DEUTSCHE
BUNDESBANK
EUROSYSTEM

Discussion Paper

Deutsche Bundesbank
No 23/2019

Bank loan supply shocks and alternative financing of non-financial corporations in the euro area

Martin Mandler
(Deutsche Bundesbank and Justus-Liebig-Universität Gießen)

Michael Scharnagl
(Deutsche Bundesbank)

Deutsche Bundesbank, Wilhelm-Epstein-Straße 14, 60431 Frankfurt am Main,
Postfach 10 06 02, 60006 Frankfurt am Main

Tel +49 69 9566-0

Please address all orders in writing to: Deutsche Bundesbank,
Press and Public Relations Division, at the above address or via fax +49 69 9566-3077

Internet http://www.bundesbank.de

ISBN 978–3–95729–599–6 (Printversion)
ISBN 978–3–95729–600–9 (Internetversion)

Non-technical summary

Research Question

External financing of non-financial corporations can occur through various instruments, such as bank loans, equity issuance, debt security issuance, loans from non-banks or trade credit. Potentially, firms can compensate for a reduced availability of bank loans by raising external financing from alternative sources. We study for the Euro Area, Germany, France, Italy and Spain whether, following a shock to banks' loan supply to firms, the different alternative external financing sources act as substitutes for or as complements to bank loans. Furthermore, if there is substitution, we ask whether it is sufficiently strong to offset the impact of a bank loan supply shock on firms' overall external financing.

Contribution

We augment a standard time series model for estimating the macroeconomic effects of bank loan supply shocks by flow-of-funds data on firms' external financing via issuance of equity and debt securities, lending from non-banks and trade credit. We assess whether a financing component is a substitute for bank loans or a complement by checking for negative or positive co-movement with bank lending after a loan supply shock. Thus, we base our classification on the joint distribution of the reactions of bank loans and each alternative external financing component rather than on the marginal distribution in order to obtain more precise results.

Results

Our results for the Euro Area show equity, debt securities and non-bank loans to be substitutes for bank loans while trade credit is a complement. Quantitatively, changes in bank loans and trade credit dominate the response of the overall sum of external financing. This result also holds in most cases at the country level. However, whether and which of the alternative financing sources are substitutes for or complements to bank loans differs across countries: Non-bank loans are complements to bank loans in France and Italy. Trade credit is a complement in France and Spain and, to some extent, in Italy. Equity financing is a substitute for bank loans in Italy. The results for Germany are inconclusive.

Nichttechnische Zusammenfassung

Fragestellung

Neben Bankkrediten verfügen nichtfinanzielle Kapitalgesellschaften über weitere Formen der externen Finanzierung in Form von Anteilsrechten, Anleihen, Krediten von Nichtbanken und Handelskrediten. Die Unternehmen könnten deshalb eine verringerte Verfügbarkeit von Bankkrediten mit anderen externen Finanzierungsformen kompensieren. Wir untersuchen für den Euroraum, Deutschland, Frankreich, Italien und Spanien, ob die verschiedenen alternativen externen Finanzierungsformen, nach einem Schock auf das Angebot an Bankkrediten, Substitute oder Komplemente für Bankkkredite darstellen. Wir analysieren außerdem, inwieweit Substitute für Bankkredite die Effekte eines Kreditangebotsschocks auf die gesamte externe Finanzierung der Unternehmen kompensieren.

Beitrag

Wir erweitern ein Zeitreihenmodell für die Analyse der Effekte von Kreditangebotsschocks um Daten aus der Finanzierungsrechnung zur Finanzierung von nichtfinanziellen Kapitalgesellschaften durch Anteilsrechte, Anleihen, Nichtbank-Kredite und Handelskredite. Die Klassifikation dieser Finanzierungsinstrumente als Substitute oder Komplemente für Bankkredite erfolgt anhand der Korrelation ihrer Anpassungsreaktion mit jener der Bankkredite nach einem Kreditangebotssschock. Sie baut auf der gemeinsamen Wahrscheinlichkeitsverteilung der Anpassungen von Bankkrediten und alternativen Finanzierungsquellen auf und ermöglicht präzisere Ergebnisse im Vergleich zur Analyse nur der Randverteilungen.

Ergebnisse

Unsere Ergebnisse für den Euroraum zeigen, dass für die externe Finanzierung von nichtfinanziellen Kapitalgesellschaften Anteilsrechte, Anleihen und Nichtbank-Kredite Substitute für Bankkredite darstellen, während Handelskredite komplementär zu Bankkrediten sind. Quantitativ wird die Entwicklung der externen Finanzierung der Unternehmen nach einem Kreditangebotsschock von den Bankkrediten und den Handelskrediten domininert. Dieses Ergebnis zeigt sich auch auf Länderebene. Die Klassifikation der externen Finanzierungsquellen in Subsitute und Komplemente für Bankkredite unterscheidet sich jedoch über die Länder: Nichtbank-Kredite sind Substitute für Bankkredite in Frankreich und Italien, Handelskredite sind ein Komplement in Frankreich und Spanien und, ansatzweise, auch in Italien. Anteilsrechte sind ein Substitut in Italien. Für Deutschland finden wir keine klaren Ergebnisse.

Deutsche Bundesbank Discussion Paper No 23/2019

Bank loan supply shocks and alternative financing of non-financial corporations in the Euro Area*

Martin Mandler
Deutsche Bundesbank
Justus-Liebig-Universität Gießen

Michael Scharnagl
Deutsche Bundesbank

Abstract

We analyse the macroeconomic effects of exogenous contractions in bank lending to non-financial corporations in the Euro Area, Germany, France, Italy and Spain using a Bayesian vector autoregressive model with endogenous hyperparameter selection and identification via sign restrictions. We focus on the behaviour of firms' external financing sources alternative to bank loans, such as financing via equity, debt securities, trade credit and lending from non-banks. We investigate whether these alternative financing sources are complements to or substitutes for bank lending using the *joint* posterior distribution of their impulse responses with that of bank loans. For the Euro Area our results show equity, debt securities and non-bank loans to be substitutes for bank loans with negative responses to a positive loan supply shock while trade credit is a complement and responds positively. We show that the substitution relationship with respect to bank loans is more clearly visible in the joint distribution of the financing sources reactions than when focusing only on the marginal impulse responses. Quantitatively, the developments in bank loans and trade credit dominate the response of the overall sum of the external financing. This result also holds in most cases at the country level. However, whether and which of the alternative financing sources are substitutes for or complements to bank loans differs across countries.

Keywords: loan supply, external financing, Euro Area, Bayesian VAR, sign restrictions, joint posterior distribution

JEL classification: C32, E32, E51

*Contact address: Deutsche Bundesbank, Wilhelm-Epstein-Strasse 14, D-60431 Frankfurt am Main, Germany. E-Mail: martin.mandler@bundesbank.de, michael.scharnagl@bundesbank.de. We are indebted to an anonymous referee, Carlo Altavilla, Makram El-Shagi, Alberto Musso, Christian Offermanns, Bernhard Winkler, Thomas Vlasopoulos, seminar participants at the European Central Bank, conference participants of the 49th Annual Conference of the Money, Macro and Finance Research Group and the 22nd Annual International Conference on Macroeoconomic Analysis and International Finance for helpful comments and discussions. This paper represents the authors' personal opinions and does not necessarily reflect the views of the Deutsche Bundesbank.

1 Introduction

The Euro Area economy as a whole and many of its member countries have experienced a sustained weakness in bank lending to firms following the financial and sovereign debt crises. An important policy question is whether this weakness in bank lending was mostly caused by weak loan demand, reflecting weak business cycle conditions which persisted well into 2015 or whether it was due to a contraction in banks' loan supply, e.g. due to weak capital positions, non-performing loans, reduced risk-taking or reassessments of risks. As a result, over the past years various have studied the effects of loan supply shocks in the Euro Area and their importance for loan dynamics, e.g. Altavilla, Darracq-Paries, and Nicoletti (2015), Deutsche Bundesbank (2015), Gambetti and Musso (2017) and Moccero, Darracq-Paries, and Maurin (2014) as well as in individual Euro Area countries e.g. Bijsterbosch and Falagiarda (2015), Hristov, Hülsewig, and Wollmershäuser (2012) and Duchi and Elbourne (2016).

Almost all of these analyses, however, do not account for firms potentially having access to alternative sources of external financing that might act as substitutes for the reduced availability of bank loans after a loan supply shock and might dampen its effects. In fact, in the Euro Area there has been a relative decline in the importance of bank financing, in particular bank loans to non-financial firms over time (e.g. Deutsche Bundesbank, 2018; European Central Bank, 2016).

In this paper we augment standard vector autoregressive (VAR) models used in the analysis of the macroeconomic effects of loan supply shocks with alternative financing sources for firms taken from the flow of funds statistics. We study the effects of loan supply shocks on the alternative external financing sources and on overall external financing of non-financial firms and investigate whether the alternative financing sources act as complements or substitutes with respect to bank loans. The analysis is carried out for the aggregate Euro Area and for the four large member countries (Germany, France, Italy and Spain). We identify loan supply shocks using sign restrictions motivated by DSGE models. Mumtaz, Pinter, and Theodoridis (1998) show VAR models with sign restrictions to be able to capture bank loan supply shocks reasonably well in simulations. Since the inclusion of additional financing sources leads to a considerable increase in the dimension of the model we estimate the models using a Bayesian approach and employ the endogenous hyperparameter selection from Giannone, Lenza, and Primiceri (2016) which selects the shrinkage imposed on the VAR coefficients in a data-driven way.

Our analysis is related Gambetti and Musso (2017) and Bijsterbosch and Falagiarda (2015). Both use time-varying VAR models which require the VAR to be of reasonably small dimension and the availability of long data series. Since we use higher-dimensional

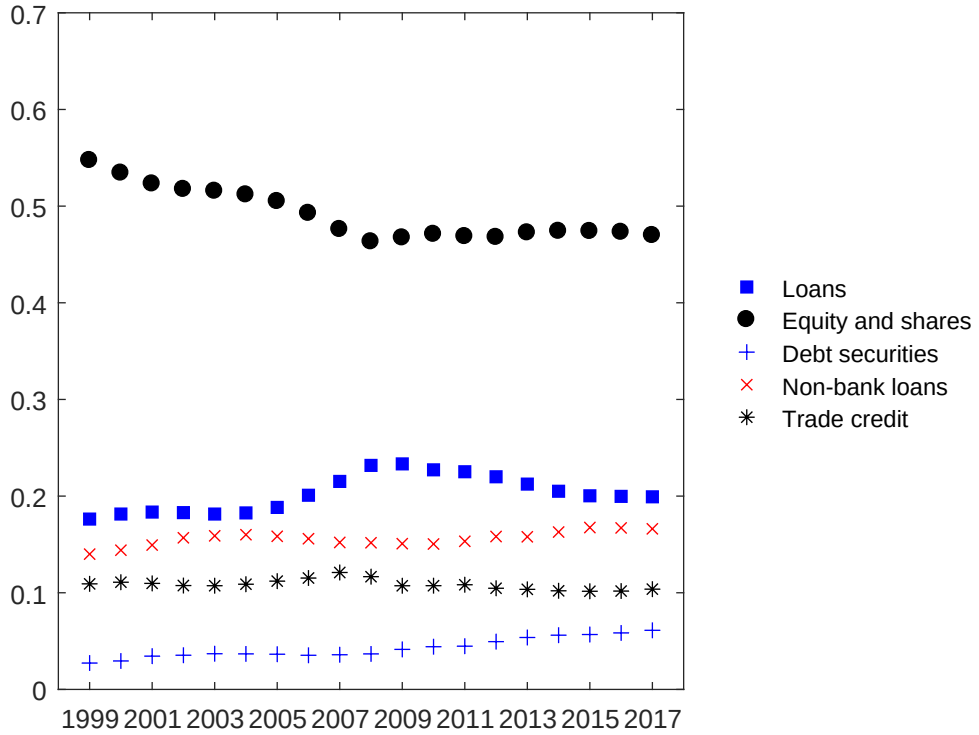
models and our data set runs from 1999 onwards only, we have to remain in a fixed-parameter VAR framework. The second important difference in our approach is that both papers do not consider alternative financing sources. For the individual country models our analysis differs from Bijsterbosch and Falagiarda (2015) furthermore, in that we include Euro Area aggregates for output and price level in the country models to improve the estimation of the monetary policy reaction function and the identification of the monetary policy shock. Our paper ist also related to Altavilla et al. (2015) who analyse the macroeconomic effects of loan supply shocks using a fixed-parameter Bayesian VAR model that includes debt securities issuance by non-financial corporations. They identify loan supply shocks using information from the Eurosystem's bank lending survey (BLS) an an external instrument approach. They find evidence for the substitution of bank loans with debt securities issuance in the wake of a negative loan supply shock. However, they neither include the full range of alternative financing sources nor do they consider possible differences across countries. Bonci (2014) adds flow-of-funds variables to a small structural VAR model for the Euro Area one-at-a-time and identifies a monetary policy shock using a Cholesky decomposition. The responses of firms' different external financing sources, however, turn out to be mostly not statistically significant and his approach does not account for possible interactions among the variables.

Aldasoro and Unger (2017) also analyse the effect of loan supply shocks on alternative financing sources but consider only the composite of equity, debt securities and non-bank loans and impose substitution between the sum of these financing sources and bank loans in their identification scheme. In contrast, we consider equity, debt securities and non-bank loans as individual components, include trade credit as another alternative financing source, and do not impose the assumption of them being substitutes for bank lending. We remain agnostic about the nature of the relationship between the alternative financing sources and bank loans, and allow for, e.g. equity and debt securities issuance to act as substitutes for bank loans while non-bank loans can act as a complement. Aldasoro and Unger (2017) also do not present results for historical decompositions and for the dynamics of the overall sum of external financing including bank loans which does not allow them to estimate to what an extent substitution across financing sources is important and whether substitution is complete or incomplete.[1]

Figures 1 and 2 provide an overview on the relative importance of non-financial corporations' different external financing sources. These include bank loans, equities and shares, debt securities issued, non-bank loans and trade credit. Non-bank loans are loans to firms from other economic sectors but not from banks. The graphs show the shares of

[1]Their results are not directly comparable to ours because their model uses levels for real GDP and prices but growth rates for financing sources while we enter all of these variables in levels which allows for the possibility of cointegration relationships.

Figure 1: Shares of external financing sources for non-financial corporations - Euro Area



Annual averages.

each component in overall external financing over time.[2] Financing through equity and shares is the most important component in the Euro Area and all countries. Bank loans are the second most important component in the Euro Area as a whole, DE and IT, and, since the late 2000s in ES, as well. Debt securities account for the smallest share in all countries. Figure 2 shows some important differences across countries: FR stands out with non-bank loans as the second most-important external financing source exceeding the share of bank loans. The share of trade credit was higher in ES but has declined from over 20 to around 12 percent since the financial crisis.

