



EUROPEAN CENTRAL BANK

EUROSYSTEM

Working Paper Series

Malin Andersson, Laurent Maurin,
Desislava Rusinova

Market finance as a spare tyre?
Corporate investment and
access to bank credit in Europe

No 2606 / October 2021

Disclaimer: This paper should not be reported as representing the views of the European Central Bank (ECB). The views expressed are those of the authors and do not necessarily reflect those of the ECB.

Abstract

We estimate a FAVAR with Bayesian techniques in order to investigate the impact of loan supply conditions on euro area corporate investment and its financing structure. We identify shocks to overall demand and loan supply with sign and impact restrictions.

Although tightened financial conditions have adversely impacted corporate investment during and after the sovereign debt crisis, the resulting impediments in loan supply, illustrated by lower loan volumes and higher spreads, have been partly alleviated by strengthened corporate debt issuance. We show that (1) part of the protracted increase in debt to loan ratio since the crisis reflects bottlenecks in the provision of bank credit and (2) the tightened loan supply has been more adverse for small corporations with limited market access.

Overall, our analysis of macro-financial developments suggests the need for policy actions to deepen the European corporate debt market and enhance market access for smaller corporates.

JEL Codes: E22, E66, G21

Keywords: financing structure, small and medium size corporates, size spread, corporate debt issuance, FAVAR model.

Non-technical Summary

The financial accelerator theory, which points at the crucial role of financial frictions for real outcomes, has since long become a part of macroeconomic modelling capturing the full impact of monetary policy shocks (Bernanke et al., 1999). The relevance of this channel has been extensively supported empirically at the microeconomic level, showing that real outcomes do depend on financial conditions and firms' balance sheets. However, at the macroeconomic level, empirical evidence is less abundant, particularly for the euro area. In this paper, we contribute to the empirical literature on the impact of loan supply and overall demand shocks on euro area corporate investment and its financing.

We estimate a Factor Augmented Vector AutoRegressive model (FAVAR) with Bayesian techniques to study the interactions between a set of macro-financial variables comprising investment and a financial condition indicator. We model the financial condition indicator as the common component of an auxiliary dataset covering the financing of investment, financial markets, the banking sector, and monetary aggregates. We expand the typical set of variables used in macro-monetary models: we incorporate corporate loans, the interbank spread, a simple ratio of market based finance and the size spread. The latter enables us to consider the asymmetric reaction to changes in financial conditions across the size of firms.

We find that loan supply shocks had a significant influence on both real and financial developments in the euro area since the beginning of 2008. Their impact is especially pronounced in the shorter run and it is estimated to have been substantial, first on activity, investment, the size and interbank spreads. However, the impact is even more persistent on corporate loans and the ratio of market based finance. For all the variables, the responses to loan supply shocks are found to be stronger and more persistent than those to demand shocks.

A scenario analysis suggests that the sharp deceleration in bank lending during the sovereign debt crisis can be associated with the increase in size spread, which pushed

up the cost of borrowing relatively more for smaller corporates that are more dependent on bank credit. Larger firms seem to have at least partly circumvented tightened access to bank credits by issuing relatively more market debt, as, according to the model, part of the protracted increase in corporate debt to loan ratio since the crisis is explained by adverse loan supply shocks. In contrast, smaller corporations, unable to issue, faced a stronger rise in borrowing costs. Overall, these adverse loan supply shocks and the more restricted corporate access to external finance also caused lower investment.

Our analysis of macro-financial developments in the euro area since 2008 suggests a strong need for policy actions to deepen the corporate debt market and to enlarge market access for smaller corporates. As euro area jurisdictions are differently populated in terms of small enterprises, a European policy is required to promote the conditions for economic convergence. In this context, the ongoing work under the umbrella of capital market 2.0 is much welcome.

1 Introduction

The relevance of financial frictions to explain corporate investment dynamics is extensively supported empirically by reduced-form studies at the microeconomic level. These studies show that real outcomes do depend on financial conditions and firms' balance sheets (e.g. Borensztein and Ye, 2018, Garcia-Posada Gomez, 2019). Sizable adverse loan supply shocks have been shown to decrease investment expenditure (e.g. Duchin et al., 2010; Campello et al. 2010), particularly for financially constrained or highly indebted firms. At the macroeconomic level, empirical evidence is less developed and more recent, particularly for the euro area. It has expanded in the aftermath of the 2008 Global Financial Crisis (GFC) and the 2011 Sovereign Debt Crisis (SDC).

During these periods, credit conditions tightened, and the share of investment in GDP declined to a record low level despite unprecedented monetary accommodation (IMF, 2015). Even though euro area investment recovered thereafter, over 2014-2019, the recovery has been broadly seen as incomplete compared both to the pre-crisis levels and to other developed economies (ECB, 2018). Moreover, these investment developments were also concomitant to relatively strong market debt issuance in Europe (EC, 2017). In the euro area, the ratio of long-term debt from non-financial corporations to GDP rose from 5.6% in 2007 to 10.9% in 2019, i.e. almost doubling over the period.² Our paper investigates both the impact of financing shocks (more specifically, loan supply shocks) on investment and the extent to which these shocks have driven the move towards more market-based finance over this period. We show evidence that part of the increase in the share of debt financing of corporates during the period 2008-2019 results from larger corporates getting around bottlenecks in the distribution of bank credits.

An important question at the aggregate level relates to the measurement of financial conditions, given that there is no unanimously accepted single indicator. While many available financial indicators contain relevant information about the financial cycle, each individual one is an imperfect and noisy proxy, being in turn affected by other

²The bulk of the increase happened before the implementation of the asset purchase program by the ECB in early 2015, as the ratio reached 10.4% in 2014.

factors. The selection of a subset of several indicators may imply that important information contained in others is missed. In a VAR-type model, which is usually low-dimensional, the omission of important variables from the model may lead to biased relationships (Bernanke et al., 2005, refer to a “price puzzle”). In this context, extracting a factor reflecting the common component of financial indicators appears to be the most appropriate modelling strategy. The FAVAR approach enables the full consideration of the information available from a large number of endogenous financial variables and its condensation into one single index taking into account the interactions between them.

To answer our research question, i.e. the impact of loan supply shocks on euro area business investment and its financing during the period 2008-2019, we estimate a FAVAR model with Bayesian techniques. We study the interactions between a set of macro-financial variables comprising investment and a factor, the financial condition indicator, modelled as the common component of an auxiliary dataset comprising a broad range of financial indicators. We then identify shocks to loan supply and overall demand on key macro-financial series using sign restrictions implemented using the methodology of Waggoner and Zha (2010) together with restrictions on impact implemented with the methodology of Baumeister and Benati (2013). Finally, we develop a counterfactual analysis illustrating what would have happened in the absence of adverse loan supply shocks during the SDC. We thereby show the impact of these shocks in terms of lost output and investment, enhanced corporate debt issuance and stronger asymmetries between small and larger corporates.

We believe that our paper adds to the existing research in its field in primarily three aspects. i) In terms of geographical focus, this paper adds to the still insufficient empirical macro evidence on the role of financial conditions in the euro area, whereas most existing research refers to the US, with a very different financial market structure. ii) To the best of our knowledge, other papers tend to focus on the implications of financial conditions on GDP and the reaction of monetary policy. In our analysis, we focus on the implications on corporate investment and a set of macro-financial variables sur-

rounding its financing. iii) The incorporation of the size spread enables us to consider the asymmetric conditions faced by smaller firms, more reliant on bank loans, while the incorporation of debt issuance enable the consideration of larger corporates' flexibility to issue debt in order to circumvent tighter access to bank credit.

The remainder of the paper consists of four sections and an appendix. Section 2 provides a brief literature review and explains the rationale for estimating a FAVAR model. Section 3 explains the methodology implemented, the data used and the identification strategy. Section 4 presents the results: the estimated financial condition indicator, the impulse responses of a loan supply shock and an overall demand shock, the forecast error variance decomposition and the historical shock decomposition of the main variables. The section ends with a scenario analysis focusing on the episode of the sovereign debt crisis. Section 5 concludes. The appendix lists the series included in the auxiliary dataset.

2 Literature review

In the literature, a broad consensus has been reached that, beyond the cost of external finance, financial factors such as credit supply conditions and the health of the balance sheets of corporations also affect real economic developments. This has led to the incorporation of financial frictions into macroeconomic models. While in earlier studies financial frictions were considered as merely amplifying business cycle fluctuations stemming from other shocks (e.g. Bernanke et al., 1999, Gertler and Karadi, 2011, Sanjani, 2014), more recent models consider financial systems as an autonomous source of shocks (e.g. Christiano et al., 2013, Adrian et al., 2013).

Regarding the optimal empirical setting for estimating the impact of a credit supply shock, it should be noted that both investment and financial conditions are highly endogenous. They both impact and react to demand, monetary policy, fiscal policy as well as the expectations surrounding these variables. Hence, empirical frameworks such as structural VARs (SVARs), which tackle the endogeneity issue, appear more suited to

investigate the impact of financial conditions on corporate capital expenditure than reduced forms estimations.

A number of recent papers have tried to identify credit supply shocks in a VAR framework in order to gauge the importance of their impact on the real economy, often using sign restrictions for shock identification. However, these studies usually consider the impact of credit supply shocks on real GDP or unemployment, and not on investment. For instance, Hristov et al. (2012) estimate a structural VAR for the euro area with bank loans, bank lending spread, the 3-month Euribor, and a financial conditions index. Credit supply shocks, identified with sign restrictions, seem to have had a significant impact on manufacturing production, lending spreads and bank loans during past crises. Aldasoro and Unger (2017) use a BVAR with a combination of zero and sign restrictions, to show that the impact of loan supply shocks on real GDP is strong and rather persistent. Gambetti and Musso (2017) investigate the impact of credit supply shocks in the euro area, US and UK, using a time-varying BVAR with sign restrictions. The short-term impact of credit supply shocks on real GDP and inflation seems to have increased over recent years and the shocks' contribution was particularly strong during the GFC. Bijsterbosch and Falagiarda (2015) show that the strong rise in cross-country heterogeneity in the reaction to credit supply shocks possibly reflect increased financial fragmentation in the euro area after the SDC.

