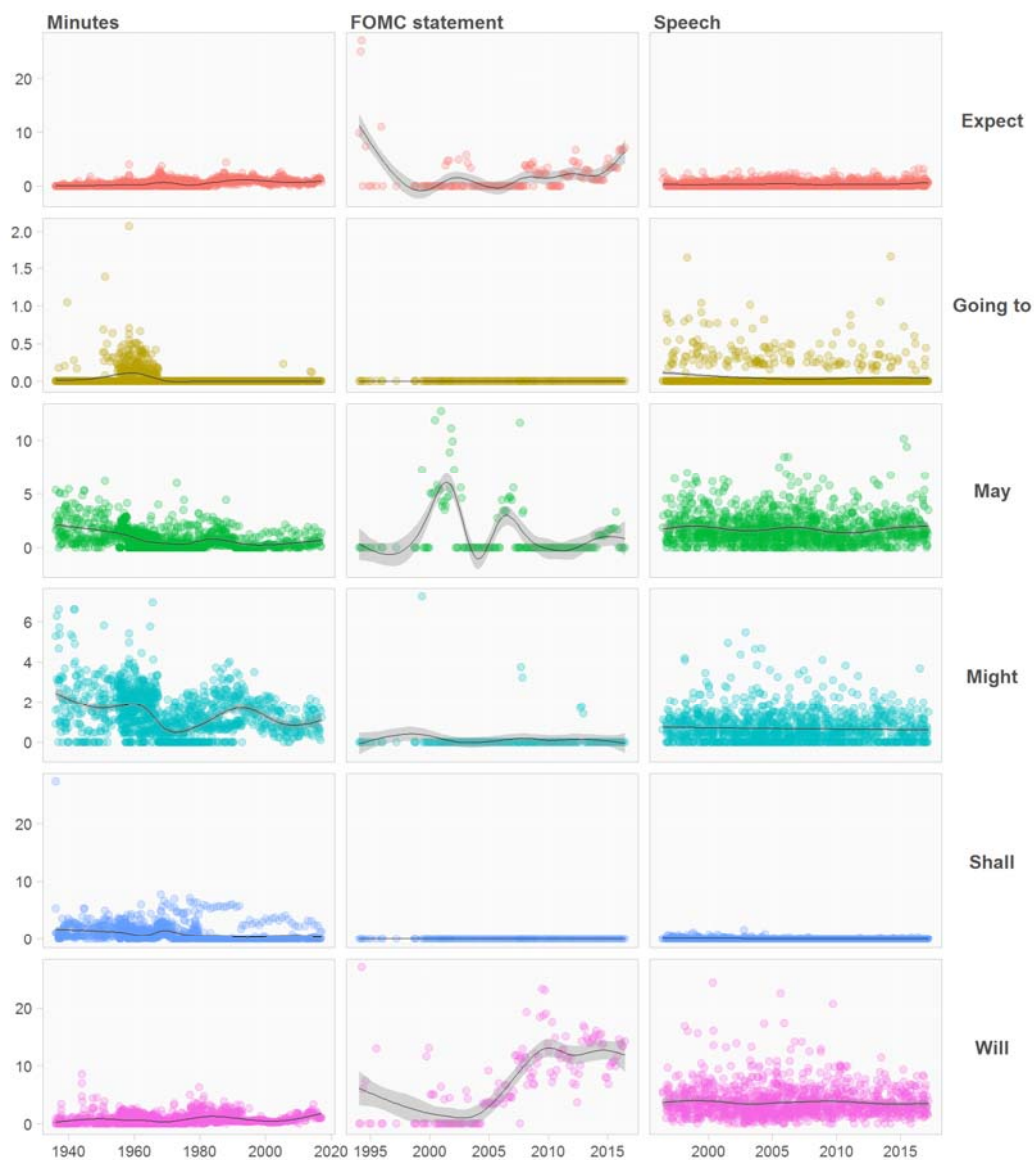
Note: This figure shows the share of different forward-looking terms (expect, going to, may, might, shall, will) per 1,000 words in the Federal Reserve's minutes, policy statements and speeches by the Governors of the Board of Governors.

A.6 The macroeconomic effects of inflation threshold-based FG on policy rates – additional results

Figure A.4: Effects of FG based on alternative threshold variables and specifications