2 Empirical approach

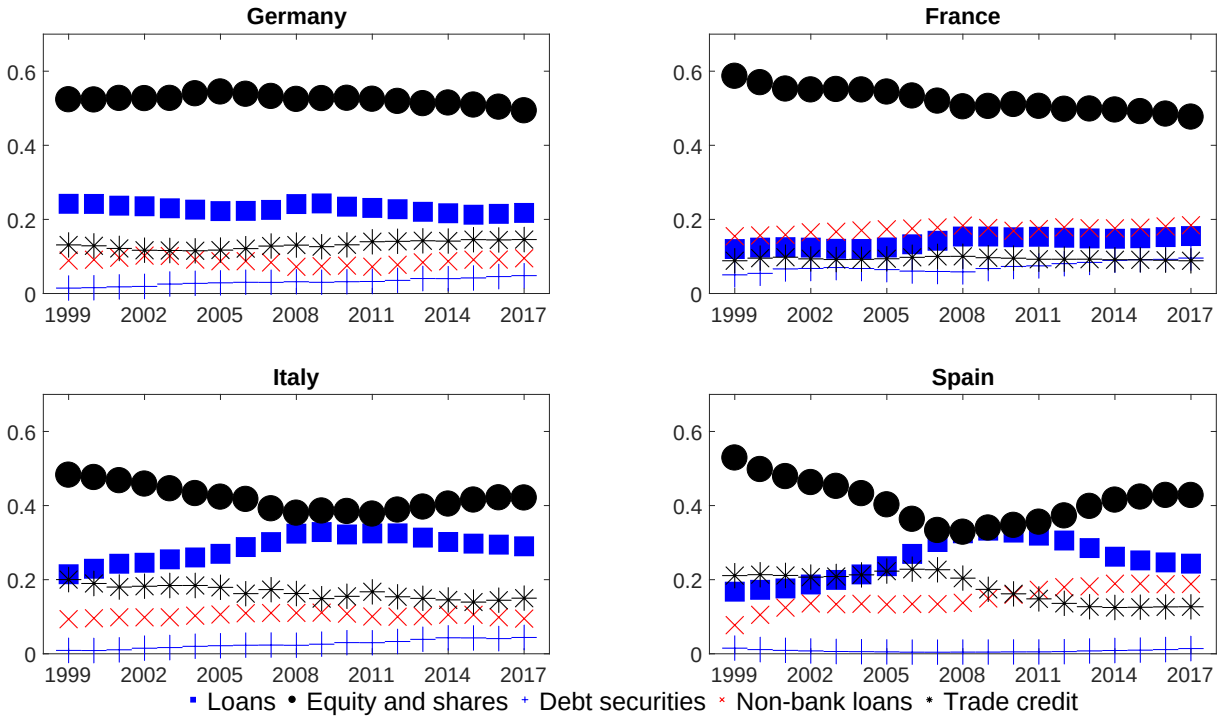
2.1 Estimation approach

We model the dynamic interactions among the variables using a Bayesian vector autoregressive (BVAR) model

$$y_t = c + B_1 y_{t-1} + \cdots + B_p y_{t-p} + \epsilon_t, \tag{1}$$

[2]For more information on the data, see section 2.2.

Figure 2: Shares of external financing sources for non-financial corporations - individual countries



Annual averages.

where y_t is a vector of n endogenous variables in period t, c is a vector of intercepts, B_i is a $n \times n$ matrix of coefficients on lag i of the endogenous variables, p is the number of lags and ϵ_t is a vector of residuals that are jointly normally distributed with mean zero and covariance Σ.

As the number of parameters is large relative to the sample size we impose shrinkage on the parameters using a Bayesian estimation approach. We estimate the model using the approach by Giannone et al. (2016) who set the hyperparameters of the prior distributions of the VAR parameters in a data-driven way. Instead of fixing them ad-hoc (Sims and Zha, 1998), by estimating them using a training sample or matching the in-sample fit of the BVAR to that of a small VAR (Banbura, Giannone, and Reichlin, 2010) they treat the hyperparameters as random variables to be estimated. This implies a hierarchical structure of the prior distribution in which "hyperpriors" are imposed on the hyperparameters.

The prior for the coefficients B_i, $i = 1, ..., p$ and for the covariance matrix Σ is of the Normal-Inverse-Wishart-type. Conditional on the vector of hyperparameters γ and on the covariance matrix of the reduced-form VAR residuals Σ we set set the prior mean of the autoregressive coefficient on the first own lag of variable i equal to the estimated coefficient from a univariate AR(1) regression $\hat{b}_i$ and the prior mean of all other coefficients

equal to zero

$$E\left(B_{k,ij}|\Sigma,\gamma\right)=\begin{cases}\hat{b}_i & \text{if } i=j \text{ and } k=1\\ 0 & \text{otherwise.}\end{cases} \tag{2}$$

The prior covariance matrix of the B_i coefficients is

$$cov\left(B_{k,ij},B_{s,hm}|\Sigma,\lambda,\Psi\right)=\begin{cases}\lambda^2\frac{1}{k^2}\frac{\Sigma_{ih}}{\Psi_{jj}} & \text{if } m=j \text{ and } s=k\\ 0 & \text{otherwise,}\end{cases} \tag{3}$$

where the hyperparameters λ and Ψ are elements of γ. The higher the lag k, the stronger the shrinkage of the dynamic coefficients towards their prior mean (2). λ controls the relative importance of the prior. The larger λ, the less important is the prior information and the smaller the shrinkage. The term $\frac{\Sigma_{ij}}{\Psi_{jj}}$ accounts for different scales of the variables.[3]

The prior on the covariance matrix of the reduced-form residuals Σ is given by an Inverse-Wishart distribution with a diagonal scale matrix Ψ and $n+2$ degrees of freedom

$$\Sigma\sim IW\left(\Psi,n+2\right). \tag{4}$$

For the hyperparameters λ and the diagonal elements in Ψ, ψ_i we follow Giannone et al. (2016) and assume relatively uninformative "hyperpriors". The prior distribution for λ is a Gamma distribution with mode equal to 0.2, the (non-random) value of λ suggested in Sims and Zha (1998), and a standard deviation of 0.4. The prior mean of the ψ_i is assumed to have an inverse Gamma distribution with scale and shape parameters equal to 0.02 (see Giannone et al., 2016).

The estimation is based on a Markov-Chain-Monte-Carlo (MCMC) algorithm and uses the Gibbs sampler to generate draws for the dynamic coefficients in the B matrices and the elements of the covariance matrix Σ conditional on the values of the hyperparameters. Giannone et al. (2016) derive a closed-form solution for the data density conditional on the hyperparameters which allows them to draw from the posterior distribution of the hyperparameters using a Metropolis-Hastings algorithm. Since this algorithm converges only slowly and since we estimate multiple versions of the VAR models (Euro Area and individual country models) we fix the hyperparameters at the mode of their joint posterior distribution which is obtained via numerical optimization. Thus, our estimates ignore the estimation uncertainty about the hyperparameters, which, however, has only very small effects on the dispersion of our objects of interest.[4]

[3]For forecasting purposes Giannone, Lenza, Momferatou, and Onorante (2014) and others include sum-of-coefficient and initial-dummy-observation priors (Sims and Zha, 1998). Since the focus of our analysis is not on forecasting we do not impose these priors.

[4]In the appendix we present results for the Euro Area using the full algorithm and show that our simplifications has little effects on the results.

2.2 Data

We use quarterly data for the Euro Area, Germany, France, Italy and Spain from 1999Q1 to 2017Q4. Our model includes real GDP ($RGDP$), the GDP deflator ($GDPDEF$), real MFI loans to non-financial corporations ($LOANS$)[5], the Euro Area shadow short rate (SSR) from Wu and Xia (2016) as proxy for the monetary policy stance including unconventional monetary policy measures[6], the interest rate on bank loans to non-financial corporations ($LRATE$), the five-year government bond yield ($RATE5Y$)[7] and four variables from the flow of funds statistics: external financing of non-financial corporations via equity and shares ($EQUITY$), debt securities ($DEBTSEC$), trade credit ($TRADECR$), and loans where we subtract bank loans from the latter series leaving only loans from non-bank sources ($NBLOANS$). Bank loans and the flow of funds data are notional stocks and are deflated using the GDP deflator.[8][9] Deutsche Bundesbank (2018) provides a narrative of recent developments in the financing of non-financial corporations in the Euro Area and in the four large EMU member countries.

The BVAR model is estimated with five lags in log-levels for all variables except for the interest rates which are taken as decimal numbers.[10] After drawing the reduced-form parameters of the VAR we discard all draws which imply an explosive model.[11]

[5]MFIs are monetary financial institutions and include mainly the commercial banking sector, building societies, money market funds and central banks.

[6]The shadow short rate is derived from the term structure of interest rates and in "normal" times it is equal to the overnight interest rate. If short-term interest rates are constrained by the interest-rate-lower bound or if unconventional monetary policy instruments are used it can deviate from the overnight interest rate and take on lower values, see Krippner (2013), Wu and Xia (2016) or, for an overview, e.g. Deutsche Bundesbank (2017). Using a shadow short rate allows us to approximately account in our estimation for the effects of unconventional monetary policy measures on the monetary policy stance without explicitly modelling these. As a robustness check we estimated our models for the Euro Area and for Germany using an alternative shadow short rate from Geiger and Schupp (2018) and found this change to have little effect on the results. In another robustness test we replaced the shadow short rate by the EONIA.

[7]We choose the five-year over the ten-year bond yield as a medium-term maturity better reflects the maturities of bank lending than the ten-year yield. As a robustness test we replaced the five- by the ten-year bond yield.

[8]Notional stocks are constructed from growth rates derived from the transactions-based changes in the series, i.e. they do not include changes due to revaluations, reclassifications etc. For details, see European Central Bank (2012a).

[9]In our analysis we focus on external financing of firms. We experimented with including gross operating surplus as a proxy for firms' internal financing but found this variable to be too strongly correlated with real GDP with little independent information.

[10]Specifically, the variables are transformed into $4\times$log-levels to make them conformable with the annualized interest rates, since the prior-selection approach is not scale invariant, see Giannone et al. (2016) for details.

[11]We discard all draws for which the maximum eigenvalue of the VARs' companion matrix exceeds 1.01. Setting a threshold slightly above one allows us to retain draws which might imply cointegrating relationships among the variables.

2.3 Identification

We identify the structural shocks through sign restrictions using the algorithm of Arias, Caldara, and Rubio-Ramírez (2015) which is an extension of the algorithm of Arias, Rubio-Ramírez, and Waggoner (2014). It allows for both sign and zero restrictions on the impulse responses to a structural shock and sign and zero restrictions on the coefficients relating the contemporaneous values of the endogenous variables to each other.[12] We identify four structural shocks, an aggregate demand shock, an aggregate supply shock (inflation shock), a monetary policy shock and a loan supply shock (Table 1). While we are mainly interested in the effects of the loan supply shock we will also present results on the effects of the other shocks on firms' external financing and check whether the role of alternative financing sources for firms might be shock dependent. The sign restrictions for the identification of the aggregate demand and aggregate supply shocks are mostly standard (Bijsterbosch and Falagiarda, 2015; Gambetti and Musso, 2017). The restriction of an increase in the policy rate after an aggregate supply shock which raises the price level is necessary to distinguish the aggregate supply from the loan supply shock (see below) but is consistent with the central bank, e.g. following a Taylor-type rule and responding more aggressively to the price level than to economic activity. For the monetary policy shock we impose the standard sign restrictions on the impulse responses, i.e. a decline in output and in the price level following an exogenous increase in the policy rate. In addition, we impose positive signs on the contemporaneous reaction of the policy rate to an increase in output or the price level as in Arias et al. (2015), i.e. we restrict the coefficients on current output and on the current price level in the structural policy reaction function to be positive.[13] However, we do not impose zero restrictions on the contemporaneous responses of the policy rate to the other variables as in Arias et al. (2015). The reason for this is that the Eurosystem's monetary policy strategy assigns an important role to monetary variables, such as bank credit which is at odds with such an identification assumption.[14] A loan supply shock is identified as an exogenous increase in real bank lending that leads to an increase in real output, a decline in the interest rate on bank loans and an increase in the monetary policy rate.[15] Thus, the loan supply shock represents a range of underlying structural disturbances that work through

[12] That is, their algorithm allows to impose sign and zero restrictions on the matrix A_0 in the structural representation of the VAR $A_0 y_t = k + A_1 y_{t-1} + \cdots + A_p y_{t-p} + e_t$ with e_t being the uncorrelated structural shocks.

[13] In terms of the notation in footnote 12 we restrict the A_0 elements for output and price level in the equation for the shadow short rate to be negative.

[14] See, e.g. European Central Bank (2011), Section 3.5. The monetary policy shock is already identified using the sign restrictions on the impulse responses alone. Thus, not imposing the zero restrictions on the reaction coefficients does not imply that the monetary policy shock is not identified.

[15] Mumtaz et al. (1998) provide a general discussion of the performance of sign restrictions in identifying loan supply shocks.

banks' loan supply, e.g. exogenous changes in bank capital or net worth, changes in banks' risk-assessment of borrowers, regulatory changes (changes to capital requirements or loan-to-value ratios) etc. This interpretation also covers more general financial markets shocks which also affect banks' lending behaviour and is consistent with the results of various DSGE models with a banking sector.[16] We leave the impulse responses of firms' alternative financing sources unrestricted, allowing for the possibility of a negative effect (i.e. substitution between bank loans and other financing) as well as for a positive effect (i.e. both financing sources being complements in the dynamic responses to the shock). Since we do not impose restrictions beyond those in the standard literature the results from our, extended model can be compared to the already established empirical evidence which is based on models without alternative financing sources.

The identifying restrictions on the loan supply shock are similar to those in Gambetti and Musso (2017) and Bijsterbosch and Falagiarda (2015). However, as in Deutsche Bundesbank (2015) we do not impose the restriction that the loan supply shock causes a positive correlation between bank loans and the price level on impact, since this is not a robust implication across the DSGE literature on bank lending shocks (see, e.g. Gambetti and Musso (2017), Table II) and there is some evidence that restrictive financial shocks might lead to an initial increase in the price level, (e.g. Gilchrist, Schoenle, Sim, and Zakrajsek, 2017; Abbate, Eickmeier, and Prieto, 2016).[17] In order to disentangle the loan supply from the aggregate supply shock without the restriction on the price level response we impose the assumption that an expansionary loan supply shock causes the central bank to increase its policy rate as it expects a future increase in the price level (see Deutsche Bundesbank, 2015).[18]

The sign restrictions are imposed on impact. Part of the literature combines sign restrictions on the effects of loan supply shocks with zero restrictions on output and prices (e.g. Peersman, 2011; Hristov et al., 2012; Breitenlechner, Scharler, and Sindermann, 2016). While this might be defensible on a monthly frequency, results from both estimated DSGE models (e.g. Gertler and Karadi, 2011; Gerali et al., 2010) as well as from empirical studies on the effects of financial shocks (e.g. Abbate et al., 2016) provide strong evidence for financial shocks affecting the real economy within the quarter and thus make zero restrictions on loan supply shocks difficult to defend.[19]

[16]For examples, see Gerali, Neri, Sessa, and Signoretti (2010); Gertler and Karadi (2011) or the summary in Gambetti and Musso (2017), Table II.

[17]See also Meinen and Röhe (2018) for evidence on an ambiguous response of the price level to a financial shock in the U.S.

[18]As a robustness test we also consider a version in which we impose a zero restriction on the monetary policy response to an aggregate supply shock. This models the central bank "looking through" temporary deviations of inflation due to supply shocks (e.g. Bean, Paustian, Penalver, and Taylor, 2011). Our results are robust with respect to this change.

[19]We also do not identify a loan demand shock since this is already contained in the aggregate demand

Restrictions on impulse responses

Variable / Shock	*RGDP*	*GDPDEF*	*LOANS*	*SSR*	*LRATE*
AD shock	+	+		+	+
AS shock	-	+		+	
MP shock	-	-		+	
LS shock	+		+	+	-

Restrictions on contemporaneous coefficents

to / from	*RGDP*	*GDPDEF*	*LOANS*	*SSR*	*LRATE*
RGDP				+	
GDPDEF				+	

AD: aggregate demand shock, AS: aggregate supply shock, LS: loan supply shock, MP: monetary policy shock, RGDP: real GDP, GDPDEF: GDP deflator, LOANS: real MFI loans to non-financial corporations, SSR: shadow short rate, LRATE: lending rate. Sign restrictions on impulse responses imposed on impact.