VAR models have however a limitation regarding the maximum number of included variables, which amounts to only a small fraction of the variables available to and usually monitored by investors, policy-makers and financial market participants. A major challenge is indeed that the external finance premium is unobservable, and, more broadly, there is no agreement on a common indicator to properly measure financial conditions (de Graeve, 2008). This means that important economic information is excluded and that the estimations of effects based only on a few variables may generate counter-intuitive results.³ This caveat can to some extent be overcome by the use of the

³Well-known are cases where VARs with a small number of variables sometimes lead to counter-intuitive impulse responses such as the commonly noted price puzzle. The puzzle happens when a

factor-augmented VAR (FAVAR) method, introduced by Bernanke et al. (2005).

In order to support the identification of the credit supply shock, a measure of financial conditions is included as a factor along the other series in the VAR. Any available individual financial indicator is only an imperfect and noisy proxy of an unobserved financial cycle and is also driven by other factors. Nevertheless, each financial indicator can a priori contain important information for identifying the financial cycle. In addition, the signal extracted from a larger number of indicators tends to be more stable and less time-dependent: while some indicators are well-suited for capturing financing developments in a particular period, they may lose importance in other periods. In this context, extracting a factor reflecting the common component of a number of indicators appears the dominant modelling strategy.

Some studies use large data sets of corporate bond spreads, e.g. the difference in yields between corporate debt instruments and government securities of comparable maturity. For example, Gilchrist and Zakrajsek (2012) as well as Gilchrist and Mojon (2016) construct a highly-informative bond spread based on the spread of prices of individual bonds traded in the secondary market and show that those are good predictors of real outcomes. This approach suits the case of the US where the corporate debt market is more developed, but it is less viable for the euro area where most of the external financing takes place through bank loans. Dave et al (2013) examine the bank lending channel of monetary transmission in a FAVAR, considering an alternative identification of monetary shocks and analysing the lending response of banks at the individual level. They find that the existence of the bank lending channel is more prevalent than previously thought using aggregated lending data. Hosszu (2017) distills two credit supply factors from a multitude of financial variables for Hungary. Adding these into a time-varying FAVAR model, the author shows that a willingness-to-lend shock primarily increases lending activity while a lending-capacity shock influences GDP through country risk and monetary policy. For the euro area, Altavilla et al. (2019) construct a contractionary monetary policy shock seems to be followed by a rise in the price level. See Bernanke et al., 2005.

loan supply indicator using granular bank-level data on standards applied to loans from the Bank Lending Survey, and use it as an external instrument. Moccero et al. (2014) build a financial conditions index, which summarises the information about the future state of the economy from a large set of financial variables including interest rates, asset prices, and many other indicators related to debt securities, equities and loans. The authors show that incorporating the index in the VAR enables to better identify credit supply shocks for the euro area: shocks are detected earlier and are found to have larger spillovers.

A strand of the literature on the real impact of credit supply shocks analyses the substitution between bank and market financing in times of financial distress (i.e. market financing being used as a spare tyre), and the extent to which this substitution can mitigate the impact of a credit supply shock. The theoretical mechanism of substitution is investigated for instance in De Fiore and Uhlig (2015), where the optimal financing choices of corporates can result in a shift from bank loans to bonds. In this model, firms have heterogeneous risks of default which can be observed only by banks, but not by bondholders. In this context, a shock which increases the dispersion of individual default risk or decreases the relative screening efficiency of banks, induces a shift from loans to bonds. At the same time, the impact of the shock is exacerbated for firms that cannot substitute bank finance with bond finance, such as Small and Medium-sized enterprises (SMEs). Becker and Ivashina (2014) also demonstrate that in conditions of decline of bank financing, corporates revert to market-based financing.

On the empirical side, Aldasoro and Unger (2017), in a BVAR setting, consider separate shocks to bank loans and market-based financing. They confirm that after a negative shock to bank loans, flows of market financing increase and mitigate the negative impact of the shock on real GDP, but are unable to fully compensate the adverse impact. Holguin and Uribe (2019) estimate a FAVAR identified with sign restrictions. The authors find evidence of substitution between bank loans and commercial papers, i.e. a reduction in bank loans alongside an increase in the commercial papers issuance by firms, as a reaction to monetary policy in the US over the period 2001-2016. Altavilla

et al. (2019) show that in response to an adverse loan supply shock, non-financial corporations significantly increase their issuance of debt securities, although on impact they reduce their use of both bank loans and securities finance. Holm-Hadulla and Thurwachter (2021) show that the aggregate structure of corporate debt financing affect the transmission of monetary policy. Bond finance dampens the overall response of firm credit to monetary policy shocks in economies with a high initial share of bond- relative to bank-based finance. Corporate bond markets act as a “spare tyre” in situations when bank lending contracts.

Our research question relates to the impact of bank lending supply shocks on euro area business investment and its financing during the period 2008-2019 (covering the Global Financial Crisis, and the Sovereign Debt Crisis). In particular, we analyse whether the increase in the share of debt financing of corporates during the period 2008-2019 results from larger corporates getting around bottlenecks in the distribution of bank credits. Aiming at identifying as many details as possible of the shock impact on the real economy and the financial sector, we work with a relatively large-dimensional VAR and estimate a FAVAR model with a financial factor using a one-step approach and Bayesian techniques (Koop and Korobilis, 2009).

3 The estimated FAVAR model

The FAVAR incorporates a set of K measurement equations linking each of the $y_{i,i=1\dots K}$ variables included in the auxiliary dataset to $F = (F_1, \dots, F_M)$, the vector of M common components, and the N observed variables included in the main VAR model, $Z = (z_1, \dots, z_N)$:

$$y_{i,t} = \lambda_{0,i} + \lambda_i \cdot f_t + \gamma_{i,j} \cdot Z_t + \varepsilon_{i,t} \quad (1)$$

Where $\varepsilon_{i,t}$ is i.i.d and $N(0, \sigma_i^2)$. The FAVAR model also comprises a set of state equations which have a VAR(p) form:

$$\begin{pmatrix} f_t \\ Z_t \end{pmatrix} = \tilde{\varphi}_1 \cdot \begin{pmatrix} f_{t-1} \\ Z_{t-1} \end{pmatrix} + \dots + \tilde{\varphi}_P \cdot \begin{pmatrix} f_{t-p} \\ Z_{t-p} \end{pmatrix} + \tilde{\varepsilon}_t^f \quad (2)$$

Where ε_t^f is i.i.d and $N(0, \tilde{\Sigma}^f)$, Z_{it} is a TxN matrix containing a panel of macroeconomic and financial variables, f_t (or \hat{f}_t) are the factors, extracted from a dataset comprising the variables y_i and λ_i are the factor loadings. The so-called auxiliary dataset is composed of the series y_t while the main dataset consists of the series Z_t . Conditional on the parameters, the factors are sampled using state space methods where f_t is the unobserved state variable (see Koop and Korobilis 2009). This is implemented by using the Kalman filter. The parameters are then sampled conditional on the current MCMC draw of the factors. The codes used to run the estimation draw on Koop and Korobilis (2019), Banbura et al. (2010) and Blake and Mumtaz (2012).⁴

3.1 Main and auxiliary datasets

Two datasets are required to implement the FAVAR estimation. Both of them are quarterly over the period 1999Q1-2019Q3. We exclude from the analysis the very volatile period of the Covid-19 pandemic that would require a specific econometric framework to be incorporated (Lenza and Primiceri, 2020).

First, the main dataset consists of the series Z_t . This dataset augments the standard set of variables considered in monetary policy models with variables related to banks' supply of credit and the structure of corporate liabilities. However, since we do not aim at identifying monetary policy shocks, price indicators are not incorporated in the model.⁵ The vector Z in equations 1 and 2 contains seven variables. First, we use real non-financial corporate investment, taken from EUROSTAT integrated accounts, and real GDP net of investment, henceforth activity. The two series are expressed in real

⁴We are grateful to these authors for having made their codes public.

⁵Deflators would be required only to distinguish between monetary policy and "pure" demand shocks as demand indicators and monetary policy rates move identically in both cases, and only prices would move differently, increasing in the case of a demand shock and decreasing in the case of a monetary policy shock.