Panel A: Threshold variable: 1-year-ahead consumer price inflation, threshold value: 1.9%
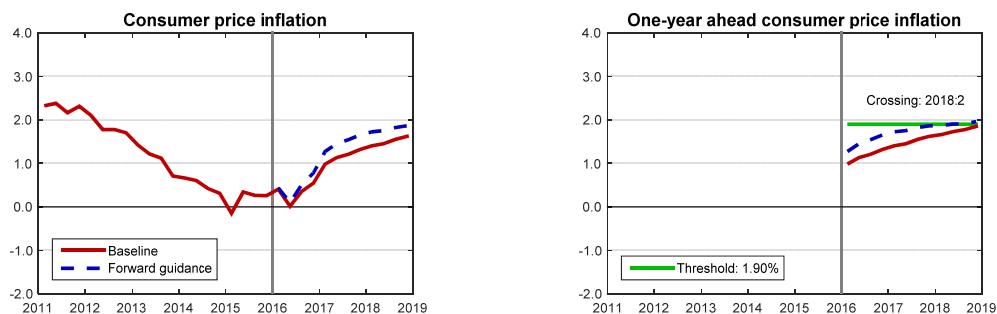
Panel B: Threshold variable: current GDP deflator inflation, threshold value: 1.9%
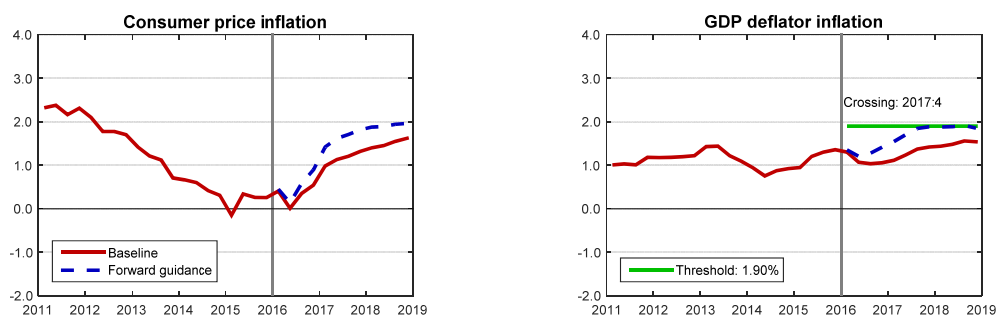
Panel C: Threshold variable: current GDP deflator inflation, threshold value: 1.75%
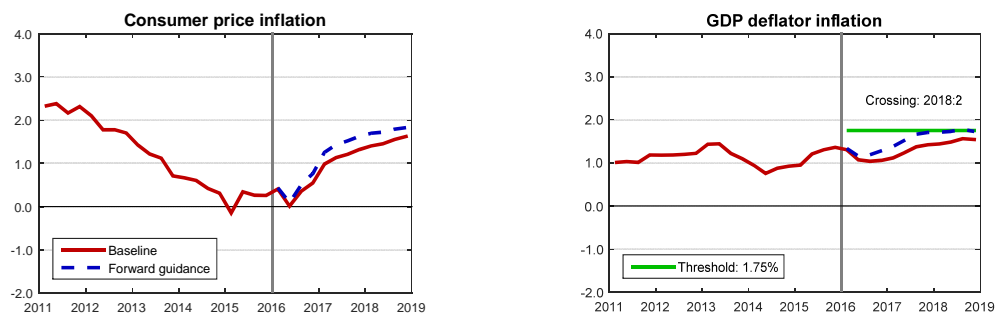
Panel D: Threshold variable: current GDP deflator inflation, threshold value: 1.9%, delayed lift-off
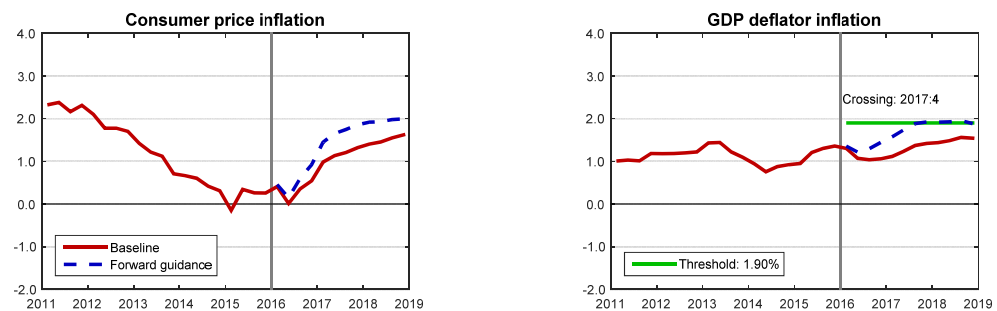
Note: See Figure 9 in the main text.

Figure A.5: Peak effects of FG based on alternative threshold variables and specifications
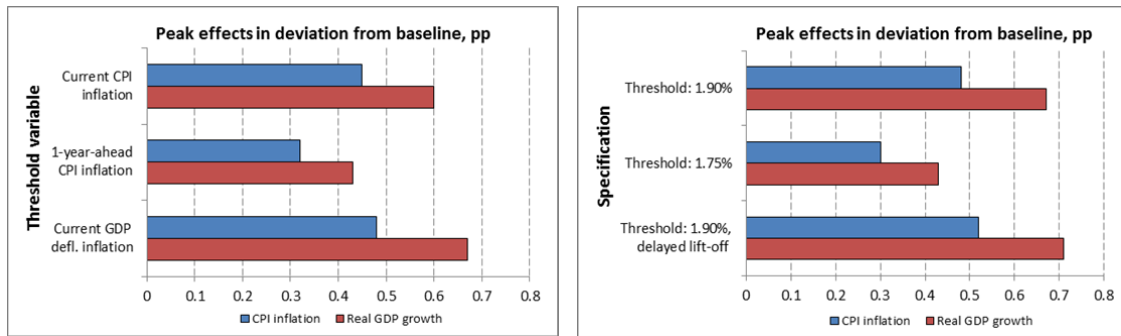
Note: Counterfactual simulations based on the NAWM. The peak effects refer to the maximum of the average percentage-point baseline deviations of the annual rates of consumer price inflation (CPI) and real GDP growth in a given calendar year across the three-year horizon of the March 2016 MPE from 2016 to 2018. The left panel shows simulations with the inflation threshold being specified in terms of alternative inflation measures, whereas the right panel shows simulations for alternative specifications related to a GDP deflator-based threshold.

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