Table 1: Sign restrictions - Euro Area model

We augment the analysis at the Euro Area level by analyses of the effects of loan supply shocks in the four large Euro Area countries (Germany, France, Italy and Spain). Since the Eurosystem's monetary policy responds to developments in the aggregate Euro Area economy there is the potential problem that the monetary policy reaction function and thus the dynamics of the policy rate will be incorrectly estimated if the national variables do not represent the Euro Area aggregates reasonably well. To account for this, we include Euro Area aggregates of real GDP and the GDP deflator in each individual country model and impose additional sign restrictions on the impulse responses of the Euro Area aggregates. As shown in the appendix, the estimated identified monetary policy shocks are qualitatively very similar across all country models. Identifying restrictions for the other three shocks are placed on the country-specific variables only, except for the monetary policy indicator. Hence, aggregate demand, supply and loan supply shocks potentially capture both country-specific and Euro Area common shocks. Here an issue arises with the sign restriction on the monetary policy response to these shocks. The assumption of the Euroystem responding to potentially idiosyncratic shocks in individual countries would be difficult to maintain if we were considering small Euro Area countries. However, since the four countries in question carry considerable weights in the Euro Area aggregates even a country-specific aggregate demand, supply or loan supply shock will,

shock. Since the budget constraint and the optimization problem of firms imply that a demand-driven increase in financing will be associated with an increase in inputs to production or in investment, imposing zero restrictions on output and the price level in order to disentangle aggregate demand from financing demand shocks would be be inconsistent with micro-foundations.

Restrictions on impulse responses

Variable / Shock	$RGDP$	$GDPDEF$	$LOANS$	SSR	$LRATE$	$RGDP_{EA}$	$GDPDEF_{EA}$
AD shock	+	+		+	+		
AS shock	-	+		+			
MP shock	-	-		+		-	-
LS shock	+		+	+	-		

Restrictions on contemporaneous coefficents

to / from	$RGDP$	$GDPDEF$	$LOANS$	SSR	$LRATE$	$RGDP_{EA}$	$GDPDEF_{EA}$
$RGDP_{EA}$				+			
$GDPDEF_{EA}$				+			

AD: aggregate demand shock, AS: aggregate supply shock, LS: loan supply shock, MP: monetary policy shock, RGDP: real GDP, GDPDEF: GDP deflator, LOANS: real MFI loans to non-financial corporations, SSR: shadow short rate, LRATE: lending rate, subscripts 'EA' denote Euro Area variables. Sign restrictions on impulse responses imposed on impact.

Table 2: Sign restrictions - country model

all other things equal, affect the Euro Area averages and thus trigger a policy response. The identification scheme for the country models is summarized in Table 2.

3 Results

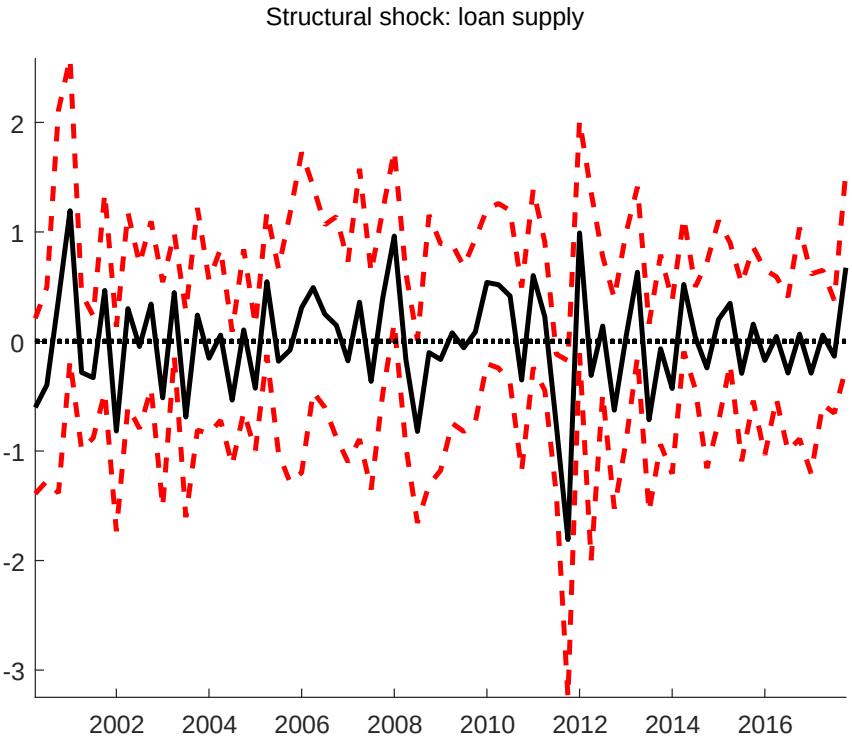
3.1 Euro Area

Figure 3 shows information on the posterior distribution of the identified loan supply shock. There are marked contractionary shocks in 2008Q3 and 2011Q4 when loan supply conditions deteriorated (European Central Bank, 2012b). The large positive shock in 2012Q1 can be linked to the very-long-term maturity refinancing operations (VLTRO) with maturity of three years.

Figure 4 displays the impulse responses of the Euro Area macroeconomic variables to an expansionary one-standard deviation loan supply shock in percentage deviations from baseline or, in case of the interest rates, in percentage points. The graphs show the median (in blue) of the marginal posterior distribution of the impulse response functions together with the interval between the 16- and 84%-percentiles. In interpreting the results we base our assessment on the location of the posterior distribution relative to the zero line. If the zero line lies outside the 16- and 84%-percentiles interval the posterior-odds ratio of the impulse response being positive (negative) is more than 4:1 and the zero line within the bands but close to the edges can still imply a posterior-odds ratio of 3:1.

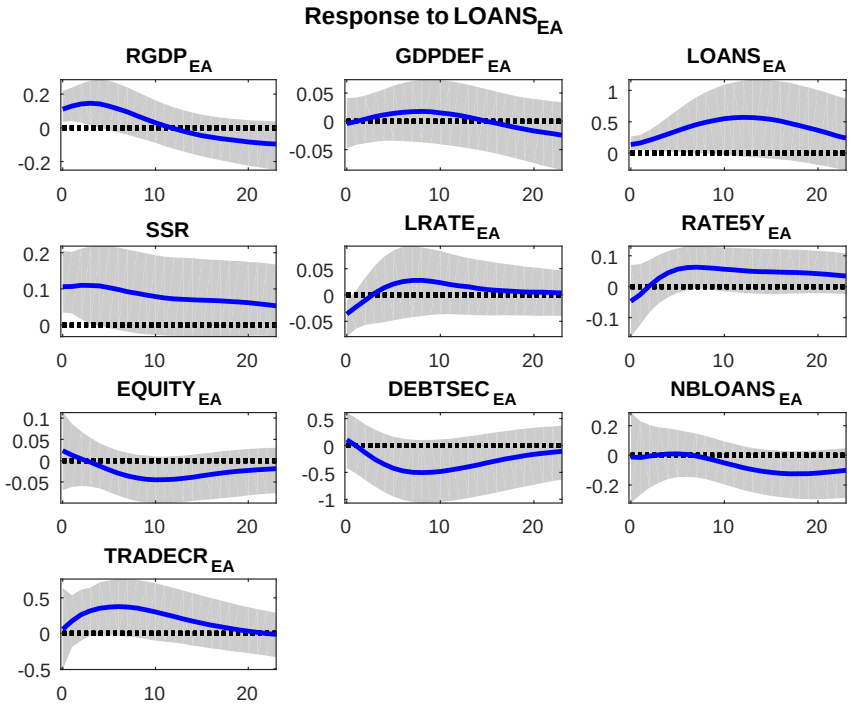
The expansionary loan supply shock causes a temporary increase in output and, with delay, also a weak increase in the price level. The central bank responds with a relatively persistent increase in the policy rate. Considering the delayed increase in the price level

Figure 3: Identified loan supply shock - Euro Area



Median and 16- and 84% percentiles of marginal posterior distribution of impulse responses.

Figure 4: Impulse responses to loan supply shock - Euro Area



Median and 16- and 84% percentiles of marginal posterior distribution of impulse responses.

and the hump-shaped pattern of the increase in bank lending the assumption of an increase in the policy rate in the identification scheme seems reasonable if the central bank sets monetary policy in a forward-looking way. The bank lending rate drops initially by assumption but then returns around baseline, most likely due to the monetary tightening and the increase in economic activity which both work in the direction of higher lending rates and compensate for the expansion in loan supply. These impulse responses are consistent with the evidence of Gambetti and Musso (2017) who also estimate a rise in the lending rate after the initial decline and an increase in the growth rate of bank lending that persists for about ten quarters.[20]

None of the alternative financing sources reacts to the increase in bank lending immediately but financing by equity and debt securities declines afterward below baseline and both reach a trough after about eight to ten quarters. In contrast, non-bank lending remains broadly unchanged for at least two years before it declines.[21]Trade credit moves in the same direction as bank lending but reaches its peak at about five quarters - much earlier than bank lending.

The negative medium-term developments in equity financing and debt securities after a loan supply shock that increases bank lending suggest that these two alternative financing sources might act as a substitute for bank loans while the positive response in trade credit suggests this financing source being a complement to bank lending. However, an assessment based on the marginal distributions of the impulse response functions shown in Figure 4 might be misleading since it should be based on the *joint* distribution of the impulse responses of the external financing variables.[22] Thus, in Figure 5 we show scatter plots of the joint distribution of the impulse response in bank lending and each of the other external financing sources. Each row refers to another alternative financing source while the columns refer to different horizons for the impulse responses. The black lines are fitted values from a linear regression including a constant.

Figure 5 suggests a negative association between the increase in bank loans after a loan supply shock and the change in each alternative financing source relative to baseline, except for trade credit, at horizons of four quarters and longer.[23] However, the negative

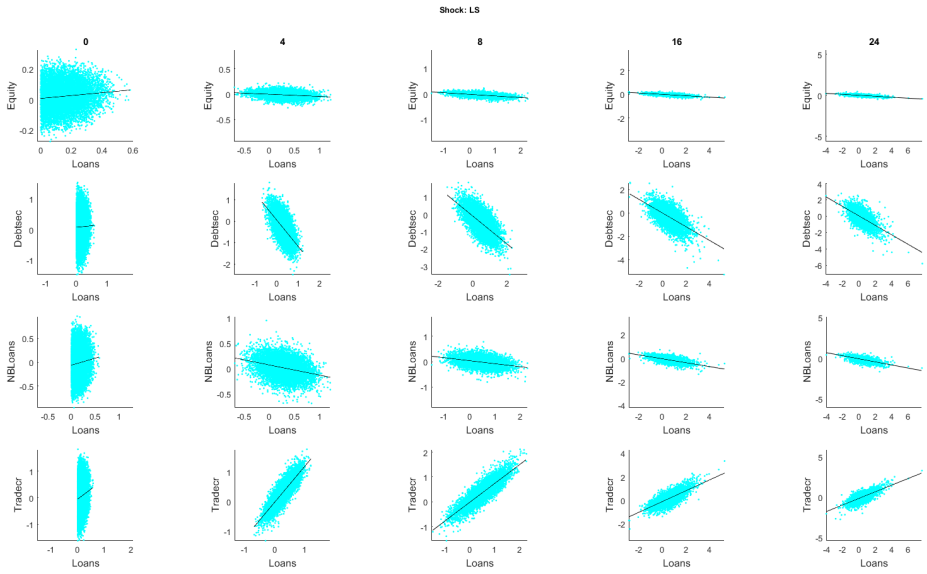
[20]This refers to the sample averages of their estimated impulse responses from their time-varying VAR.

[21]The posterior distribution of the impact response of financing via equity and debt securities exhibits substantial mass above zero, in fact, the median responses are positive on impact. This supports the interpretation of a loan supply shock in a broad sense as discussed in Section 2 as also encompassing more general financial market shocks that impact bank lending.

[22]It would be misleading to compare specific percentiles of the impulse responses of bank lending and an alternative financing sources to each other, even at a given point in time, as these are not generated from the same draw for the identified VAR model, see Fry and Pagan (2011) or Kilian and Lütkepohl (2018).

[23]In the impact period the response of bank loans (horizontal axis) is strictly positive because of the sign restriction.

Figure 5: Joint distribution of impulse responses of bank loans and alternative financing sources to loan supply shock - Euro Area



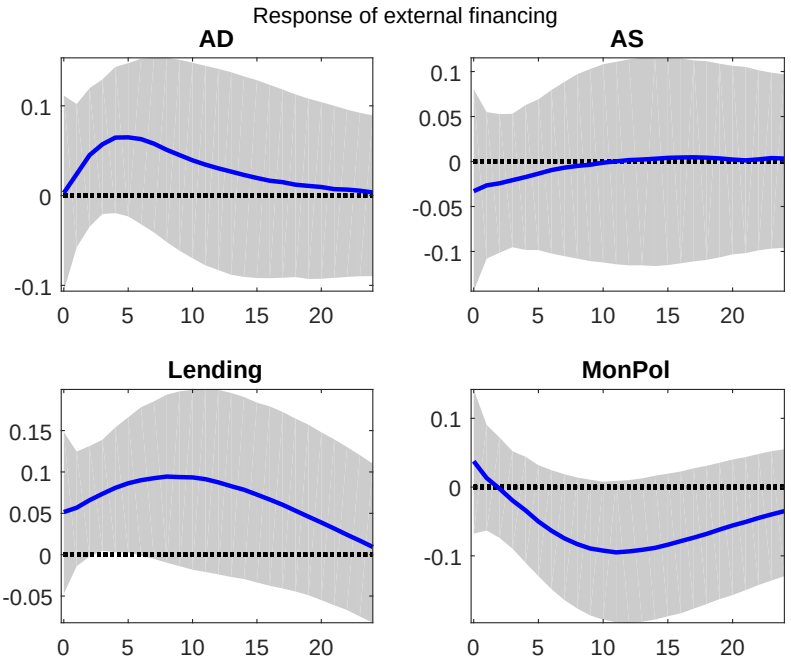
Scatter plots of impulse response of real MFI loans to non-financial corporations (horizontal axes) and impulse response of variable indicated (vertical axes). Columns indicate impulse response horizon. 0 is impact period. Black lines are obtained from linear regression of impulse response on vertical axes on impulse response on horizontal axes.

comovement between bank loans and equity is relatively weak as can be seen from the flat regression line. For the impulse response of trade credit the scatter plots show strong positive comovement with that of bank loans. We recall that we did not place sign restrictions on the impulse responses of the alternative external financing sources. This is reflected in the lack of a clear correlation between the impulse responses of the flow-of-funds variables and bank loans on impact. Nevertheless, our results suggest that equity, debt securities and non-bank loans act as substitutes for bank loans while trade credit acts as a complement.

Given these relationships among financing sources we investigate to what an extent the changes in equity, debt securities and non-bank lending offset the changes in bank lending and trade credit after a loan supply shock. The lower left panel in Figure 6 shows the impulse response of the sum of the five external financing sources in the model to the loan supply shock.[24] The result shows that a positive loan supply shock results

[24]The posterior distribution of the impulse responses is obtained by computing a weighted average of the individual variables' impulse responses for each draw of the model - which are percentage deviations from baseline - with weights equal to the average relative share of the variables in overall external financing over the estimation period (approx. 20% for bank loans, 49% for equity, 4% for debt securities, 16% for non-bank lending, and 11% for trade credit). Since the weighted average is a function of the model parameters from the MCMC simulations the resulting distribution is a valid approximation to the posterior distribution of the response of overall external financing.