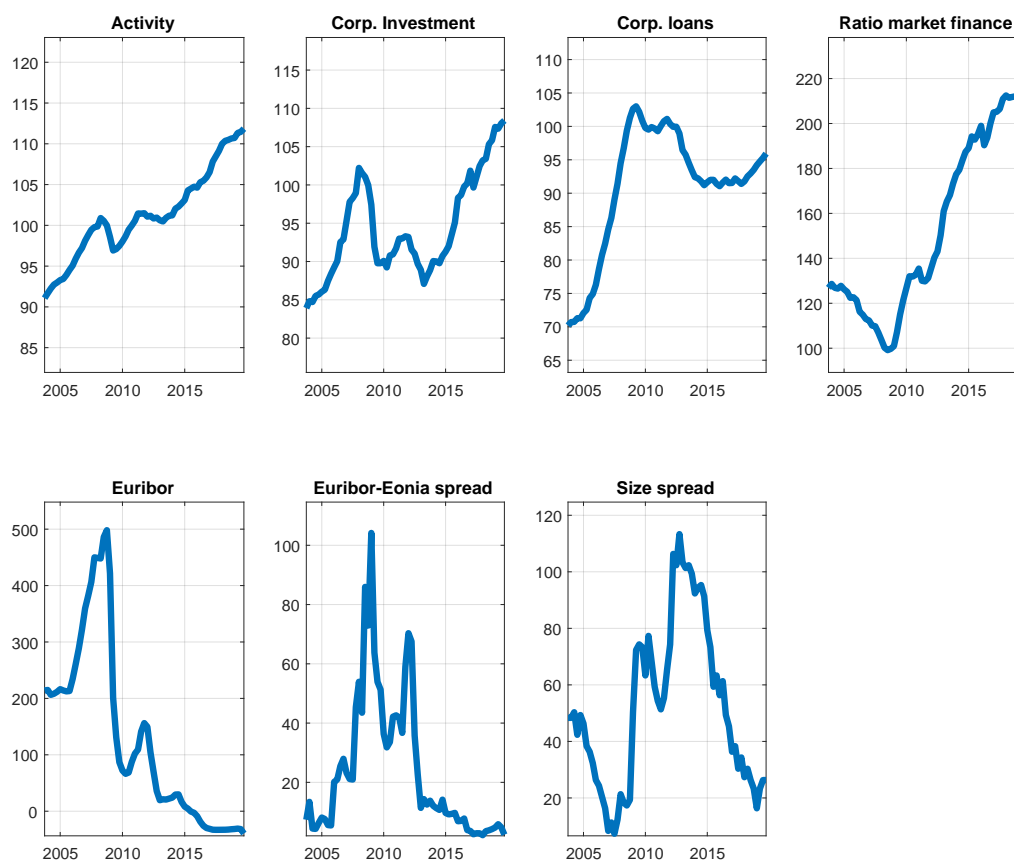
terms, indexed to 100 in 2008. Besides, we incorporate the 3-month Euribor as a measure of the monetary policy rate, from Refinitiv.⁶ The banking sector is represented by three variables: First, real corporate loans (MFI lending to non-financial corporations in real terms, indexed to 100 in 2008); second, the size spread, i.e. the difference between the bank lending rate on small corporate loans and that on large corporate loans.⁷ Third, we use the Euribor minus Eonia spread as a measure of tensions in the interbank market. Finally, we also consider a measure of market debt finance, i.e. the ratio of long-term non-financial corporate debt securities over total external financing. This series is constructed as the ratio between the outstanding amounts of euro area corporate debt and the sum of the same series and the outstanding amount of bank corporate loans (all taken from the ECB Statistical Data Warehouse). The series is indexed to 100 in 2008. In all cases, to compute the real series, we deflate the nominal series with the GDP deflator. The series incorporated in the main dataset are plotted in Figure 1 over the period 2003Q1 to 2019Q3.

Second, the auxiliary dataset consists of the series y_t . In the euro area, loan finance plays a much more prominent role compared to market-based financing than in the US (ECB, 2013). Hence, while a set of financial market price indicators may be sufficient for the extraction of a financial condition indicator in the US (e.g. Gilchrist and Zakrajsek, 2012), for euro area countries it should include a broader set of indicators, comprising both prices and quantities, and necessarily indicators of the banking sector. The auxiliary dataset comprises 40 series, reflecting both prices and quantities related to financial institutions, fixed income markets, stock markets, and foreign exchange markets (as done for instance in Maurin, 2019, or Moccero et al. 2014). The measures characterising banks and other financial institutions comprise indicators of bank liquidity, capital ratio, asset holdings, bank deposits and other components of monetary aggregates. Financial market-based data include government bond spreads relative to the German

⁶The Euribor rate is the preferred measure of policy-related interest rates, as it is key for the transmission of monetary policy and is also a reference for the pricing of many financial products, as well as for a broad set of interest rates.

⁷The series are taken from the ECB Statistical Data Warehouse. Small loans are loans of less than EUR 0.25 mn while large loans are of more than EUR 1 mn.

Figure 1: MACROECONOMIC SERIES INCLUDED IN THE MAIN DATASET



Notes: Corp. stands for corporates. Investment, activity (GDP excluding investment), and corporate loans are expressed in real terms. Together with the ratio of market debt finance, they are reported in level and indexed to 100 in 2008. Euribor, Euribor-Eonia spread and size spread are reported in basis points.

Bund at various maturities, risk spreads, measures of financial market volatility and the price to book ratio as a proxy for the aggregate Tobin's q . Correlations among some financial indicators are also included. Given the openness of the euro area economy, the nominal exchange rate of the euro and its volatility, and oil and commodity prices are also included. Finally, the Baker et al. (2016) measure of political uncertainty is featuring.⁸ In line with common practice in the literature, the series are also de-meanned and standardised before being used in the model.

⁸The Appendix details the list of series, sources and transformations operated prior to their inclusion in the auxiliary dataset and the computation of the common component.

3.2 Shock identification

As with traditional VARs, the identification of the shocks is a very important step. A Choleski decomposition is predominantly used in empirical applications. However, we do not aim at identifying all the shocks affecting the system, but only two shocks: those to overall demand and to bank lending supply. For these, it is difficult a priori to justify an ordering of the variables in the system, as both shocks are likely to affect investment simultaneously. Hence, we use sign and impact restrictions to identify them.

The imposed sign restrictions are shown in Table 1. The restrictions are imposed on shock only, during the period when the shock materialises. Thereafter, the responses are left unconstrained. In line with most of the literature, a positive demand shock is defined as a shock which has a positive impact on corporate investment and activity, and triggers a monetary policy reaction, an increase in the policy rate. The response of corporate loans is left undetermined since improved outlook could increase the demand for loans, but could also improve internal resources and enable corporations to finance investment using relatively less external finance. Finally, demand shocks do not change the risk assessment in the interbank market and therefore do not contemporaneously impact the Euribor to Eonia spread. The response of financial conditions, of the ratio of market finance and of the size spread are left undetermined a priori.

A supportive bank lending supply shock is defined as a shock which softens financial conditions, i.e. diminishes the financial condition indicator, and resembles a positive demand shock for investment, activity and the policy rate. Moreover, it narrows the asymmetric conditions faced by small enterprises, and the size spread diminishes. Hence, the softening of bank credit conditions benefits relatively more the more bank-dependent and the smaller corporations are. A supportive bank lending supply shock also reduces the interbank market spread, the Euribor to Eonia spread. The response of the ratio of market finance is left unrestricted.

The restrictions, shown in Table 1, identify the two shocks considered. Comparing with the literature, the identification of demand and bank lending supply shocks is similar to that implemented by Mumtaz et al. (2018) and Gambetti and Musso (2017)

for the variables common to the different models. The key difference between a supportive bank lending supply shock and a positive demand shock lies in the response of the spread in the interbank market: In the case of a demand shock, it does not react instantaneously, while in the case of a bank supportive lending supply shock, associated to loosened financial conditions, it narrows. Besides, there is also a difference in the reaction of the size spread. It is not constrained a priori in the case of a demand shock while it is expected to narrow in the case of a positive bank lending supply shock. These identification restrictions are used for the baseline model. However, to test the robustness of the results regarding the financial block, we also soften the identification: we relax the response of investment and size spread to bank lending shocks. Figures 3 and Figure 4 provide the comparison between the two sets of responses.

Table 1: Impact restrictions used to identify demand and bank lending supply shocks

	Euribor - Eonia spread	Fin. cond.	Real GDP	Corp. inv.	Corp. loans	Ratio market finance	Euribor	Size spread
Bank lending supply	-	-	+	+	?	-	+	-
Overall Demand	0	?	+	+	?	?	+	?

Notes: A positive demand shock is associated with an increase in activity. A positive bank lending supply shock is associated with a loosening of financial conditions. A cell with a question mark indicates that the response is left unrestricted. All the restrictions are imposed on impact. See footnote figure 1 for the names of each variable.

With the minimal restrictions summarised in Table 1, the structural shocks are identified using the methodology of Rubio-Ramirez, Waggoner and Zha (2010) that we combine with a methodology to impose zero response of the interbank spread to the demand shock on impact. First, we let $\Omega = P.P'$ be a Choleski decomposition of the VAR covariance matrix Ω . Second, we draw an $N \times N$ matrix J from a $N(0, 1)$ distribution and compute its $Q_0 R_0$ decomposition and let $\tilde{A}_0 = P.Q$ be the contemporaneous matrix of response of the shocks. Third, we impose a zero restriction on the instantaneous impact of the demand shock on the financial condition indicator by using a

second rotation matrix, R_1 , ($R_1 \cdot R_1' = I$), defined as:

$$R_1 = \begin{pmatrix} \sin(\varphi) & \cos(\varphi) & & & & \\ -\cos(\varphi) & \sin(\varphi) & & & & \\ & & 0_6 & & & \\ & & & & & \\ & & & & & \\ & & & & & I_6 \end{pmatrix} \quad (3)$$

Where I_6 (0_6) is a 6×6 identity (null) matrix and $\varphi = \tan^{-1}(\tilde{A}_0^{1,2} / \tilde{A}_0^{1,1})$ where $\tilde{A}_0^{i,j}$ denotes the i -response to the j -shock and \tan denotes the tangent function. Defining the response matrix as $\tilde{A}_1 = \tilde{A}_0 \cdot R_1$, one can show that the response of the first variable to the second shock is null (see Baumeister and Benati, 2013).