Figure 6: Impulse responses of external financing to identified shocks - Euro Area

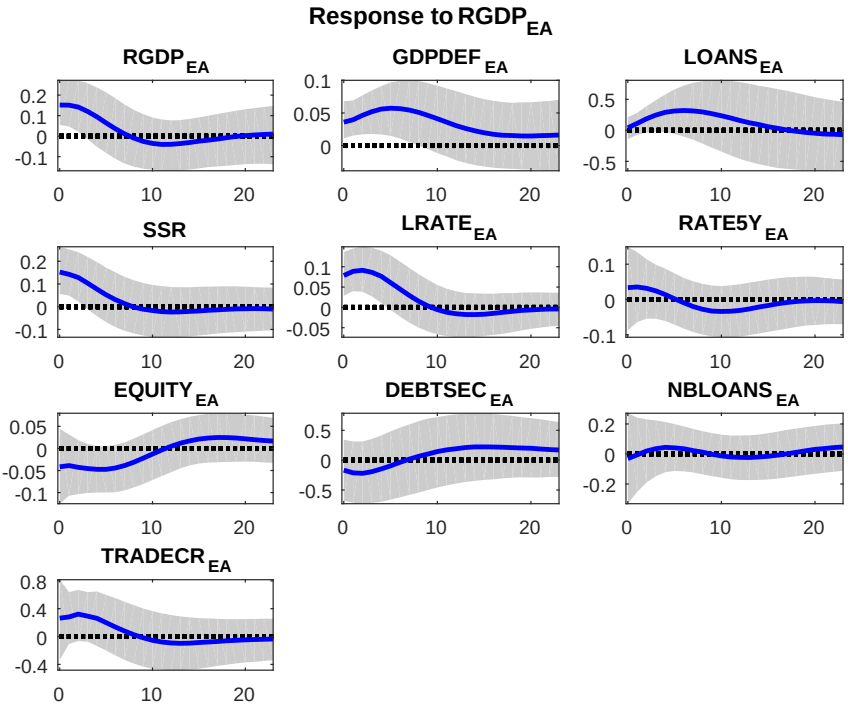


Median and 16- and 84% percentiles of marginal posterior distribution of impulse responses. AD: aggregate demand shock, AS: aggregate supply shock, Lending: loan supply shock, MonPol: monetary policy shock. AD and Lending shocks increase output, AS and MonPol shocks reduce output.

in an increase in overall external financing that persists for about four years. Over this horizon, the expansion in bank lending and the accompanying rise in trade credit dominate the contraction in equity and debt securities issuance. Consequently, a contractionary (negative) shock to bank lending would result in an overall reduction of external financing since the expansion in the substitutes would be not sufficient to compensate for the decline in bank lending and trade credit.

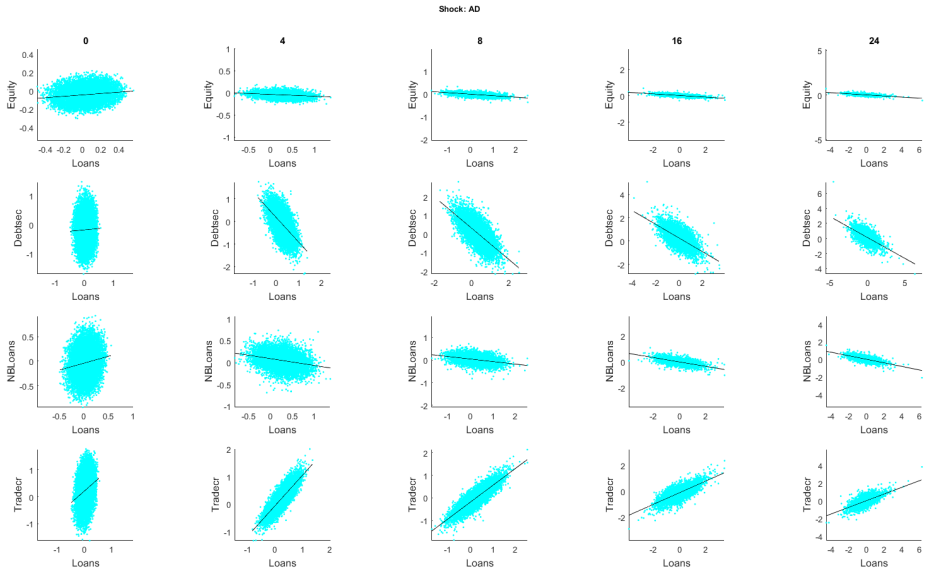
Concerning the effects of the other identified shocks on external financing we find a positive aggregate demand shock to have no contemporaneous but a delayed positive effect on external financing of non-financial firms which peaks at about five quarters (see top left panel in Figure 6). Figure 7 shows that this results from the expansion in bank lending and trade credit to firms while, in particular equity financing for up to about two years, but to some extent also debt securities show a negative response. Moving beyond the marginal impulse response distributions Figure 8 indicates that equity, debt securities and non-bank loans are substitutes for bank loans after about four to eight quarters while trade credit, as before, is a complement. For the aggregate supply (inflation) shock the marginal posterior distributions of the impulse responses of all five external financing components do not suggest a clear pattern with the median responses close to zero Figure 9 which carries over to the weighted sum (upper right panel in Figure 6). How-

Figure 7: Impulse responses to aggregate demand shock - Euro Area



Median and 16- and 84% percentiles of marginal posterior distribution of impulse responses.

Figure 8: Joint distribution of impulse responses of bank loans and alternative financing sources to aggregate demand shock - Euro Area



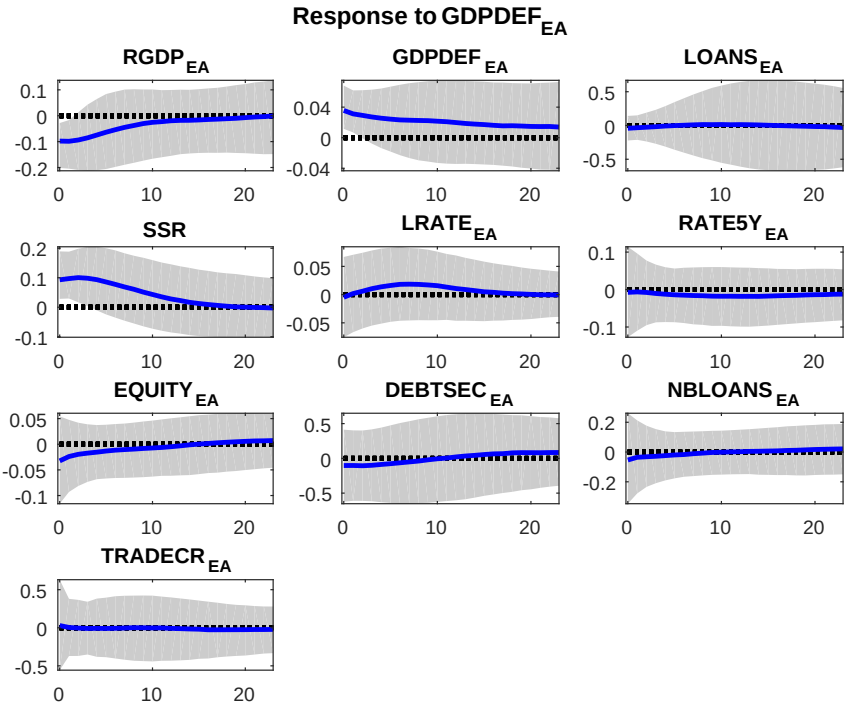
Scatter plots of impulse response of real MFI loans to non-financial corporations (horizontal axes) and impulse response of variable indicated (vertical axes). Columns indicate impulse response horizon. 0 is impact period. Black lines are obtained from linear regression of impulse response on vertical axes on impulse response on horizontal axes.

ever, as evident by Figure 10 the joint posterior distribution of the impulse responses still suggests substitution, i.e. a negative relationship between the impulse response of bank lending and the responses of equity, debt securities and non-bank loans following an aggregate supply shock and positive comovement of bank lending and trade credit. In the case of the aggregate supply shock but also for the response of non-bank lending to the aggregate demand shock, the marginal posterior impulse response distributions obscure the substitution relationships which become visible when inspecting the estimated joint density. Finally, a contractionary monetary policy shock leads to hump-shaped decline in bank lending to firms (Figure 11). Debt securities and non-bank lending do not show a clear response to the shock while the marginal posterior impulse response distributions of equity financing and trade credit display transitory negative reactions with troughs after five (ten) quarters. This would suggest a complementary relationship between bank lending and equity financing after a monetary policy shock, at least in the short run. However, the results for the joint posterior distribution do not show a marked positive association between the impulse responses in bank lending and equity financing and (Figure 12) turns out qualitatively similar to the scatter plots for the other shocks. This strengthens our point that just looking at the marginal posterior distributions of the impulse responses, which ignores the dependence in the impulse responses across variables can be misleading. This is particularly relevant in cases, in which the impulse response of bank lending is not restricted to either positive or negative values but encompasses zero, as in Figure 11. The overall response of external financing in the bottom right panel of Figure 6 shows that a restrictive monetary policy shock implies a contraction in firms' external financing after about a year with a trough after three years.

The substitution relationship between equity, debt securities and non-bank lending on the one and bank lending on the other side as well as the complementary relationship between bank loans and trade credit turn out to be largely independent of the structural shock hitting the economy as the scatter plots are similar across the structural shocks. However, different structural shocks potentially have the strongest effects on the correlation structure of the variables on impact. As the impulse response horizon becomes longer the effect of the dynamic coefficients becomes more and more important. Since our results do not indicate strong differences in the impact effect of the shocks on the alternative financing sources our results are likely to be mostly driven by the dynamic coefficients which lead to similar results across shocks when the impulse response horizon grows longer.

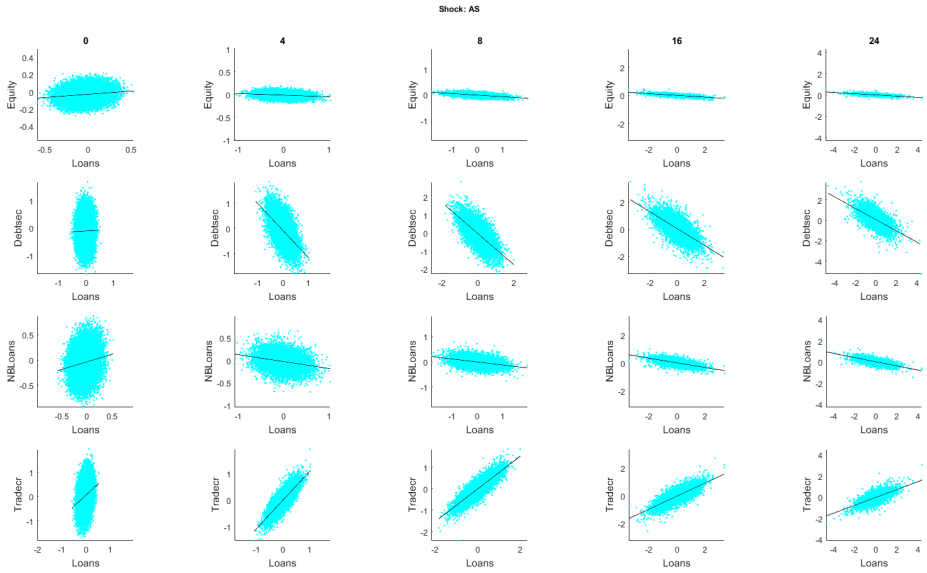
Turning once again to Figure 6 we conclude that, excluding the aggregate supply shock, for which we do not find much evidence for a directional reaction in financing, the response of the sum of the external financing is always in the direction of the response of

Figure 9: Impulse responses to aggregate supply shock - Euro Area



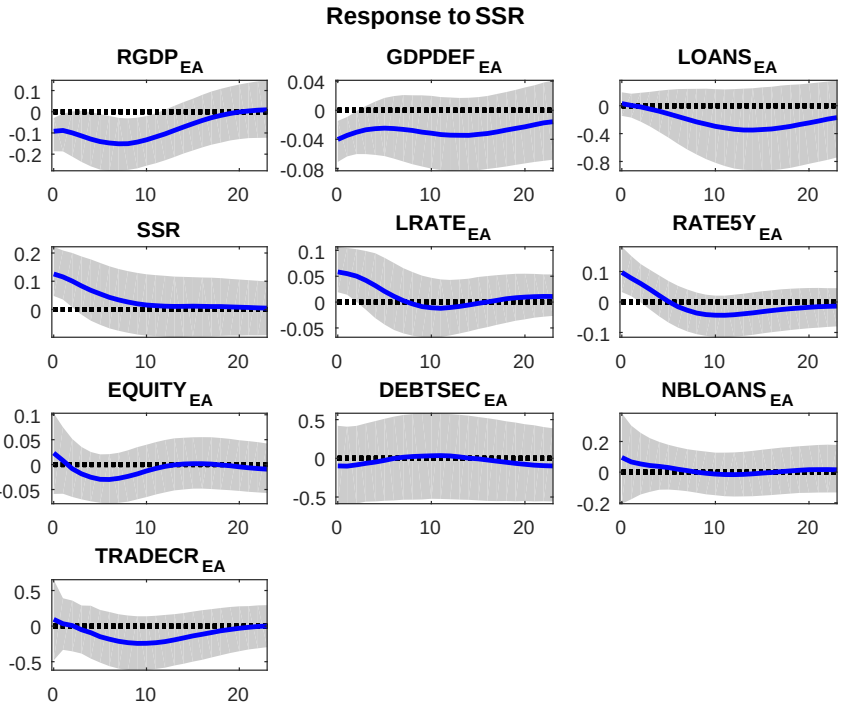
Median and 16- and 84% percentiles of marginal posterior distribution of impulse responses.

Figure 10: Joint distribution of impulse responses of bank loans and alternative financing sources to aggregate supply shock - Euro Area



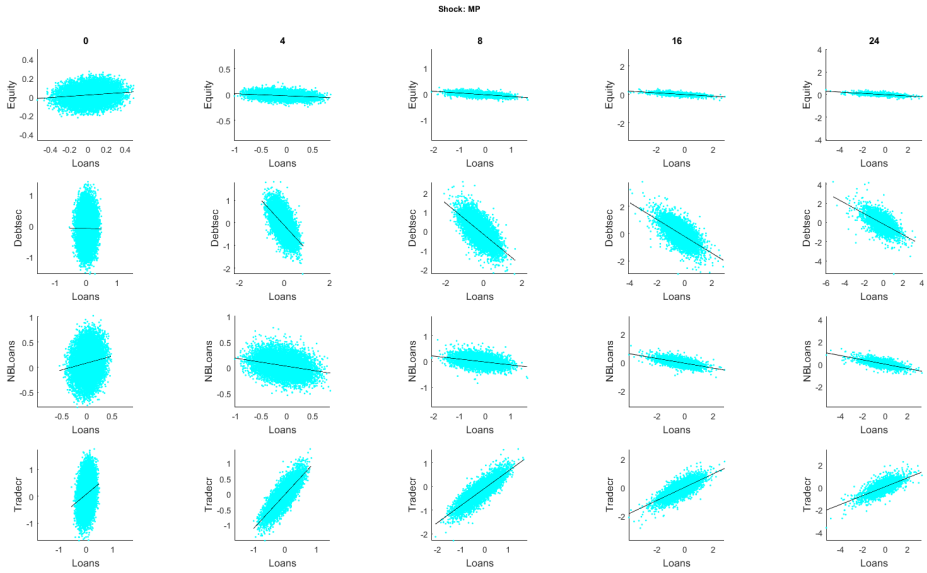
Scatter plots of impulse response of real MFI loans to non-financial corporations (horizontal axes) and impulse response of variable indicated (vertical axes). Columns indicate impulse response horizon. 0 is impact period. Black lines are obtained from linear regression of impulse response on vertical axes on impulse response on horizontal axes.

Figure 11: Impulse responses to monetary policy shock - Euro Area



Median and 16- and 84% percentiles of marginal posterior distribution of impulse responses.

Figure 12: Joint distribution of impulse responses of bank loans and alternative financing sources to monetary policy shock - Euro Area



Scatter plots of impulse response of real MFI loans to non-financial corporations (horizontal axes) and impulse response of variable indicated (vertical axes). Columns indicate impulse response horizon. 0 is impact period. Black lines are obtained from linear regression of impulse response on vertical axes on impulse response on horizontal axes.

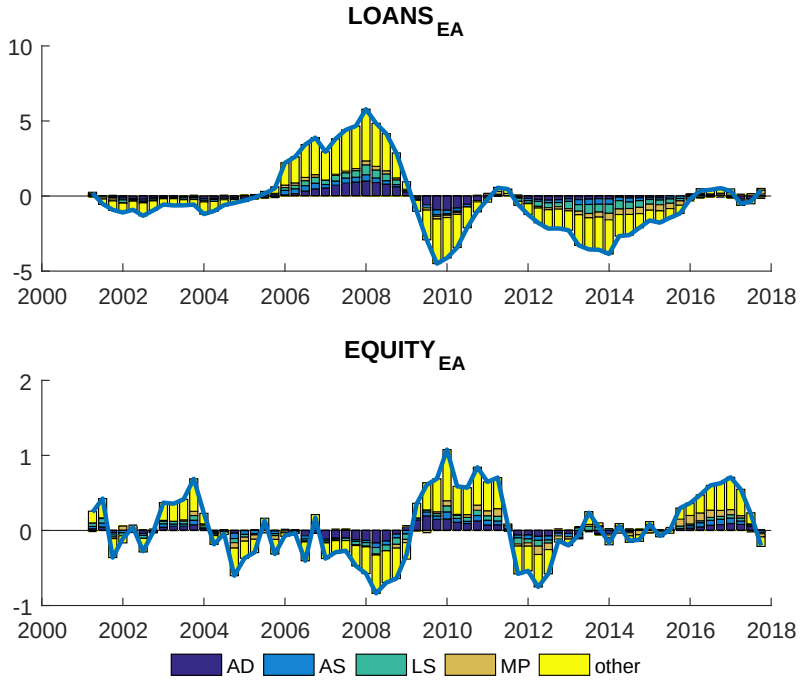
bank lending, although bank loans and its complement trade credit only account for about 20% and 11% of the sum of all five financing sources in the sample average, respectively (see footnote 24). Thus, substitution is only partial and the changes in the other external financing components are not sufficient to compensate for the change in bank lending and trade credit. For a negative loan supply shock this implies that, although some of the other financing sources will expand while bank lending contracts, the substitution will be incomplete, the decline in bank lending will dominate and firms' overall external financing will decrease.

Figure 13 and Figure 14 show the historical decomposition of the annual growth rates of bank loans, equity finance, debt securities, non-bank loans and trade credit. Specifically, the stacked coloured bars show the median contribution of each of the four identified shocks to the series' deviation from its unconditional forecast from the beginning of the sample while the black line denotes the median deviation of the actual series from this unconditional forecast across all draws from the posterior distribution. The yellow bars represent the effects of the unidentified shocks as well as the approximation error resulting from the sum of the median contributions not being equal to the median of the sum of the contributions. Given that the model contains six unidentified structural shocks the identified shocks generally account for less than half of the deviations from the unconditional forecasts.

The effects of current and past loan supply shocks contributed positively to growth in bank lending between 2006 and 2009. From 2012 into 2015 loan supply shocks exerted a negative influence on its growth rate. Although we established equity financing being a substitute for bank loans the effects of loan supply shocks on equity financing turn out to be very small throughout the sample period. In contrast, loan supply shocks had a sizable impact on financing through debt securities and raised the growth rate of this component of external financing between 2012 and 2014. We only find a notable positive impact of loan supply shocks on the growth in non-bank lending between 2014 and 2016, later than for debt securities, which is due to a more delayed substitution between bank and non-bank loans (see Figure 5) while the contributions of loan supply shocks to trade credit broadly mirror those to bank loans themselves as expected from the complementary relationship of these two financing sources. Our results for the contributions of loan supply shocks to the growth rates of bank lending and debt securities issuance are qualitatively in line with the evidence in Altavilla et al. (2015) but are considerably smaller.[25] Figure 15 shows the posterior-odds ratio for a positive (negative) impact of current and past loan supply shocks on the deviation of the annual growth rate in the external financing variables from

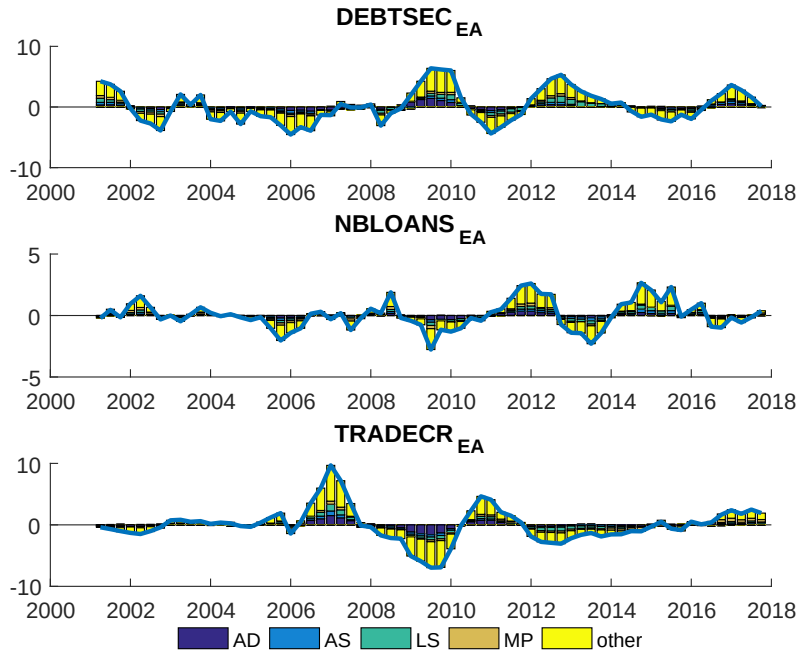
[25]However, the deviation of bank loan growth from baseline in the historical decomposition is substantially smaller in our model, as well.

Figure 13: Historical decomposition of bank loans and equity financing - Euro Area



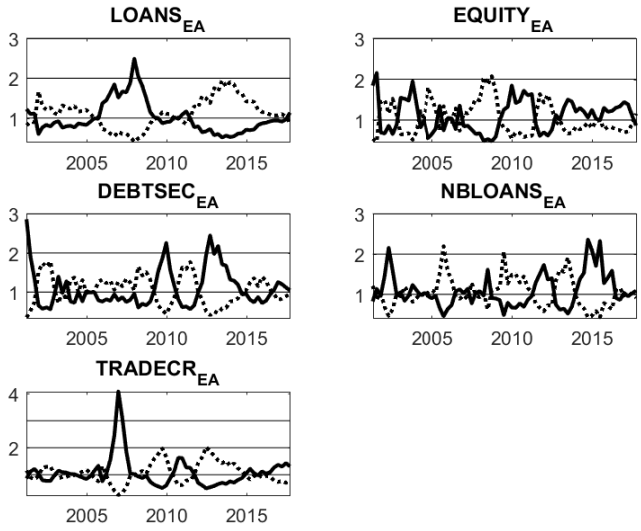
Annual growth rates. Median contributions of identified shocks to deviation from unconditional forecast. AD: aggregate demand shock, AS: aggregate supply shock, LS: loan supply shock, MP: monetary policy shock.

Figure 14: Historical decomposition of debt securities, non-bank loans and trade credit - Euro Area



Annual growth rates. Median contributions of identified shocks to deviation from unconditional forecast. AD: aggregate demand shock, AS: aggregate supply shock, LS: loan supply shock, MP: monetary policy shock.

Figure 15: Posterior-odds ratio for contribution of loan supply shocks - Euro Area



Contribution to annual growth rates of variable. Posterior-odds ratio for positive (solid) and negative (dashed) contribution of loan supply shock to deviation from unconditional forecast.

the unconditional forecast. These are derived from the marginal posterior distribution of the shock contributions. Horizontal lines denote odds-ratios of 1:1, 2:1 and 3:1. If we base our assessment on a 2:1 odds ratio we estimate positive (negative) contributions of loan supply shocks to the dynamics of bank lending in the mid-to late 2000s (2013/2014) and these results are mirrored by the contributions to trade credit. The substitution for bank loans by non-bank loans and debt securities reflects in positive contributions of loan supply shocks to their growth rates in 2014/2015 and 2010 and 2012, respectively. The spike around 2010 in the graph for debt securities represents the substitution for bank loans following the negative loan supply shocks at the onset of the financial crisis that are implied by the quick fall of the contribution of loan supply shocks to credit growth around this time (Figure 13).[26] For equity financing, the posterior-odds ratios are almost always below 2:1 but there is some evidence that the credit boom preceding the financial crisis might have caused a decline in the growth rate of equity issuance.

The scatter plots of the joint posterior density of the changes in each of four alternative financing sources and the change in bank loans after the loan supply shock have given us some intuition about the nature of equity and debt securities issuance, non-bank loans and trade credit as complements to or substitutes for bank loans. Table 3 summarizes the results from the scatter plots. It presents mean estimates of the elasticities of the alternative financing sources with respect to a change in bank lending after a shock. To

[26]This is also reflected in the decline of the posterior-odds ratio for their positive contributions to bank loans from above two to below one.

derive this table, we run OLS regressions on the scatter plots of the impulse responses (e.g. Figure 5) and tabulate the estimated slope coefficients. Since the impulse responses are measured in percentage deviations from baseline the slope coefficients can be interpreted as elasticities of the alternative financing sources with respect to bank lending after a shock. We use these elasticities as summary statistics for the information in the scatter plots. Negative values indicate substitution, positive ones complementarity in financing sources.

In order to assess how much confidence we are to place in the estimates in Table 3 we compute for the same impulse response horizons the share of draws from the BVAR model for which the response of bank loans and the alternative external financing source in question have an identical sign, i.e. the responses go in the same direction. Shares above 0.5 indicate complementarity (more matching signs in the impulse responses than opposing signs), while shares below 0.5 indicate substitution (more opposing signs than matching signs). The full table is in the appendix. Those mean elasticity estimates which coincide with posterior-odds ratios of 2:1 for or against identical signs in the impulse responses are set in bold in Table 3.[27] In the following discussion we focus on these estimates.

For the Euro Area we find marked negative elasticities on debt securities for all shocks and all horizons, supporting our conclusion of a substitution relationship with bank lending. The elasticities on non-bank loans and, in particular, and equity are small in absolute value. However, although elasticities remain weak, equity can be considered a substitute for bank loans from eight quarters on based on the posterior-odds for negative comovement. For non-bank loans elasticities become markedly negative at the 16 quarters horizon at which these loans can be classified as substitutes for bank loans. Trade credit is a complement to bank loans at all horizons but its elasticity with respect to bank loans becomes less as the impulse response horizon lengthens. The classification into substitutes and complements is robust with respect to the structural shocks as the bold coefficients do not change their sign.

3.2 Country results

The second to fight panels of Table 3 show estimated elasticities of alternative financing sources with respect to bank lending for the four largest Euro Area countries. As for the aggregate Euro Area these serve as summary statistics for the joint posterior of the impulse response functions of bank lending and each of the alternative financing sources. The scatter plots and the impulse responses for each country and structural shock can

[27] This corresponds to shares above $0.6\overline{6}$ or below $0.3\overline{3}$ in Table B.1.

Euro Area

horizon	4 quarters				8 quarters				16 quarters			
shock	EQ	Debt	NBL	TC	EQ	Debt	NBL	TC	EQ	Debt	NBL	TC
LS	-0.04	**-1.23**	-0.20	**1.20**	**-0.06**	**-0.82**	-0.12	**0.76**	**-0.06**	**-0.58**	**-0.17**	**0.46**
AD	**-0.04**	**-1.09**	-0.16	**1.11**	**-0.07**	**-0.84**	-0.11	**0.75**	**-0.06**	**-0.58**	**-0.17**	**0.44**
AS	-0.04	**-1.06**	-0.15	**1.07**	**-0.06**	**-0.86**	-0.12	**0.77**	**-0.06**	**-0.61**	**-0.17**	**0.47**
MP	-0.04	**-1.09**	-0.16	**1.09**	-0.07	**-0.82**	-0.11	**0.73**	**-0.06**	**-0.61**	**-0.17**	**0.47**

Germany

horizon	4 quarters				8 quarters				16 quarters			
shock	EQ	Debt	NBL	TC	EQ	Debt	NBL	TC	EQ	Debt	NBL	TC
LS	0.02	-0.23	-0.96	0.36	0.05	-0.53	-0.89	0.20	0.06	-0.68	-0.88	-0.07
AD	0.05	-0.04	-0.62	0.17	0.05	-0.38	-0.83	0.12	0.07	-0.52	-0.94	-0.13
AS	0.05	-0.25	-0.68	0.27	0.05	-0.53	-0.70	0.20	0.06	-0.60	-0.70	0.10
MP	0.04	-0.09	-0.55	0.19	0.06	-0.50	-0.75	0.22	0.04	-0.58	-0.69	0.15

France

horizon	4 quarters				8 quarters				16 quarters			
shock	EQ	Debt	NBL	TC	EQ	Debt	NBL	TC	EQ	Debt	NBL	TC
LS	-0.02	-0.48	**0.15**	**0.39**	-0.05	-0.39	**0.27**	**0.37**	-0.05	0.20	0.25	**0.28**
AD	-0.01	-0.03	**0.19**	**0.32**	-0.04	-0.14	0.28	**0.33**	-0.06	-0.22	**0.25**	**0.30**
AS	0.01	0.02	**0.13**	**0.29**	-0.03	-0.18	**0.25**	**0.34**	-0.05	-0.28	**0.24**	**0.31**
MP	0.02	0.10	0.10	**0.31**	-0.02	-0.03	**0.23**	**0.33**	-0.05	-0.20	**0.23**	**0.31**

Italy

horizon	4 quarters				8 quarters				16 quarters			
shock	EQ	Debt	NBL	TC	EQ	Debt	NBL	TC	EQ	Debt	NBL	TC
LS	-0.17	-0.12	**0.35**	**0.55**	**-0.34**	-0.52	**0.49**	**0.55**	**-0.42**	-1.32	**0.59**	0.36
AD	-0.08	0.31	0.44	0.30	**-0.30**	-0.79	**0.54**	0.52	**-0.40**	-1.48	**0.62**	0.42
AS	-0.04	-0.26	0.45	0.36	**-0.31**	-0.77	0.59	0.47	**-0.40**	-1.48	**0.58**	0.38
MP	-0.07	-0.57	0.55	0.33	**-0.30**	-0.85	**0.69**	**0.46**	**-0.39**	-1.57	**0.68**	**0.37**

Spain

horizon	4 quarters				8 quarters				16 quarters			
shock	EQ	Debt	NBL	TC	EQ	Debt	NBL	TC	EQ	Debt	NBL	TC
LS	0.01	0.28	-0.14	**1.29**	-0.04	-0.01	-0.08	**1.17**	-0.06	-0.09	0.03	**0.92**
AD	0.01	0.11	-0.04	**1.10**	-0.04	-0.09	-0.03	**1.10**	-0.07	-0.09	0.02	**0.92**
AS	0.02	0.11	-0.02	**1.03**	-0.03	-0.08	0.03	**1.12**	**-0.07**	-0.09	0.02	**0.94**
MP	0.01	0.02	-0.03	**1.03**	-0.05	-0.09	-0.03	**1.04**	**-0.07**	-0.08	-0.01	**0.96**

Elasticity of deviation of volume of financing from baseline with respect to the deviation in bank loans from baseline. Estimated slope coefficients of OLS-regression of impulse responses of alternative financing source on impulse response of bank loans. Regression includes constant. AD: aggregate demand shock, AS: aggregate supply shock, LS: loan supply shock, MP: monetary policy shock, EQ: equity, Debt: debt securities, NBL: non-bank loans, TC: trade credit. Elasticities with posterior-odds ratios for positive or negative comovement above 2:1 in bold.

Table 3: Estimated impulse response elasticities of alternative financing sources with respect to bank loans

be found in the appendix. Again bold figures denote positive or negative elasticities at posterior-odds ratios of 2:1.[28]

Although the signs of the estimated elasticities for Germany point at equity and trade credit being complements to bank loans while debt securities and non-bank loans are substitutes the posterior-odds ratios are insufficient to draw these conclusions with confidence.[29] Even the sizable elasticities for debt securities and non-bank loans are wrought with high estimation uncertainty. For France Table 3 shows trade credit and non-bank loans to be complements to bank loans. Compared to the results for the Euro Area aggregates, the estimated elasticities of trade credit with respect to bank loans are smaller. The evidence for equity and debt securities is inconclusive. Similar to France, non-bank loans in Italy can be categorized as complements to bank loans, in particular following a loan supply shock for which we find posterior odds for positive comovement of 2:1 or more from four quarters onwards. Elasticities are also bigger than in France where we found complementarity between bank and non-bank loans, as well. Equity financing moves negatively with bank loans after eight quarters.[30] In Italy trade credit acts as a complement for bank lending for the loan supply and the monetary policy shock but the signs on the elasticities are also positive for the other shocks. However, for Italy, the evidence on the complementarity between changes in bank lending and in trade credit which obtains for the Euro Area, France and Spain is weaker. The only clear result for Spain is that trade credit is a complement to bank loans at all horizons with elasticities around one.