Given the relatively large number of variables included in our VAR and the relatively short sample, we shrink the parameter space of the reduced-form VAR using Bayesian techniques. An advantage of using Bayesian methods to estimate the VAR model is that it allows us to overcome the potential problem of underestimating persistence, which arises when using the conditional likelihood instead of the exact likelihood. We follow the methodology developed by Koop and Korobilis (2009). We first estimate the factor as the principal component of the auxiliary dataset to initiate the Kalman filter. We then estimate the Bayesian Vector Autoregressive model (BVAR) detailed in equation 2 that incorporates four lags, a trend and a constant. We use a standard natural conjugate prior that assumes a normal distribution for the coefficients in the VAR and an inverse-Wishart distribution for the covariance matrix. The BVAR estimation is implemented via dummy-priors following the methodology of Banbura et al. (2010).⁹ The Gibbs-sampler algorithm is used: 20000 replications are estimated and the first 1000 draws are burned.

Impulse responses are constructed by taking a joint draw from the unrestricted Normal-Wishart posterior for the VAR parameters as well as a random possible de-

⁹As shown by Blake and Mumtaz (2012), while analytically equivalent, the use of dummy observations greatly reduces the computational time as the size of the variance covariance matrix to invert is significantly reduced. There are four hyperparameters $\{\tau, c, \delta_j, \sigma_j\}$ that together generate sequences of dummy data, which in turn imply a Normal-Inverse-Wishart prior. The first two hyperparameters control the degrees of prior tightness: τ governs the overall tightness of the prior while c determines the tightness of the prior on the constant. In line with values often used in the literature, we set these two hyperparameters to $\tau = 0.1$ and $c = 1$.

composition B of the variance-covariance matrix. For each set of estimated parameter, up to 500 draws of the rotation matrix J are taken until the response matrix $A1$ fulfills the sign restrictions described in Table 1. When this happens, the draw is retained, the impulse response functions are generated and the corresponding shocks stored.

4 Estimation results

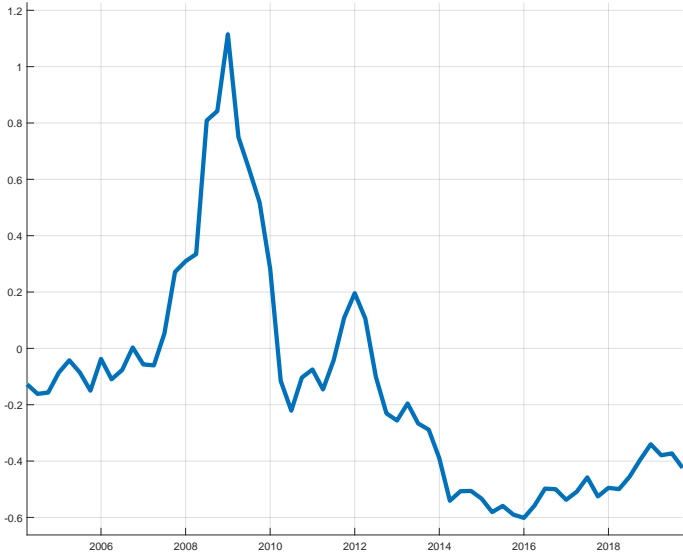
In this section, we present a set of standard outputs enabling an assessment of the model: the estimated financial condition indicator, the impulse responses, the forecast error variance decomposition and the historical decomposition of the two shocks identified to the historical movements of the main variables. Finally, we develop a scenario to illustrate the impact of the bottlenecks in banks' distribution of credits during the sovereign debt crisis.

4.1 The estimated financial factor

Figure 2 plots the estimated financial factor. A higher value of the factor signals a tightening in financial conditions, and *vice versa*. The estimated factor tracks well the major financial shocks experienced by the euro area economy over the past decade. Displaying two major humps, it is overall comparable to the indicator estimated by Moccero et al. (2014) or Maurin (2019) and also correlates well with the interbank spread. First, its value starts increasing already in 2007, at the start of the sub-prime crisis in the US, and before the bankruptcy of Lehman brothers. The financial factor then deteriorates abruptly throughout 2008 to reach a peak in the first quarter of 2009. From then, it declines until the beginning of 2010. Then follows the sovereign debt crisis. From early 2010, concerns start to spread in several euro area sovereigns, escalating in late 2011-beginning of 2012 when market access was suspended for several sovereigns. Following the disbursement of financial support, Troika assistance and the OMT program set up by the ECB, the crisis then slowly receded. Interestingly, the second hump was not as pronounced as in the aftermath of the Lehman bankruptcy, as this crisis was limited

to the euro area and, despite the area-wide slowdown, euro area economies were hit much more asymmetrically during the sovereign debt crisis. Since 2014, the indicator evolves in a narrow range, below the levels recorded during the two years preceding the GFC.

Figure 2: ESTIMATED FINANCIAL FACTOR



Notes: The Figure reports the median of the indicator. An increase portrays a tightening in financial conditions.

4.2 Estimated response functions

Figures 3 and 5 present the impulse responses of the main variables to shocks to, respectively, bank lending supply and overall demand.

4.2.1 Bank lending supply shock

As shown in Figure 3, an adverse bank lending supply shock, associated with a tightened access to bank credit, has a significant impact of up to four quarters on the financial condition index. For a 0.1 increase in the financial conditions indicator, the Euribor to Eonia spread widens by around 3 bps on impact. The short-lived upward

effect vanishes within three quarters.¹⁰ On impact, real GDP growth declines, reaches a low around three quarters after the shock, and the negative effect vanishes around 6 quarters after the shock. In line with what is found in reduced form estimations, the profile of corporate investment resembles that of activity but with a magnitude twice as strong.

The responses of the macro financial variables are much more protracted. The bank lending supply shock reduces the Euribor rate over a period of more than 3 years, as the confidence band crosses the zero line after about 14 quarters. Corporate loans, while not being constrained to react in the identification, are reduced on impact. They reach a low of around 0.8 pp. of annual growth after six quarters and the negative impact lasts for 14 quarters. The size spread (constrained to increase) also widens by up to 4 bps in the first year after the shock, an impact that vanishes within three years. These patterns, in particular the fact that the reactions of the variables to the shock are significant and, in some cases, quite protracted, are in line with the financial accelerator theory emphasizing the role of financial intermediaries as a very important element of the financial accelerator mechanism (Bernanke et al., 1999).

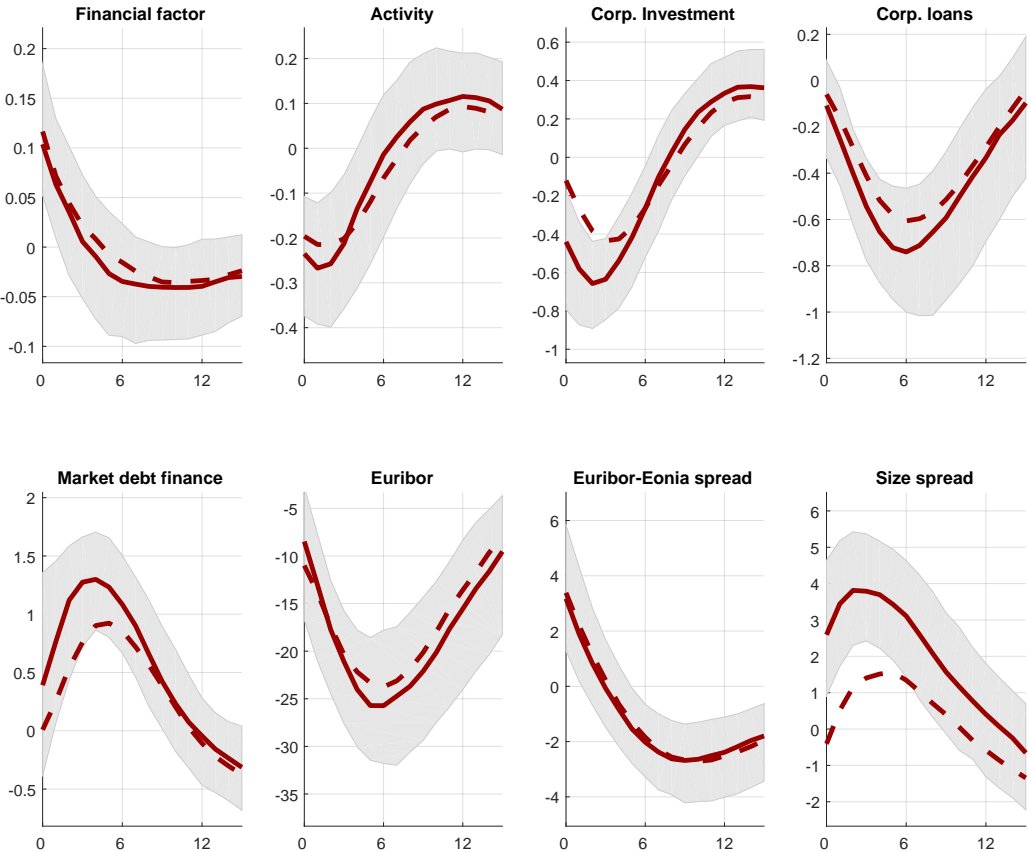
Besides, following an adverse bank lending supply shock, the ratio of market finance increases, with a median impact of up to 1.3% one year after the shock. The positive response is mostly significant while it is not imposed a priori. In addition, the impact is quite prolonged, remaining significant 9 quarters after the shock. This provides evidence that adverse bank lending supply shocks are to some extent circumvented by corporations by stronger debt issuance, and an increase in the share of external finance coming from the market, as corporations substitute bank loans with market debt. This is not possible for small enterprises without market access however. As shown by the rise in the size spread, they face a wider increase in their bank borrowing cost, 4 bps above that recorded by larger corporations.