Concerning the different structural shocks our estimates show that the categorization of the alternative financing sources as substitute for or complement to bank loans is largely independent of the shock. The bold entries never change sign and for each country and at a given horizon the elasticity estimates do not differ much by shock.

3.2.1 Germany

In this and the following subsections we turn to some additional results for the individual countries. We analyse the effects of the structural shocks on the dynamics of firms' overall external financing and the role of loan supply shocks for the historical dynamics of bank lending and the other financing sources.[31]

Table 3 provided little evidence on systematic comovements between bank lending and other external financing sources of German firms following a structural shock. Although

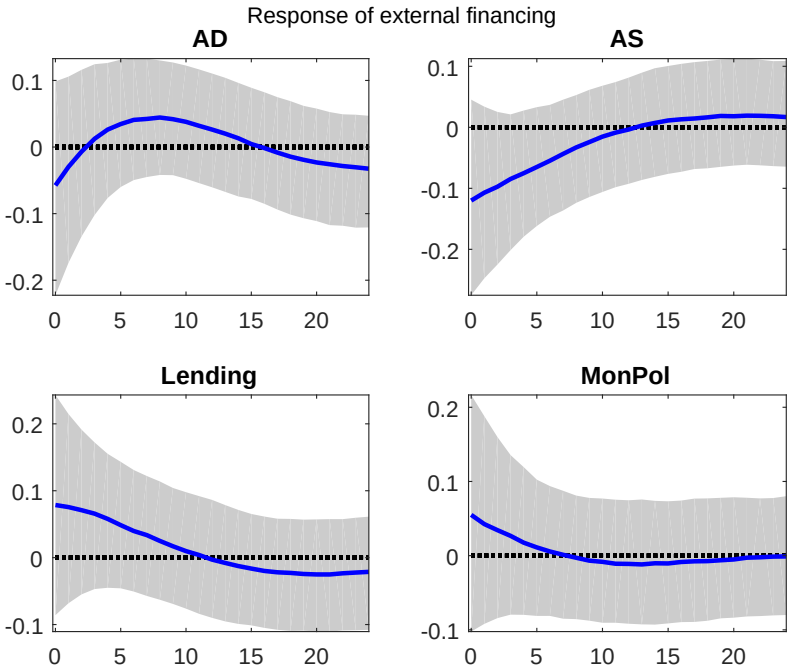
[28] See table Table B.1 in the appendix.

[29] For Germany, the shares in Table B.1 are all in the interval between 0.4 and 0.6 which corresponds to maximum posterior-odds ratios for positive or negative comovement of 3:2.

[30] For the aggregate demand and supply shocks, posterior odds for negative comovement with bank loans at eight horizons are about 1.8:1.

[31] The scatter plots of the joint posterior distribution of the impulse responses, the impulse response variables of the individual variables and other results are in Appendix D.

Figure 16: Impulse responses of external financing to identified shocks - Germany

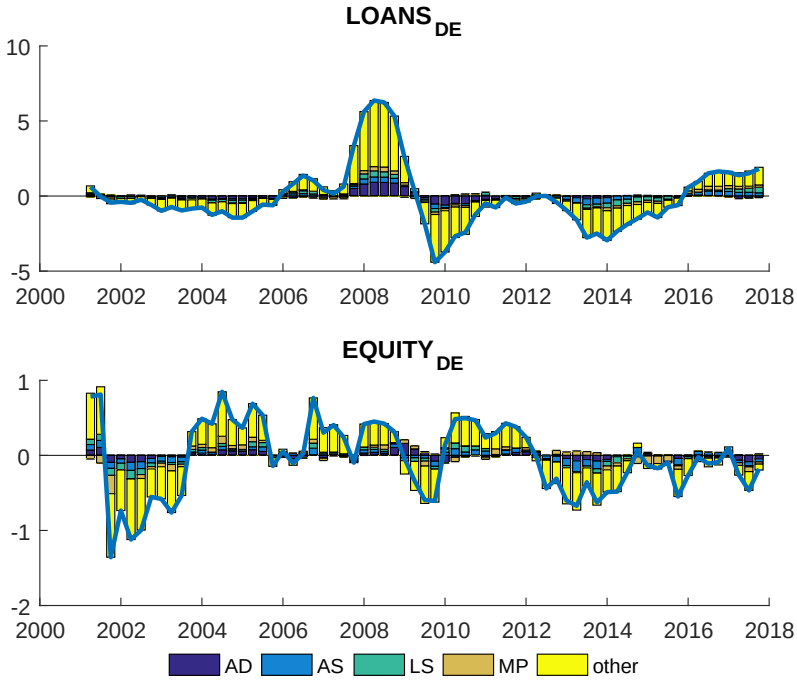


Median and 16- and 84% percentiles of marginal posterior distribution of impulse responses. AD: aggregate demand shock, AS: aggregate supply shock, Lending: loan supply shock, MonPol: monetary policy shock. AD and Lending shocks increase output, AS and MonPol shocks reduce output.

the sign patterns of the elasticities resembles the one for the Euro Area higher estimation uncertainty leads to too low posterior-odds ratios to draw clear conclusions.[32] The impulse responses of the weighted sum of the four external financing sources in Figure 16 show that an expansionary loan supply shock leads overall to a temporary increase in external financing11 which persists for somewhat more than one year. The aggregate demand shock causes a temporary expansion of external financing similar to the Euro Area. Different to the Euro Area the aggregate supply shock lowers external financing in the short run and the monetary policy shock does not result in a marked decline in German firms' external financing.

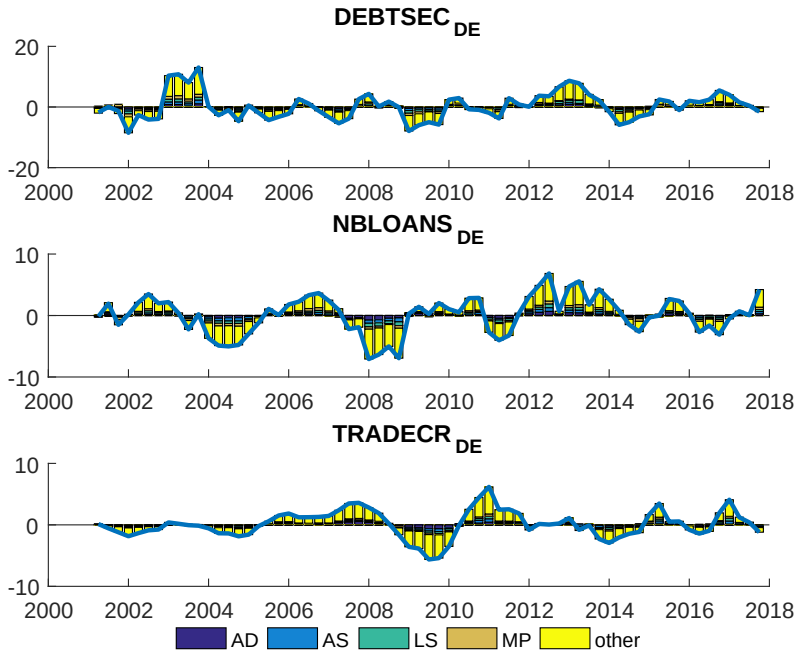
[32]See the vertical dispersion in the scatter plots in Appendix D.

Figure 17: Historical decomposition of bank loans and equity financing - Germany



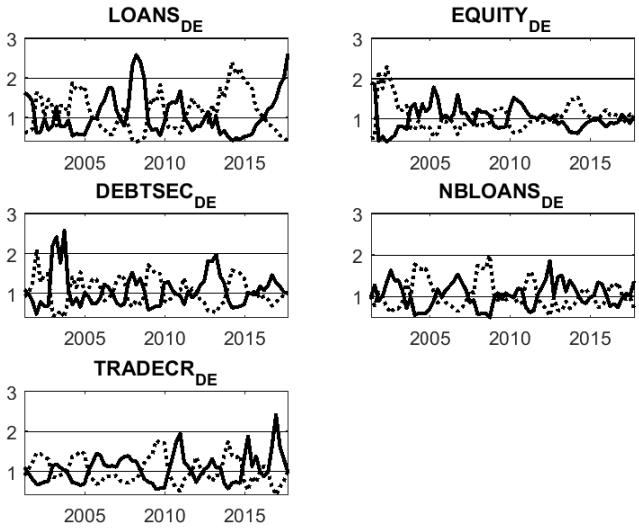
Annual growth rates. Median contributions of identified shocks to deviation from unconditional forecast. AD: aggregate demand shock, AS: aggregate supply shock, LS: loan supply shock, MP: monetary policy shock.

Figure 18: Historical decomposition of debt securities, non-bank loans and trade credit - Germany



Annual growth rates. Median contributions of identified shocks to deviation from unconditional forecast. AD: aggregate demand shock, AS: aggregate supply shock, LS: loan supply shock, MP: monetary policy shock.

Figure 19: Posterior odds ratio for contribution of loan supply shocks - Germany



Contribution to annual growth rates of variable. Posterior-odds ratio for positive (solid) and negative (dashed) contribution of loan supply shock to deviation from unconditional forecast.

The historical decompositons in Figure 17 and Figure 18 do not indicate a quantitatively important role for loan supply shocks in explaining the historical developments in firms' financing via equity, debt securities, non-bank loans or trade credit. Furthermore, the impact of loan supply shocks on the dynamics of bank lending to non-financial firms also turns out to be less important in Germany than for the Euro Area aggregate: although Figure 19 shows that loan supply shocks affected the dynamic of bank loans during the credit boom in the late 2000s (positively) and in 2014 (negatively) the size of the contributions is overall small (Figure 17). Interestingly, both Figure 17 and Figure 19 show that at the end of the sample period, loan supply shocks are exerting an overall positive effect on the growth rate of bank loans which has been accelerating recently. Comparing the contributions of the loan supply shock to loan growth to the estimates in Bijsterbosch and Falagiarda (2015) we find the estimated relative contributions of our loan supply shocks to loan growth to be generally smaller in all countries (see later sections). However, this is likely to reflect, at least in part, the fact that our model is much larger (twelve vs. five variables) while the number of identified shocks stays the same and, thus, the unidentified shocks play a relatively bigger role in our model.

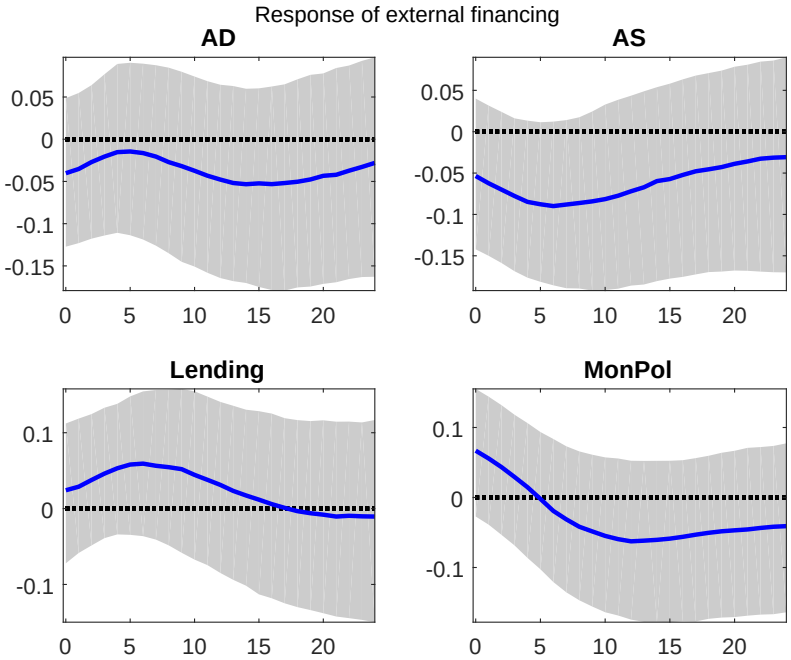
3.2.2 France

For France Table 3 indicates positive comovement between the impulse responses of bank lending on one and non-bank lending and trade credit on the other side. Median estimates

of the elasticity of the impulse response of debt securities issuance with respect to that of bank lending are negative but because of high estimation uncertainty posterior-odds for a negative association is are below 2:1. The impulse-response distribution for the sum of external financing for non-financial firms in France in Figure 20 provides evidence of a temporary increase in external financing following a positive loan supply shock. While bank lending, non-bank lending and trade credit expand after the shock (see appendix) the contraction in equity financing and debt securities shifts the overall response of external financing back towards zero: the substitution relationship with equity and debt securities financing leads to partial compensation for changes in bank lending and its complements non-bank lending and trade credit, although there is still more probability mass in the aggregate response in the same direction as the response in bank lending. For the aggregate demand shock this compensation is more pronounced. The weakly positive response of bank lending, which peaks after about one year and of its complements is offset by the decline in equity financing and debt securities, which makes the overall response of external financing, given the estimation uncertainty, not much different from zero. This is in contrast to the Euro Area and Germany, where the aggregate demand shock caused an overall increase in external financing. A partial offsetting of the decline in bank loans, non-bank loans and trade credit by equity and debt financing is also behind the weak decline in overall external financing after a contractionary monetary policy shock after a few quarters, which, nevertheless is more pronounced than in Germany. Similar to Germany, the aggregate supply shock leads to an overall contraction in external financing of French non-financial firms.

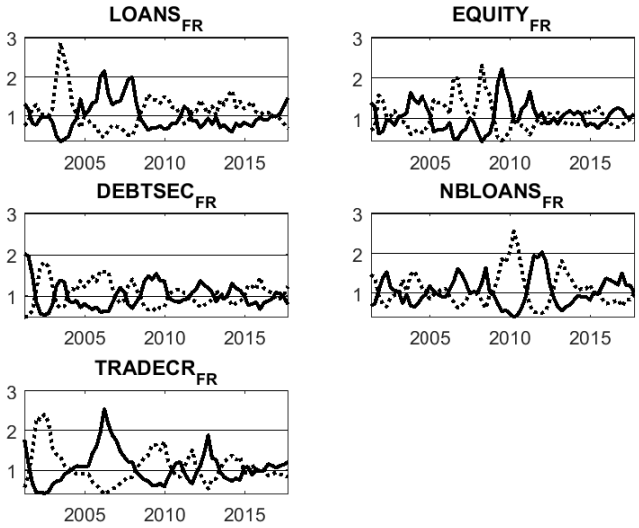
Except for some short episodes in the early-to-mid 2000s, identified loan supply shocks have been of little importance for the dynamics in bank lending to non-financial corporations in France (Figure 21). During the financial and sovereign debt crises, loan supply shocks appear not to have had strong effects on the dynamics in bank loans although we find posterior-ratios exceeding 2:1 for positive effects on non-bank loans in 2012 and equity issuance in 2009 and for negative effects on non-bank loans in 2009. The negative (positive) contributions to growth in equity financing (trade credit) during the credit boom are consistent with their role as substitutes (complements) relative to bank loans. Overall, quantitatively the contributions of loan supply shocks to the dynamics in the five financing variables is estimated to have been very small (Figure 22 and Figure 23).