This result appears to be robust to a looser identification. In figure 3, we also report

¹⁰As shown in Figure 2, during the Lehman crisis, the financial factor increased from around 0 to 1.2, twelve times the magnitude of impact on shock on the financial factor. According to the estimation, bank lending supply shocks would have explained almost half of the rise in the interbank spread recorded during the period, 36 out of 80 bps increase.

the response to a bank lending supply shock identified without restricting the responses of investment and size spread. The results are very similar to those obtained with the entire set of restrictions. The median response of both the ratio of market debt finance and size spread is positive at horizon up to 2 years. It is somewhat less pronounced however, especially for the size spread.

Figure 3: RESPONSES TO A BANK LENDING SUPPLY SHOCK - MAIN VARIABLES



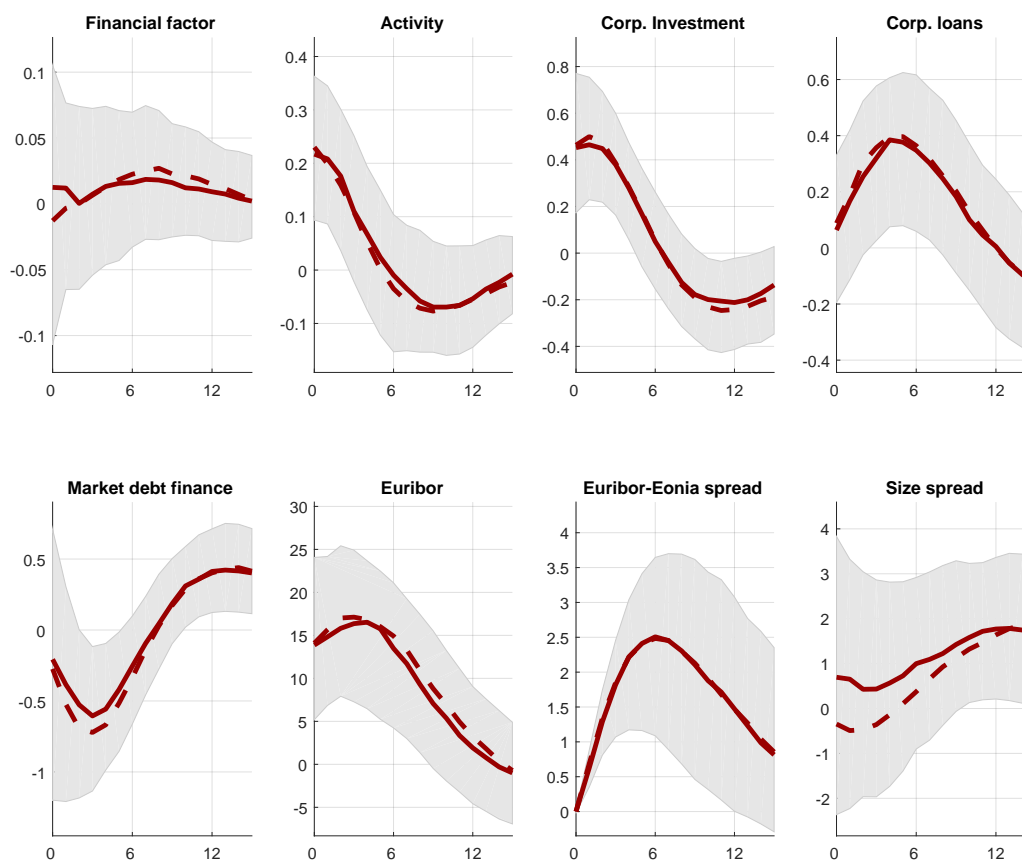
Notes: The impulse-response-functions (IRFs) are estimated based on the VAR presented in Equation (1). The shock is identified with sign restrictions (Table 1). The red line reports the median of the estimated impact while the grey area reports the range of its distribution within the 15% to 85% interval. The dotted line reports the results obtained when relaxing the responses of investment and size spread to bank lending supply shocks. For activity, corporate loans and investment, the responses relate to the annual growth rate, in pp, while for the other variables, the responses relate to the level, in bps.

4.2.2 Demand shock

As shown in Figure 4, a positive demand shock leads in the short-term to an increase in activity, corporate investment and loans. Monetary policy reacts with an instantaneous increase in the Euribor, lasting eight quarters. Regarding the magnitude of the impacts, activity accelerates by 0.2 pp, and the Euribor increases by up to 15 bps. Similarly to the bank lending supply shock, investment reacts stronger than activity: the increase in corporate investment is twice as strong as that in activity. Corporate loans (unconstrained), react positively and significantly after three quarters. These reactions resemble those to a supportive bank lending supply shock, in terms of profile and magnitude; however, in the case of the demand shock no significant pattern is observed for the size spread and the ratio of market-based finance: for both, the confidence interval encompasses the zero line over the whole horizon (only the ratio of debt finance shows a significant but brief negative impact). There is also no significant response in the estimated financial factor. The muted response of the financial variables is to be expected, as in the case of the demand shock the transmission goes rather through the real economy.

To summarise, the reactions of activity, investment and monetary policy, the usual variables in monetary policy VARs, show differences across the two shocks in terms of magnitude and to some extent duration. In each case, the reaction of investment mimics that of activity but is twice as strong. The response of corporate loans is more persistent than that of activity or investment. However, the response of the banking block differs across the two types of shocks. In line with the imposed sign restrictions, in the case of an adverse bank lending supply shock, financial conditions tighten, the interbank market spread widens, the size spread increases and corporates adjust their financial liability structure, increasing the share of external finance obtained from markets. The latter two effects are protracted, lasting more than two years. In line with these impacts, corporate loan growth (which is not restricted) also declines significantly in a protracted way. In contrast, after a demand shock, there is a significant impact on the real variables (although it is smaller in magnitude compared to the bank lending sup-

Figure 4: RESPONSES TO A DEMAND SHOCK - MAIN VARIABLES



Notes: See notes Figure 3.

ply shock) while the response of the financial variables remains muted.

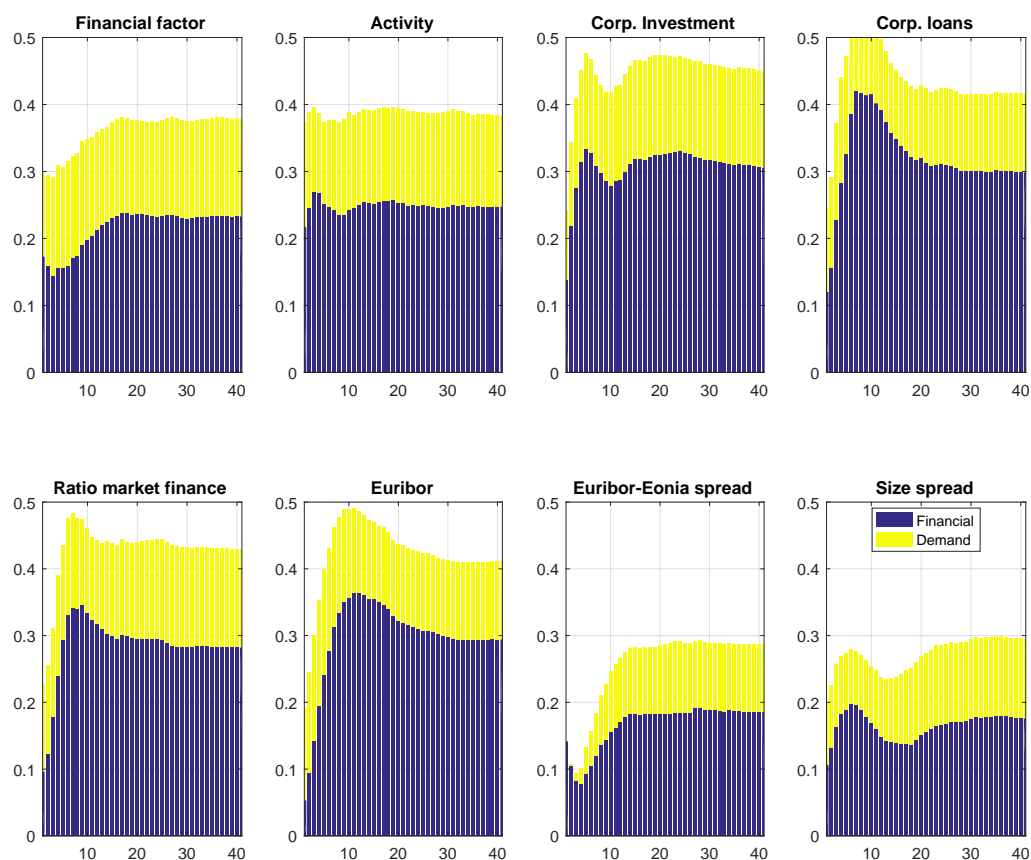
4.3 Shock contributions

In this subsection, we comment on the results obtained for the shock contributions to the variance of the forecast errors and to the historical developments of the macroeconomic series.

4.3.1 Forecast error variance decomposition

The contribution of the two structural shocks to the variance of the forecast error of each main variable at short to medium-term horizons is plotted in Figure 5. At a horizon of 1 to 10 years, the two shocks contribute to explain between one fourth and half of

Figure 5: VARIANCE DECOMPOSITION OF THE UNEXPECTED COMPONENT



Notes: the y-axis reports the share of the variance explained by the shocks, between 0 and 1. The x-axis reports the horizon in quarters.

the variance of the forecast errors. Lower contributions are recorded for the Euribor-Eonia spread and the size spread, and higher values respectively for corporate loans, the ratio of market finance and the Euribor. Over time, the contribution of the demand shock remains relatively stable while that of the bank lending supply shock peaks one to two years after the shock. Over the estimation period, overall bank lending supply shocks explain a larger part of unexpected developments than demand shocks for all the variables, but especially for activity, corporate investment and loans, Euribor and the ratio of market finance. For business investment, shocks to bank lending supply shocks explain up to 30% of the variance of the unexpected component, a protracted effect that remains almost constant from the second to the eighth year. For activity, their median contribution to the variance of the forecast error is very similar over time, but

somewhat smaller in terms of magnitude, with a peak of around 25%. For corporate loans and the Euribor, the opposite is true and bank lending supply shocks explain up to 40%. Interestingly, besides corporate loans, the two shocks contribute relatively little to explaining the other variables in the banking block, i.e. the interbank spread, the size spread and the financial condition indicator. For the two former ones, the contributions add-up to 25 to 30% after one year.

While estimated on the euro area economy, the model reaches conclusions very similar in nature to those obtained in the cases of the US or UK regarding the major role of financial shocks in explaining business cycle fluctuations over the past 15 to 20 years. Christiano et al. (2013) find that the financial shocks associated with the financial intermediary sector play the largest role for the business cycle fluctuations in investment in the US. More generally, shocks of financial origin (risk shock, equity premium shock, external finance premium shock) play an important role for past macroeconomic fluctuations, and larger than conventional demand or supply shocks (de Graeve, 2008).

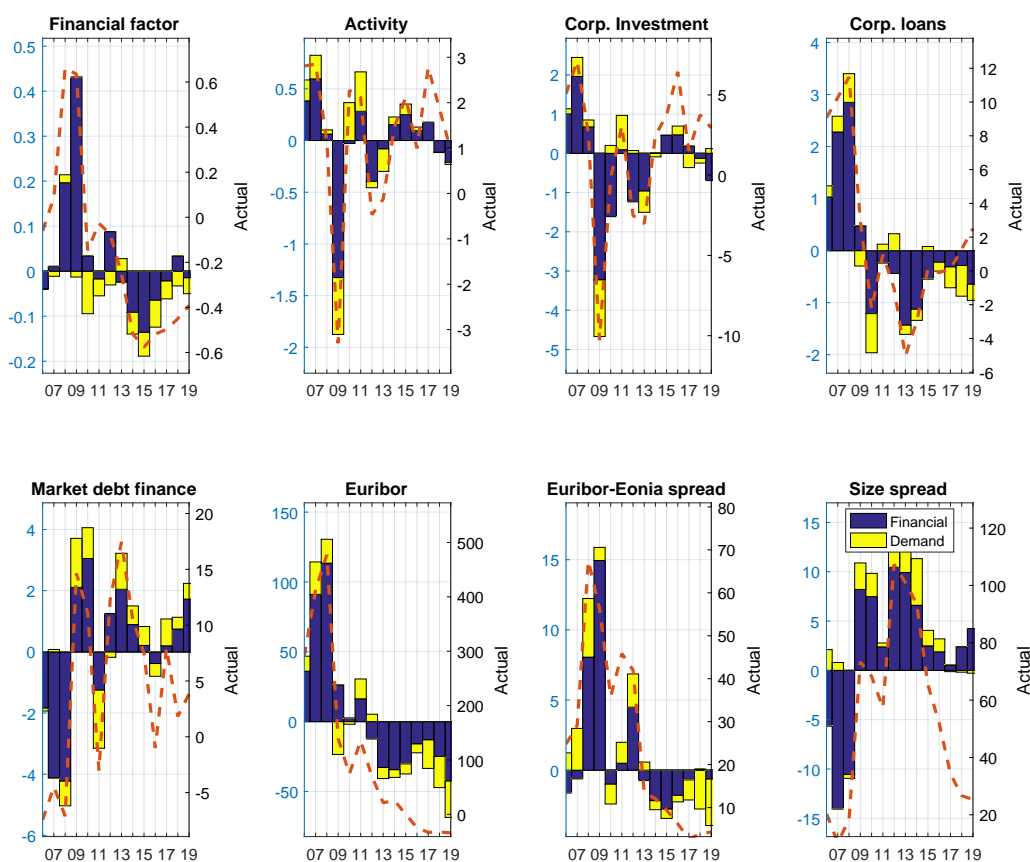
4.3.2 Shock contributions to the main variables over history

Figure 6 shows the median contributions of the two shocks identified to the main variables on an annual basis, derived from the orthogonalised impulse responses and the estimated structural shocks. For each variable, the historical evolution is also reported.

Substantial positive contributions of bank lending supply shocks to the financial indicator are observed in 2008-2009, after the Lehman bankruptcy, and in 2012, at the peak of the sovereign debt crisis. During the first period, bank lending supply shocks explain up to two-thirds of the tightening in financial conditions reported by the indicator, i.e. 0.7 pp out of an estimated rise of 1 pp. During the two periods of adverse bank lending supply shocks, real variables were negatively affected. From 2008 to 2012, bank lending supply shocks reduced corporate investment by close to 7 pp and activity by 2 pp in cumulative terms. It is only from 2014 onwards that bank lending supply shocks start to exert a moderate but positive impact on investment and activity.

Compared to real variables, the negative impact of the bank lending supply shocks on corporate loans is lagged, starting in 2010 but lasting until 2016, dampening loan

Figure 6: Estimated shocks contribution



Notes: The Figure reports the median of the estimated historical contributions. The contributions are plotted as bars and reported on the left axis. The historical series are plotted as red ticked lines reported on the right axis. Activity, corporate investment and corporate loans are reported as annual rate of change, in %, while the ratio of market finance is reported as annual change, in pp.

growth by more than 0.7% each year on average. Notably, bank lending supply shocks contributed positively by close to 2 pp to annual growth in corporate loans prior to the onset of the financial crisis, in 2006-2008. Over the same period, they also contributed to compressing the size spreads but their effect turned positive, up to 10 bps in 2009-2010 and 2012-2014. The negative effect of bank lending supply shocks is even more protracted on Euribor compared to corporate loans, remaining negative until 2019. Finally, throughout most of the period starting with the financial crisis, bank lending supply shocks have contributed positively to the rise in the ratio of market debt finance, by close to 1.2 pp each year on average from 2009 to 2019, thereby contributing to the doubling

of the ratio recorded over the period (see Figure 1).

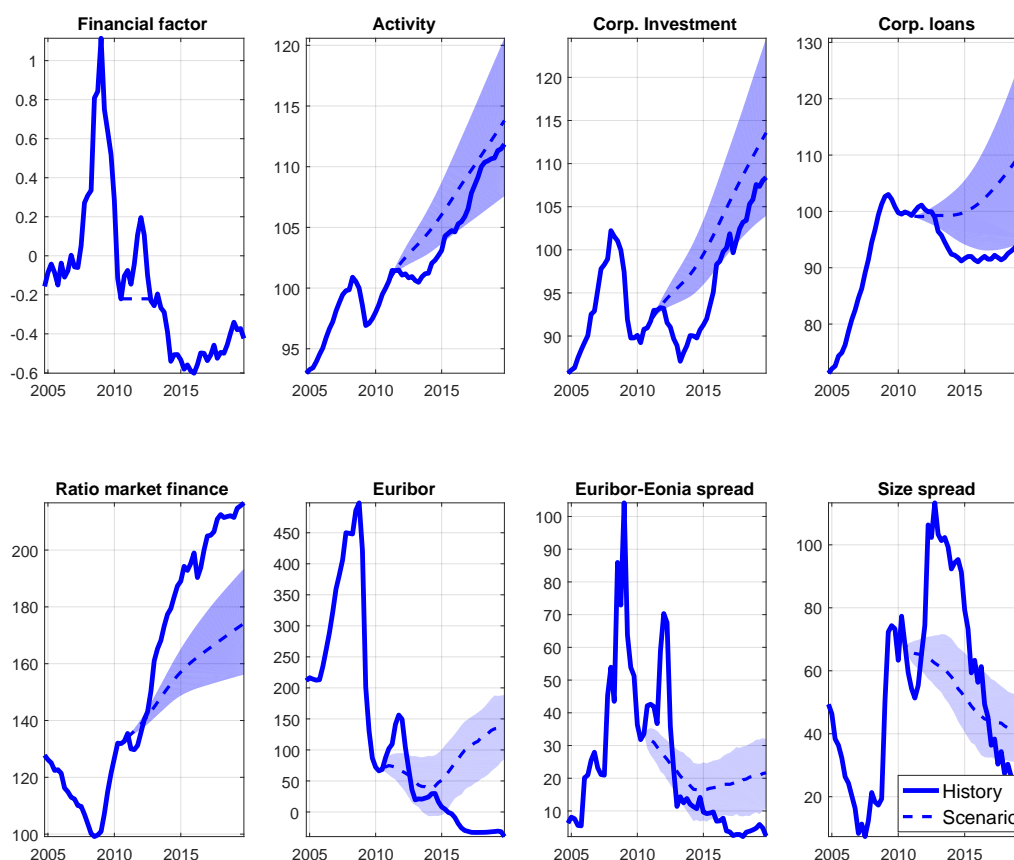
The analysis corroborates the assessment of the forecast error variance contribution: the contribution of the overall demand shock appears less substantial than that of bank lending supply shocks over the period. The latter have remained negative for the financial condition indicator and Euribor for most of the period since 2010.

4.4 Scenario of neutral financing conditions

The estimated model and the two shocks identified can be used to derive a counterfactual scenario, which illustrates the path of each of the VAR variables if the shocks are instrumentalised. In this subsection, we carry out such an exercise in order to illustrate what would have happened to corporate investment had financial conditions remained constant at their level in the second quarter of 2010 until the first quarter of 2013 - a level close to their historical average since 1999. As shown in Figure ??, this path removes the escalation in financial tensions recorded during the sovereign debt crisis. After determining the sequence of bank lending supply shocks consistent with this path, we then compute the implied trajectory of the other variables. The conditional forecast is computed based on the methodology developed by Waggoner and Zha (1999) where only the bank lending supply shock is assumed to adjust to ensure the new path for the financial condition indicator.