Figure 20: Impulse responses of external financing to identified shocks - France



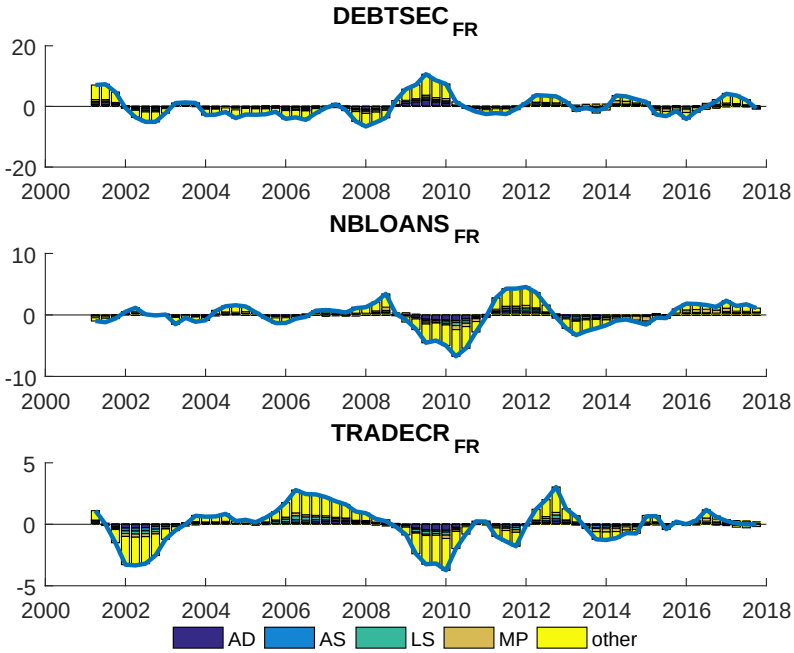
Median and 16- and 84% percentiles of marginal posterior distribution of impulse responses. AD: aggregate demand shock, AS: aggregate supply shock, Lending: loan supply shock, MonPol: monetary policy shock. AD and Lending shocks increase output, AS and MonPol shocks reduce output.

Figure 21: Posterior odds ratio for contribution of loan supply shocks - France



Contribution to annual growth rates of variable. Posterior-odds ratio for positive (solid) and negative (dashed) contribution of loan supply shock to deviation from unconditional forecast.

Figure 22: Historical decomposition of bank loans and equity financing - France



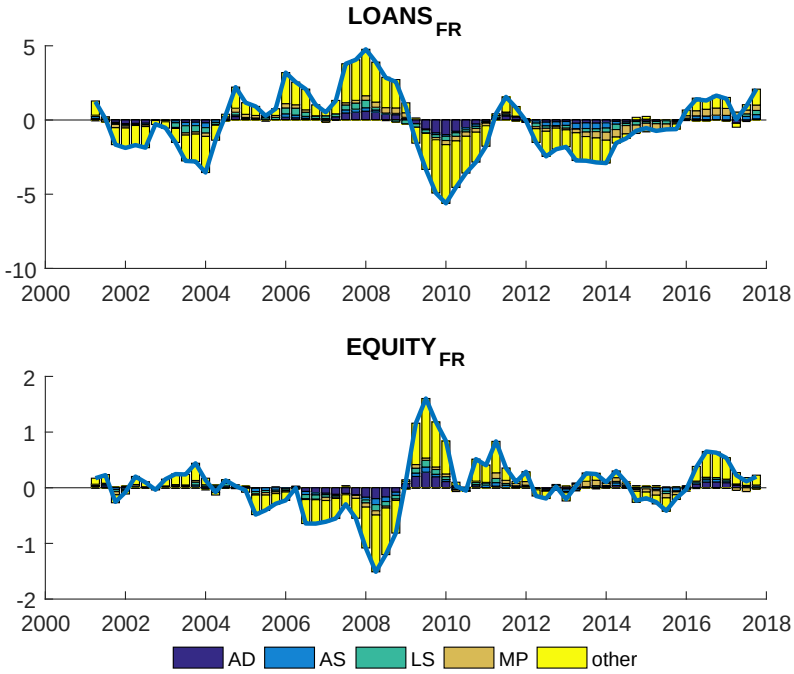
Annual growth rates. Median contributions of identified shocks to deviation from unconditional forecast. AD: aggregate demand shock, AS: aggregate supply shock, LS: loan supply shock, MP: monetary policy shock.

3.2.3 Italy

The results in Table 3 show for Italy evidence for negative association between impulse responses in bank lending and equity financing and positive association between impulse responses in bank lending and both non-bank lending and trade credit. For debt securities, estimation uncertainty is high to place sufficient confidence in the negative median elasticity estimate. The aggregate response of the four external financing sources in the model to a loan supply shock is positive (Figure 24): the substitution between equity and potentially debt securities on the one and bank, non-bank lending and trade credit on the other side is incomplete and the sum of the financing components moves in the direction of bank lending. Aggregate supply shocks result only in a brief decline in financing while the effects for the aggregate demand and monetary policy shocks are inconclusive.

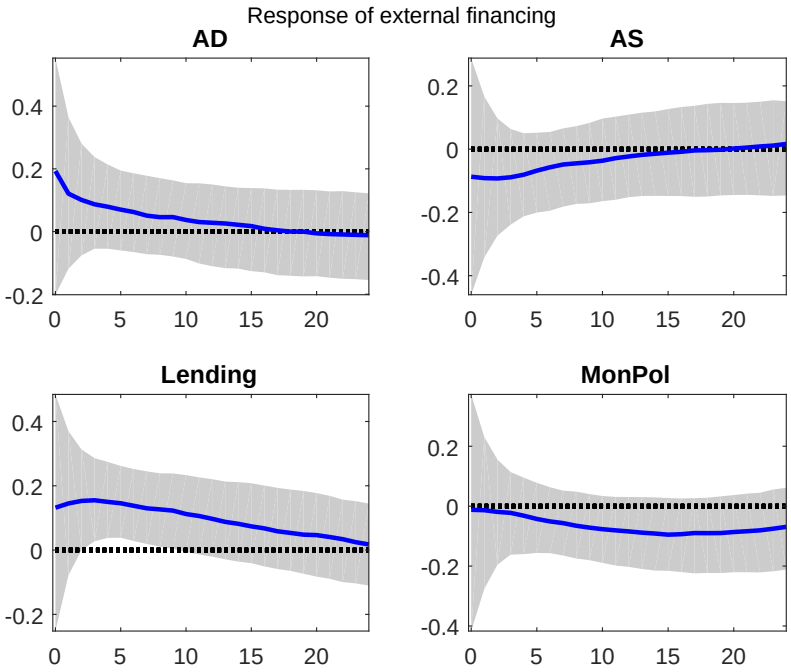
Loan supply shocks have been an important driver of the dynamics of bank lending in Italy during the credit boom in the late 2000s (positive) and around 2012 (negative) (Figure 25). The complementary relationship between bank lending and trade credit reflects in a qualitatively similar pattern in the contribution of loan supply shocks to the growth rates in both financing variables and, to some extent it is also visible in the loan supply shock contributions to non-bank loans. Posterior-odds ratios around 2:1 for a positive impact of loan supply shocks to the growth in equity financing during the financial

Figure 23: Historical decomposition of debt securities, non-bank loans and trade credit - France



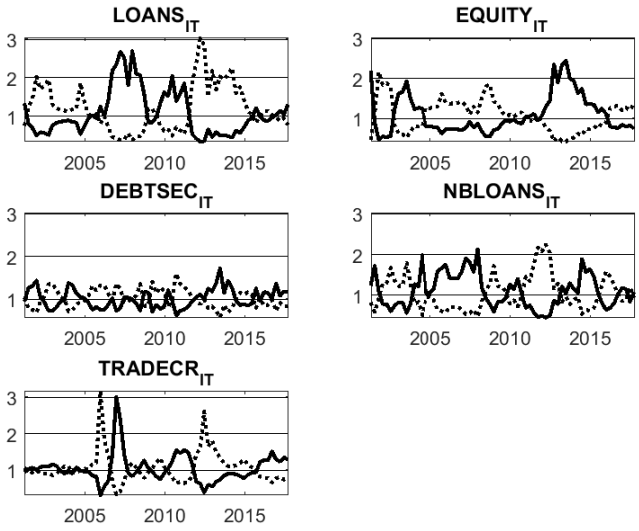
(a) Annual growth rates. Median contributions of identified shocks to deviation from unconditional forecast. AD: aggregate demand shock, AS: aggregate supply shock, LS: loan supply shock, MP: monetary policy shock.

Figure 24: Impulse responses of external financing to identified shocks - Italy



Median and 16- and 84% percentiles of marginal posterior distribution of impulse responses. AD: aggregate demand shock, AS: aggregate supply shock, Lending: loan supply shock, MonPol: monetary policy shock. AD and Lending shocks increase output, AS and MonPol shocks reduce output.

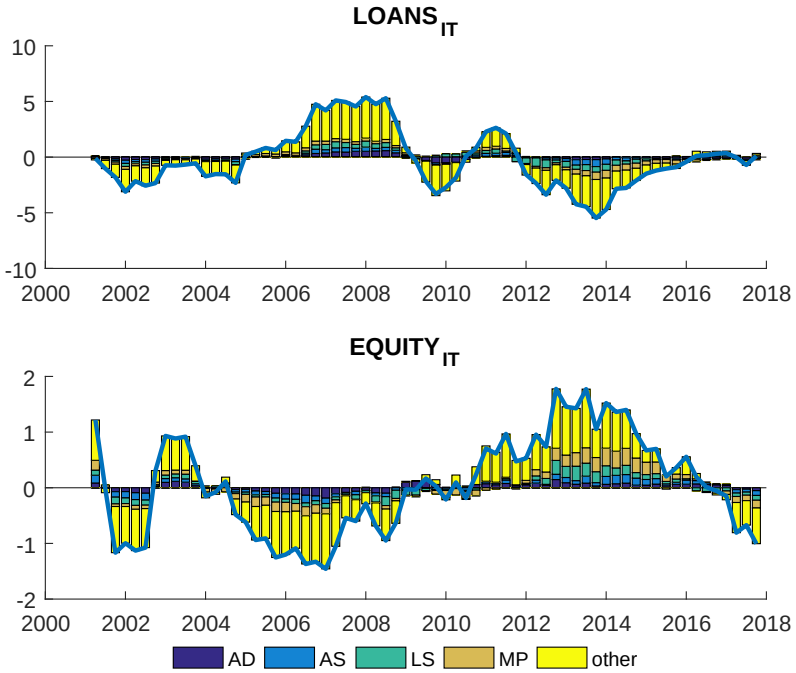
Figure 25: Posterior odds ratio for contribution of loan supply shocks - Italy



Contribution to annual growth rates of variable. Posterior-odds ratio for positive (solid) and negative (dashed) contribution of loan supply shock to deviation from unconditional forecast.

and sovereign debt crises show the substitution relationship with bank loans since, over this period, these shocks negatively affected the growth in bank lending. The contributions of loan supply shocks were quantitatively important (Figure 26 and Figure 27) for the dynamics of bank loans, equity, trade credit, and, around 2012, for non-bank loans but not for debt securities.

Figure 26: Historical decomposition of bank loans and equity financing - Italy



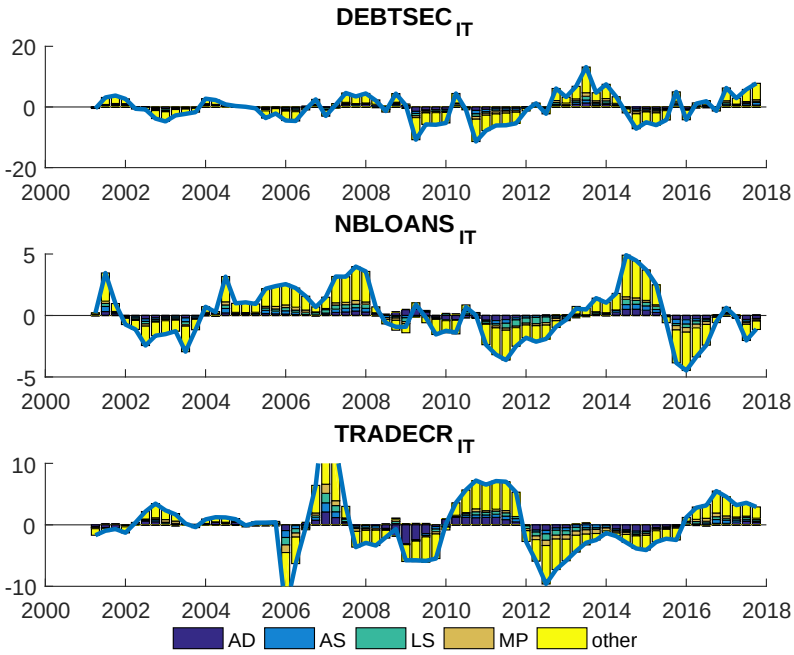
Annual growth rates. Median contributions of identified shocks to deviation from unconditional forecast. AD: aggregate demand shock, AS: aggregate supply shock, LS: loan supply shock, MP: monetary policy shock.

3.2.4 Spain

For Spain Table 3 only gives us reliable results for a positive relationship between changes in trade credit and bank lending after any type of structural shock. Figure 28 shows that the responses of the sum of the external financing sources to the identified shocks are mostly similar to those in the Euro Area with the difference that we do not find a change in overall external financing of non-financial corporations in Spain after an aggregate demand shock. Again, for those shocks, which cause pronounced changes in bank lending, i.e. monetary policy and loan supply shocks, the change in bank lending and in its complements dominates the dynamics of the sum of the five external financing sources.

Figure 29 reveals that loan supply shock supported growth in bank lending during the credit boom after 2005. There is some evidence for negative contributions around 2012/2013 but the posterior-odds ratio does not cross the 2:1 threshold. For trade credit as a complement to bank lending the results are similar but here we find strong evidence for a negative impact on growth of trade credit due to loan supply shocks in the first phase of the financial crisis. The historical decomposition of the annual growth in bank lending to non-financial firms in Spain shows that loan supply shocks indeed have been quantitavely important in these episodes with contributions about the same size or larger

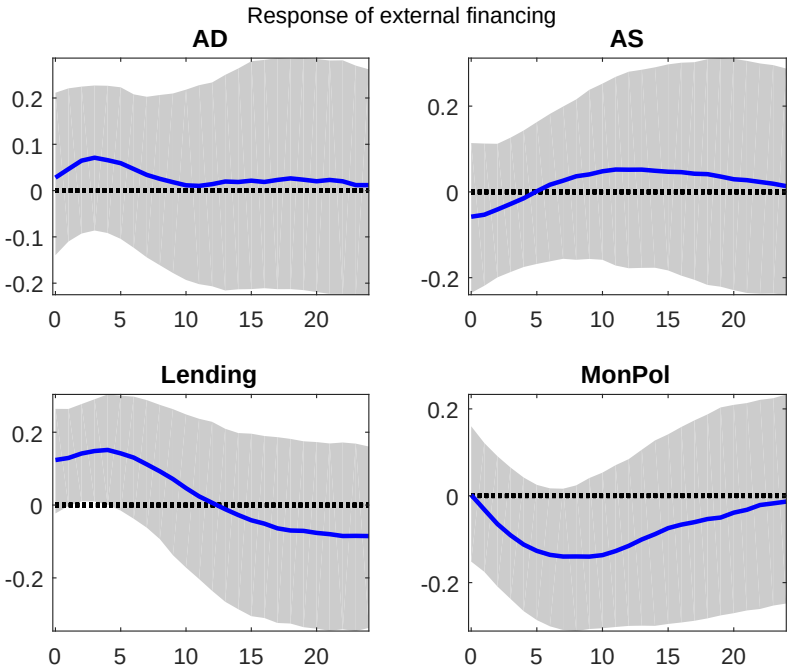
Figure 27: Historical decomposition of debt securities, non-bank loans and trade credit - Italy



Annual growth rates. Median contributions of identified shocks to deviation from unconditional forecast. AD: aggregate demand shock, AS: aggregate supply shock, LS: loan supply shock, MP: monetary policy shock.