The results of the counterfactual simulations are plotted in Figure 7. The tightening in financial conditions in the wake of the SDC substantially reduced activity, corporate investment and real corporate loans. In the beginning of 2013, when financial conditions are assumed to have resumed their estimated path, activity, corporate investment and corporate loans are respectively 3.5, 8.0 and 2.5 pp below their median level in the counterfactual scenario, i.e. in the absence of the adverse shocks. For the two former variables, the gap narrows after 2013 and is no longer significant from mid-2015 onwards. Over the entire period, the deviations from the counterfactual path in corporate investment follow those in activity but are magnified by a factor of more than 2. For corporate loans, the gap widens further after the beginning of 2013, by up to 15 pp

Figure 7: A counterfactual scenario illustrating the absence of sovereign debt crisis



Notes: The Figure reports the counterfactual evolution of the macroeconomic series, had financial conditions remained constant at their level in the second quarter of 2010 until the first quarter of 2013. Only the bank lending supply shock is assumed to adjust to ensure the new path for the financial condition indicator. The interval bands report the interval of the 20th and 80th deciles. See note figure 1 for the dimension of the variables.

until the end of 2016, and remains significant until the end of the estimation period.

The sharper deceleration in bank loan growth observed in the historical path can be associated with the large increase in size spread that pushed up relatively more the cost of borrowing for smaller corporates, which are more dependent on bank credit. In the absence of crisis, the spike in size spread between small and large loans would most likely not have occurred. Comparing historical developments with the counterfactual path, the size spread appears to have widened by up to 55 bps in the beginning of 2012 due to the rise in financial tensions. It is estimated to have remained above its

counterfactual value until the beginning of 2016.

Also, in the absence of SDC, the interbank spreads would have continued to decline from its GFC peak until the beginning of 2015. The second spike, 45 bps above its counterfactual value in the beginning of 2012, would not have materialised. The rise in the ratio of market debt finance would have been less pronounced. The tightening in credit standards together with the increase in the cost of bank borrowing that occurred during the crisis provided an incentive to corporates to issue relatively more market debt. According to the simulations, at the end of 2019, the ratio of market finance is 40 pp above what its value would have been in the absence of a crisis. Instead of increasing by 115% between 2008 and 2019, the ratio would have increased by 75%.

Finally, at the end of 2019, the Euribor, the interbank spread and the size spread are 200, 20 and 20 bp respectively below their counterfactual path.

5 Concluding remarks

In the wake of the GFC, economic research has recalled the role played by financial shocks in explaining business cycles. We contribute to this literature by focusing on the euro area and expanding the typical set of variables used in macro-monetary models, i.e. activity, investment and monetary policy rate. We complement this set with corporate loans, the interbank spread, the size spread and a simple ratio of market based finance. The two latter enable us to consider the asymmetric conditions of smaller corporations, more reliant on bank loans, and the greater flexibility of larger corporates that can issue debt to circumvent tighter access to bank credit.

In order to account for financial tensions, we estimate a financial factor extracted from a large number of financial variables. The factor - a summary measure of financial conditions - is distilled from a number of financial price and quantity indicators related to market prices and volatility, yields, security issuance, bank balance sheet indicators and monetary aggregates. The factor is then incorporated into the BVAR model completing the set of macroeconomic series.

We find that bank lending supply shocks, identified through impact and sign re-

restrictions, had a significant influence on both real and financial developments in the euro area in the period from 2008 to 2019. The impact of bank lending supply shocks is especially pronounced in the shorter run for real variables. It is estimated to have been substantial on activity, investment, size and interbank spreads, reaching a peak around six quarters after the shock. The impact is even more persistent on corporate loans and the ratio of market-based finance. Adverse shocks to bank lending supply are accompanied by some substitution away from bank loans into debt securities, hence an increase in the ratio of market finance, as corporates need to circumvent bottlenecks in the bank credit distribution. For all the variables, the responses to bank lending supply shocks in the euro area since the beginning of 2000s are found to be stronger and somewhat more persistent than those to demand shocks. Adverse shocks to bank lending supply resulted in a more restricted corporate access to external finance and therefore lowered investment.

The persistence of the impact of bank lending supply shocks relates to the super-debt cycle hypothesis, according to which financial tensions result in a protracted period of adjustment and repair in the financial sector. This is likely to explain part of the sub-par-investment in Europe since the beginning of the recovery, from 2013 onwards. The analysis also shows that to some extent, larger firms took advantage of their access to the market to circumvent the tightened access to bank credits. Indeed, part of the protracted increase in corporate debt to loan ratio since the crisis reflects adverse shocks to bank lending supply. Conversely, smaller corporations, unable to issue, faced a higher rise in borrowing costs.

Our analysis of macro-financial developments in the euro area between 2008 and 2019 suggests a strong need for policy actions to deepen corporate debt markets and enlarge market access for smaller corporates. As euro area jurisdictions are differently populated in terms of small enterprises, a European policy is required to promote the convergence in conditions of access to finance. Two main strategies are feasible: alleviating the hurdles to primary debt issuance and leveraging on banks' asset-backed securities issuance. They are not exclusive, however. In this context, the ongoing work under the umbrella of capital market 2.0 is much welcome.

References

- [1] Adrian T., P. Colla, and H.S. Shin (2013), “Which financial frictions? Parsing the evidence from the financial crisis of 2007-9”, In D. Acemoglu, J. Parker and M. Woodford (Eds.), *NBER Macroeconomics Annual*, Vol. 27, 159-214, The University of Chicago Press.
- [2] Aldasoro I. and R. Unger (2017), “External financing and economic activity in the euro area - why are bank loans special?”, *BIS Working Papers*, No. 622, March.
- [3] Altavilla C., M. Darracq Paries and G. Nicoletti (2019), “Loan supply, credit markets and the euro area financial crisis”, *Journal of Banking Finance*, vol. 109, issue C.
- [4] Banbura M., D. Giannone and L. Reichlin (2010), “Large bayesian vector auto regressions”, *Journal of Applied Econometrics*, 25, pp.71–92.
- [5] Baumeister C. and L. Benati (2013), “Unconventional monetary policy and the great recession: estimating the macroeconomic effect of a spread compression at the zero lower bound”, *International Journal of Central Banking*, June 2013, pp. 165-212.
- [6] Becker B. and V. Ivashina (2014), “Cyclicality of credit supply: firm-level evidence”, *Journal of Monetary Economics*, 62, pp. 76–93.
- [7] Bernanke B., M. Gertler and S. Gilchrist (1999), “The financial accelerator in a quantitative business cycle framework”, *Handbook of Macroeconomics*, vol. 1, Chapter 21, edited by JB. Taylor and M. Woodford, Elsevier Science.
- [8] Bernanke B., J. Boivin and P.S. Elias (2005), “Measuring the effects of monetary policy: a structural interpretation: a Factor-Augmented Vector Autoregressive (FAVAR) Approach”, *The Quarterly Journal of Economics* 120 (1), pp. 387-422.

- [9] Bijsterbosch M. and M. Falagiarda (2015), "The macroeconomic impact of financial fragmentation in the euro area: Which role for credit supply?", *Journal of International Money and Finance*, Volume 54, June 2015, pp. 93-115.
- [10] Blake A. and H. Mumtaz (2012), "CCBS Technical Handbook No.4. Applied Econometrics for Central Bankers", Bank of England.
- [11] Borensztein E. and L.Ye (2018), "Corporate debt overhang and investment", World Bank Policy research working paper No. 8553.
- [12] Campello M., J.R. Graham and C. Harvey (2010), "The real effects of financial constraints: evidence from a financial crisis", *Journal of Financial Economics*, vol. 97, Issue 3, pp. 470-487.
- [13] Christiano L., R. Motto and M. Rostagno (2013), "Risk Shocks", *American Economic Review*, vol. 104, N1, pp. 27-65.
- [14] Dave C., S. J. Dressler and L. Zhang (2013) "Bank-lending Channel: A FAVAR Analysis" *Journal of Money, Credit and Banking*, Vol. 45, No. 8, pp. 1705-1720.
- [15] De Fiore F. and H. Uhlig (2015), "Corporate Debt Structure and the Financial Crisis", *Journal of Money, Credit and Banking*, Vol. 47, No. 8, pp. 1571-1598.
- [16] De Graeve F. (2008), "The external finance premium and the macroeconomy: US-post WWII evidence", *Journal of Economic Dynamics and Control*, 32, pp. 3415-3440.
- [17] Duchin R., O. Ozbas and B.A. Sensoy (2010), "Costly external finance, corporate investment, and the subprime mortgage credit crisis", *Journal of Financial Economics* 97, pp. 418-435.
- [18] EC (2017), "Analysis of the European corporate bond market", Analytical report supporting the main report from the Commission Expert Group on Corporate Bonds, November.

- [19] ECB (2018), “Business investment in EU countries”, WGEM team on investment, ECB Occasional paper No. 215, October 2018.
- [20] Gambetti L. and A. Musso (2017), “Loan supply shocks and the business cycle” *Journal of Applied Economics*, 32, pp.764–782.
- [21] Garcia-Posada Gomez, M. (2019), “Credit constraints, firm investment and employment: Evidence form survey data””, *Journal of Banking and Finance*, pp. 99:121-141.
- [22] Gertler M. and P. Karadi (2011), “A model of unconventional monetary policy”, *Journal of Monetary Economics*, Vol. 58, pp. 17-34.
- [23] Gilchrist S. and E. Zakrajcek (2012), “Credit Spreads and Business Cycle Fluctuations”, *American Economic Review*, Vol. 102, No. 4, pp. 169-1720.
- [24] Gilchrist S. and B. Mojon (2016), “Credit Risk in the euro area”, *The Economic Journal*, 128 (February), 118–158.
- [25] Holguín, J.S. and J.M. Uribe (2020), “The credit supply channel of monetary policy: evidence from a FAVAR model with sign restrictions”. *Empirical Economics* 59, pp. 2443–2472.
- [26] Holm-Hadulla, F. and C. Thurwachter (2021), “Heterogeneity in corporate debt structures and the transmission of monetary policy”. *European Economic Review*, July 2021, Vol. 136.
- [27] Hosszú, Z. (2018), “The impact of credit supply shocks and a new Financial Conditions Index based on a FAVAR approach”, *Economic Systems*, vol. 42, Iss. 1, pp. 32-44.
- [28] Hristov H., O. Nikolay, T. Hulsewig and T. Wollmershauser (2012), “Loan supply shocks during the financial crisis: Evidence for the Euro area”, *Journal of International Money and Finance*, vol. 31, issue 3, pp. 569-592.

- [29] IMF (2015), "Private investment: what's the holdup?", *World Economic Outlook*, April.
- [30] Koop G. and D. Korobilis (2009), "Bayesian multivariate time series methods for empirical macroeconomics", mimeo, The Rimini Center for Economic Analysis.
- [31] Lenza M. and G.E. Primiceri (2020), "How to estimate a VAR after March 2020", *ECB Working Paper Series*, (2461).
- [32] Maurin L. (2019), "Weakness of investment in Portugal: what role do credit supply and fiscal consolidation shocks play?", *Portuguese Economic Journal*, 18, pp. 19–45.
- [33] Moccero D., M. Darracq-Parries and L. Maurin (2014), Financing Condition Index and identification of credit supply shock for the euro area, *International finance*, Vol 17, Issue 3, pp. 297-321.
- [34] Mumtaz H., G. Pinter and K. Theodoridis (2018), "What do VARs Tell Us about the Impact of a Credit Supply Shock? An Empirical Analysis", *International Economic Review*, Vol. 59, Issue 2, pp. 625-646.
- [35] Rubio-Ramirez J.F., D.F. Waggoner and T. Zha (2010), "Structural Vector Autoregressions: Theory of Identification and Algorithms for Inference", *Review of Economic Studies*, Vol. 77, pp. 665-96.
- [36] Sanjani M.T. (2014), "Financial Frictions and Sources of Business Cycle", *IMF Working Paper No. 14/194*.
- [37] Waggoner D.F. and T. Zha (1999), "Conditional Forecasts in Dynamic Multivariate Models", *Review of Economics and Statistics*, Vol. 81, No. 4, pp. 639-51.

Appendix A

Series included in the auxiliary dataset: description, source and transformation

Variable	Description	Source	Transformation
Banks and financial institutions			
Capital ratio	Average capital ratio of the Euro area banking sector, defined as total capital plus reserves over total assets	ECB BSI statistics	Qtr change
Liquidity ratio	Average liquidity ratio of the Euro area banking sector, defined as securities plus cash over total assets	ECB BSI statistics	Qtr change
M1	Euro area aggregate stock of currency and overnight deposits	ECB	Qtr growth rate
M2 - M1	Euro area monetary deposits other than overnight	ECB	Qtr growth rate
M3 - M2	Marketable instruments included in Euro area M3	ECB	Qtr growth rate
Government securities	Euro area MFIs holdings of government securities	ECB BSI statistics	Qtr growth rate
Securities other than shares	Euro area MFIs holding of securities other than shares	ECB BSI statistics	Qtr growth rate
Interest rate on consumer loans	Annualised lending rate on MFIs new consumer loans, Euro area	ECB MIR Statistics	Qtr growth rate
Bank bond spread	Spread Financial AA Merrill Lynch Bond Index minus Euribor 3-months	Merrill Lynch	None
Beta Financials	Average of the rolling 60-business day covariance of the daily percentage change of the euro area's banking sector equity index and its overall stock market index, divided by the rolling 60-business day variance of the daily percentage change of the overall stock market index	Based on Refinitiv	None
Volatility financial stocks	Realised volatility of stock market returns of financial institutions. The realised volatility is defined as the Qtr average of the absolute daily returns	Based on Refinitiv	None
Fixed income market			
Gov. bond spread (2y)	Euro area - German gov. bond yield (2 years)	Based on Bloomberg	None
Gov. bond spread (3y)	Difference between Euro area and German gov. bond yield (3 years)	Based on Bloomberg	None
Gov. bond spread (5y)	Difference between Euro area and German gov. bond yield (5 years)	Based on Bloomberg	None
Gov. bond spread (7y)	Difference between Euro area and German gov. bond yield (7 years)	Based on Bloomberg	None
Gov. bond spread (10y)	Difference between Euro area and German gov. bond yield (10 years)	Based on Bloomberg	None
Gov. bond yield, volatility	Monthly average of the absolute value of daily yield changes in the German benchmark 10-year gov. bond	Based on Refinitiv	None
Corporate bond spread (NFCs, AA)	Spread between the bond index for AA-NFCS and that for Euro area governments	Based on Refinitiv and Merrill Lynch	None

Variable	Description	Source	Transformation
Fixed income market (cont.)			
Corporate bond spread (NFCs, A)	Spread between the bond index for A-NFCs and that for Euro area governments	Based on Refinitiv and Merrill Lynch	None
Corporate bond spread (NFCs, BBB)	Spread between the Bond Index for BBB-NFCs and that for Euro area governments	Based on Refinitiv and Merrill Lynch	None
Corporate bond spread (FIs, AAA)	Spread between the bond index for AAA-FIs and that for Euro area governments	Based on Refinitiv and Merrill Lynch	None
Corporate bond spread (FIs, AA)	Spread between the bond index for AA-FIs and that for Euro area governments	Based on Refinitiv and Merrill Lynch	None
Corporate bond spread (FIs, A)	Spread between the bond index for A-FIs and that for Euro area governments	Based on Refinitiv and Merrill Lynch	None
Corporate bond spread (FIs, BBB)	Spread between the Bond Index for BBB-FIs and that for Euro area governments	Based on Refinitiv and Merrill Lynch	None
Spread on high yield	Spread between the yield on euro-denominated corporate bonds with sub-investment grade category and that on Euro area governments	Based on Refinitiv and Merrill Lynch	None
Implied bond market volatility	Euro area bond market	Refinitiv	None
Implied stock market volatility	EUROSTOXX equity market	Refinitiv	None
Stock market			
Stock prices (NFCs)	Stock price index of Euro area NFCs	Refinitiv	Qtr growth rate
Stock prices (FIs)	Stock price index of Euro area FIs	Refinitiv	Qtr growth rate
Price-to-Book (NFCs)	Index of price to book value of Euro area NFCs	Refinitiv	None
Price-to-Book (FIs)	Index of price to book value of Euro area FIs	Refinitiv	None
Equities stock (NFCs)	Notional index of equity stock of Euro area NFCs	ECB	Qtr growth rate
Equities stock (FIs)	Notional index of equity stock of Euro area FIs.	ECB	Qtr growth rate
Stocks and Bond correlation	Qtr average of the rolling 30-business day correlation between the daily percentage change of the euro area equity index (Eurostoxx) and German benchmark government bond yield	Based on ECB and Refinitiv	None
Volatility stocks NFCs	Realised volatility of stock market return of European NFCs. Qtr average of absolute daily returns	Based on Refinitiv	None

Variable	Description	Source	Transformation
Forex and world economy			
Euro nominal effective exchange rate	Euro area nominal effective exchange rate vis-à-vis 12 trading partners	ECB	Qtr growth rate
Euro, nominal effective exchange rate (volatility)	Realised volatility of nominal effective exchange rate of the euro vis-à-vis 12 trading partners. Qtr average of absolute daily return	Based on ECB	None
World market price of raw materials	Index of Cost of imported raw material in the industrial countries (euro area and OECD countries, in euros)	HWWI	Qtr growth rate
Oil Price	WTI index in euros	HWWI	Qtr growth rate
Policy uncertainty	Index of EU policy uncertainty; see “Measuring Economic Policy Uncertainty” by S. R. Baker, N. Bloom and S. J. Davis.	www.PolicyUncertainty.com	None

Acknowledgements

The views expressed in the paper are those of the authors and do not necessarily reflect the position of the EIB nor of the ECB.
Corresponding author: Laurent Maurin.

Malin Andersson

European Central Bank, Frankfurt am Main, Germany; email: malin.andersson@ecb.int

Laurent Maurin

European Investment Bank, Luxembourg, Luxembourg; email: l.maurin@eib.org

Desislava Rusinova

European Central Bank, Frankfurt am Main, Germany; email: desislava.rusinova@ecb.int

© European Central Bank, 2021

Postal address 60640 Frankfurt am Main, Germany

Telephone +49 69 1344 0

Website www.ecb.europa.eu

All rights reserved. Any reproduction, publication and reprint in the form of a different publication, whether printed or produced electronically, in whole or in part, is permitted only with the explicit written authorisation of the ECB or the authors.

This paper can be downloaded without charge from www.ecb.europa.eu, from the [Social Science Research Network electronic library](#) or from [RePEc: Research Papers in Economics](#). Information on all of the papers published in the ECB Working Paper Series can be found on the [ECB's website](#).

PDF

ISBN 978-92-899-4859-3

ISSN 1725-2806

doi:10.2866/22681

QB-AR-21-097-EN-N