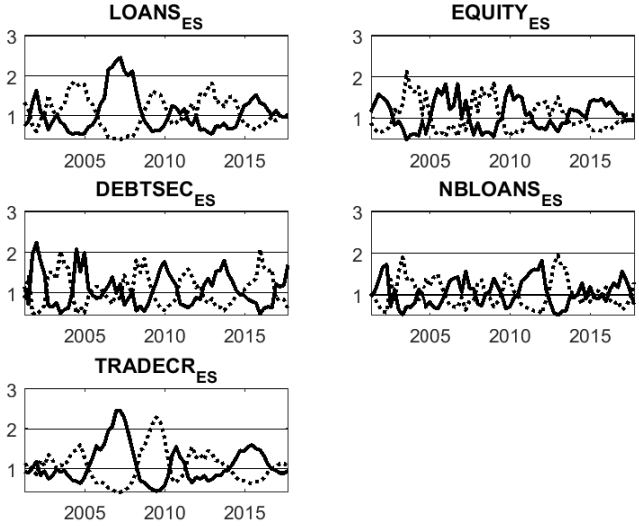
than that of the other shocks (Figure 30). Their contribution to the deviations of the growth rates of the other external financing sources from their unconditional forecasts was, however, relatively small (Figure 30 and Figure 31).

Figure 28: Impulse responses of external financing to identified shocks - Spain



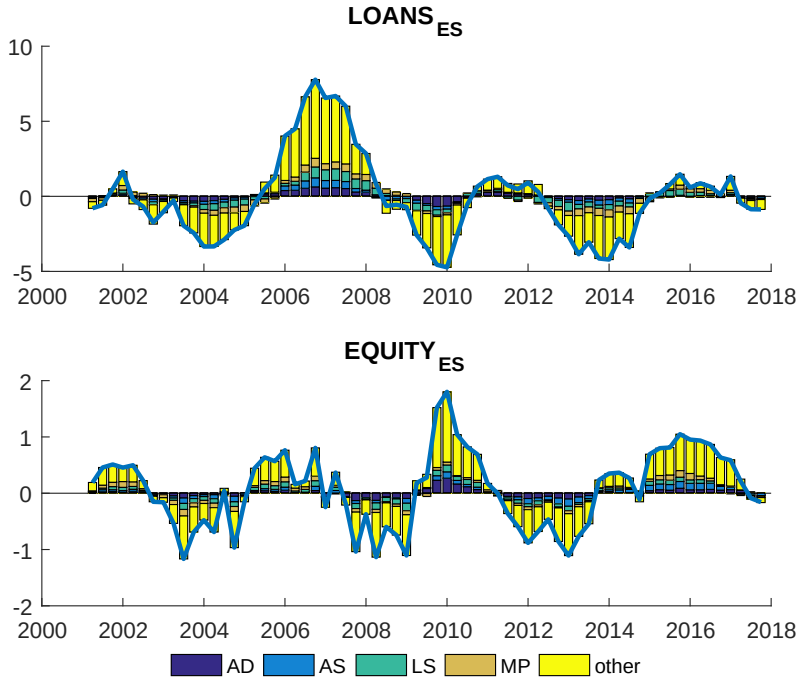
Median and 16- and 84% percentiles of marginal posterior distribution of impulse responses. AD: aggregate demand shock, AS: aggregate supply shock, Lending: loan supply shock, MonPol: monetary policy shock. AD and Lending shocks increase output, AS and MonPol shocks reduce output.

Figure 29: Posterior odds ratio for contribution of loan supply shocks - Spain



Contribution to annual growth rates of variable. Posterior-odds ratio for positive (solid) and negative (dashed) contribution of loan supply shock to deviation from unconditional forecast.

Figure 30: Historical decomposition of bank loans and equity financing - Spain



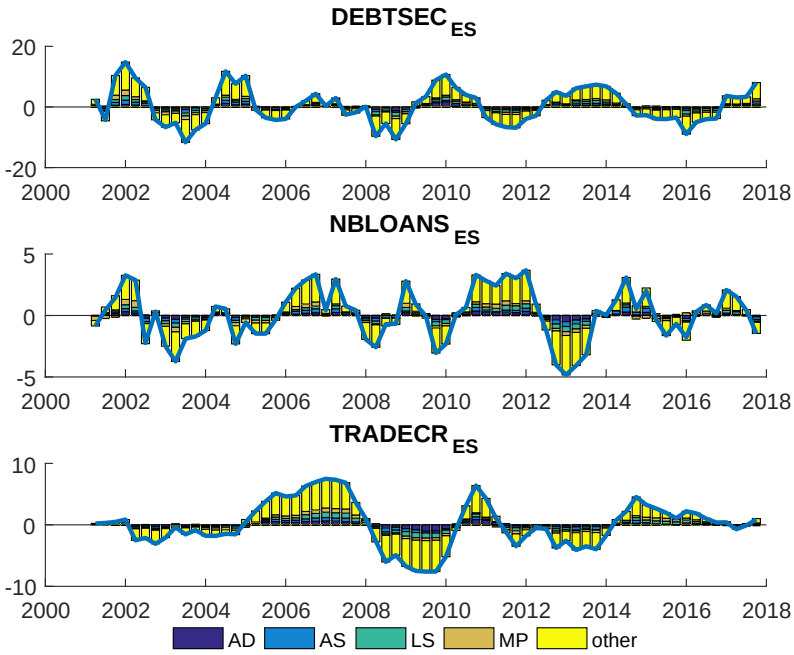
Annual growth rates. Median contributions of identified shocks to deviation from unconditional forecast. AD: aggregate demand shock, AS: aggregate supply shock, LS: loan supply shock, MP: monetary policy shock.

3.3 Robustness tests

Except for the interest rate on bank loans the models do not include indicators of the cost of firms' external financing. As a robustness check we added corporate bond yields from Gilchrist and Mojon (2018) as the cost of financing via debt securities issuance and the annual stock return as a proxy for the cost of equity financing. In the first variant of this model, we imposed no sign restrictions on the added variables. In the second variant we assumed that the impulse response of the corporate bond yield moves in the same direction as the bank lending rate. This assumption is in line with the interpretation of the loan supply shock as a broader financial markets disturbance (see section 2.3). For both of these model variants we obtained very similar results to the classification in Table 3. In another robustness check we added firms' gross savings from the flow-of-funds statistics to the model, thus, augmenting the model by a variable that proxies for firms' internal financing. The classification of the external financing sources as substitutes for or complements to bank loans remained close to the one in Table 3. An analysis as in the table for the relationship between bank loans and gross savings showed savings to be a substitute for bank loans in the Euro Area and in IT.

Replacing the five-year government bond yield by the ten-year yield in the Euro Area

Figure 31: Historical decomposition of debt securities, non-bank loans and trade credit - Spain



Annual growth rates. Median contributions of identified shocks to deviation from unconditional forecast. AD: aggregate demand shock, AS: aggregate supply shock, LS: loan supply shock, MP: monetary policy shock.

model did not change our results. We also checked the role of the shadow short rate as monetary policy indicator: (i) we replace the shadow short rate by Wu and Xia (2016) by the one from Geiger and Schupp (2018) and obtained very similar results to our baseline model(s). (ii) we use the EONIA instead of the shadow short rate. This change implies that the identified monetary policy shocks no longer account for unconventional monetary policy measures. Our results on the substitutability or complementarity of the financing sources are robust with respect to this change.

4 Discussion and conclusions

We analyse the effects of shocks to bank lending on non-financial corporations external financing both in the Euro Area and in Germany, France, Italy and Spain and account explicitly for possible interactions of bank lending with alternative sources of financing for firms. We investigate whether and which of the financing sources are complements to or substitutes for bank loans. We study the responses of the different financing variables to identified structural shocks and check for positive or negative comovement in the variables. Thus, our classification of a financing variable as a substitute or complement relative to bank loans is (a) dynamic, i.e. relates to the horizon of the impulse responses and (b)

cyclical, since it concerns deviations from steady state. Our analysis does not investigate secular developments, e.g. related to structural changes in the financial system. It is also important to point out that our results concerning non-bank loans and trade credit being complements to bank loans in some countries is a general equilibrium result. In a partial equilibrium setup in which firms choose their financing structure these alternative financing sources and bank loans might be substitutes, i.e. a reduction in the availability of bank lending or an increase in the lending rate might, all other things equal, lead to a substitution of bank loans by the other financing means. Our results concern the relationship between the external financing sources in general equilibrium when all the other endogenous variables adjust to the structural shocks, as well and the ceteris paribus assumption cannot be maintained.

We show that it is important to focus on the joint distribution of the responses of the alternative financing sources and bank loans in order to assess whether they act as substitutes or complements. On the Euro Area level we find equity, debt securities and non-bank loans to be substitutes for bank loans while trade credit is a complement. Substitution is imperfect and the overall sum of the external financing components including bank loans moves into the direction of the latter. Moving below the Euro Area aggregates, which, if any, financing sources are substitutes for or complements to bank loans differs across the individual countries. In France and Italy, non-bank loans are complements to bank loans as is trade credit in France and Spain and, to some extent in Italy. Equity financing is a substitute for bank loans to non-financial corporations in Italy. Results for Germany are inconclusive. We show our classification to be robust with respect to changes in bank lending being due to different structural shocks. In most countries and for most shocks firms overall external financing moves in the direction of bank lending. Thus the changes in bank lending, reinforced by complementarity with other financing sources, dominate the dynamics of external financing and compensation by substitutes, if any, is imperfect. In the case of a negative, i.e. contractionary loan supply shock this implies that alternative financing sources, even if some substitution takes place cannot, on a macroeconomic level, fully compensate for a the effects of a reduction in bank lending.

While we find strong evidence for a systematic relation of the dynamics in bank loans and the four alternative external financing sources for firms following structural shocks in the Euro Area aggregates, results at the individual country level are not as pronounced. This is a puzzling result as the four countries account for the bulk of the Euro Area aggregate variables.[33] One possibility might be a higher estimation uncertainty at the country level. For example, the impulse response functions of the four flow-of-funds

[33]In terms of the sample averages of the time series the four countries account for 75% of Euro Area MFI loans to non-financial corporations, 73% of equity, 72% of debt securities, 91% of non-bank loans and 89% of trade credit.

variables to the loan supply shock in the individual countries shown in the appendix generally tend to be wider than those for the Euro Area. One reason for this might be that the individual country models include two additional variables compared to the Euro Area aggregate model: Euro Area real GDP and GDP deflator, which introduces additional parameters into the model and might result in unfavourable tradeoff if they contain little additional information. As a robustness check we reestimated the country models for France and Germany without the two Euro Area variables, which might result in a misspecified monetary policy reaction function as discussed in Subsection 2.3, but we found only a small improvement in our results concerning the substitute vs complement question.[34] Another possibility is that the sign restrictions for the aggregate demand, aggregate supply and loan supply shocks at the country level on the common monetary policy interest rate might be a problem but these restrictions are required for disentangling the different structural shocks. A more favourable explanation is that country-specific noise in the flow-of-funds data might to some extent cancel out in the Euro Area aggregates which would reduce the estimation uncertainty at the Euro Area level. A fact in support of this hypothesis is that the elasticity estimates Table 3 which are large in absolute values but do not pass the test in Table B.1, such as, e.g. those for non-bank loans in Germany or for debt securities in France and Spain broadly show the same signs as those estimated for the Euro Area aggregates.

According to our estimates, loan supply shocks made important contributions to the dynamics of bank loans in the Euro Area but their importance varies across countries with little relevance in Germany and France and more important effects in Italy and Spain. Reflecting the substutability or complementarity, loan supply shocks can also contribute to deviations in the alternative financing sources from their deterministic dynamics. However, overall, the explanatory power of loan supply shocks to movements in these variables turns out to be quite low.

References

Abbate, A., S. Eickmeier, and E. Prieto (2016). Financial shocks and inflation dynamics. Discussion Paper 04/2016, Deutsche Bundesbank.

[34] For Germany we obtain for the loan supply shock some evidence for non-bank loans being a substitute for bank loans at posterior-odds ratios of 2:1. For both countries the estimation algorithm selected more shrinkage, i.e. smaller values for λ in the larger model but the modest decline does not suggest that the additional data is uninformative. We also experimented with including additional variables, such as the bank bond or corporate bond vs. government bond spreads from Gilchrist and Mojon (2018) but this also did not lead to more clear-cut results.

Aldasoro, I. and R. Unger (2017). External financing and economic activity in the Euro Area: Why are bank loans special? Discussion Paper 04/2017, Deutsche Bundesbank.

Altavilla, C., M. Darracq-Paries, and G. Nicoletti (2015). Loan supply, credit markets and the Euro Area financial crisis. Working Paper 1861, European Central Bank.

Arias, J., D. Caldara, and J. Rubio-Ramírez (2015). The systematic component of monetary policy in SVARs: an agnostic identification procedure. International Finance Discussion Papers 1131, Board of Governors of the Federal Reserve System.

Arias, J., J. Rubio-Ramírez, and D. Waggoner (2014). Inference based on SVARs identified with sign and zero restrictions: theory and applications. Dynare Working Paper 30.

Banbura, M., D. Giannone, and L. Reichlin (2010). Large Bayesian VARs. *Journal of Applied Econometrics 25*, 71–92.

Bean, C., M. Paustian, A. Penalver, and T. Taylor (2011). Monetary policy after the fall. In *Macroeconomic Challenges: The Decade Ahead*, pp. 267–328. Federal Reserve Bank of Kansas City.

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 54*, 93–115.

Bonci, R. (2014). Monetary policy and the flow of funds in the euro area. In B. Winkler, A. van Riet, and P. Bull (Eds.), *A Flow-of-Funds Perspective on the Financial Crisis:0 Volume I*, Chapter 13, pp. 296–317. Basingstoke: Palgrave Macmillan.

Breitenlechner, M., J. Scharler, and F. Sindermann (2016). Banks external financing costs and the bank lending channel: Results from a SVAR analysis. *Journal of Financial Stability 26*, 228–24.

Deutsche Bundesbank (2015). The influence of credit supply shocks on the development of real GDP and lending to Euro Area non-financial corporations. *Monthly Report September*, 36–38.

Deutsche Bundesbank (2017). Monetary policy indicators at the lower bound based on term structure models. *Monthly Report September*, 13–34.

Deutsche Bundesbank (2018). Developments in corporate financing in the Euro Area since the financial and economic crisis. *Monthly Report January*, 53–71.

Duchi, F. and A. Elbourne (2016). Credit supply shocks in the Netherlands. *Journal of Macroeconomics 50*, 451–71.

European Central Bank (2011). *The Monetary Policy of the ECB*. European Central Bank.

European Central Bank (2012a). Manual on MFI balance sheet statistics. Technical report, European Central Bank.

European Central Bank (2012b). Monetary and financial developments. *Monthly Bulletin February*, 13–37.

European Central Bank (2016). Trends in the external financing structure of Euro Area non-financial corporations. *ECB Economic Bulletin 5*, 29–32.

Fry, R. and A. Pagan (2011). Sign restrictions in structural vector autoregressions: A critical review. *Journal of Economic Literature 49*, 938–960.

Gambetti, L. and A. Musso (2017). Loan supply shocks and the business cycle. *Journal of Applied Econometrics 32*(4), 764–782.

Geiger, F. and F. Schupp (2018). With a little help from my friends: Survey-based derivation of euro area short-rate expectations at the effective lower bound. Discussion Paper 27/2018, Deutsche Bundesbank.

Gerali, A., S. Neri, L. Sessa, and F. Signoretti (2010). Credit and banking in a DSGE model of the Euro Area. *Journal of Money, Credit and Banking 42*(s1), 107–142.

Gertler, M. and P. Karadi (2011). A model of unconventional monetary policy. *Journal of Monetary Economics 58*(1), 17–34.

Giannone, D., M. Lenza, D. Momferatou, and L. Onorante (2014). Short-term inflation projections: A Bayesian vector autoregessive approach. *International Journal of Forecasting 30*, 635–644.

Giannone, D., M. Lenza, and G. Primiceri (2016). Prior selection for vector autoregessions. *Review of Economics and Statistics 97*, 436–452.

Gilchrist, S. and B. Mojon (2018). Credit risk in the Euro Area. *Economic Journal 128*, 118–158.

Gilchrist, S., R. Schoenle, J. Sim, and E. Zakrajsek (2017). Inflation dynamics during the financial crisis. *American Economic Review 107*(3), 785–823.

Hristov, N., O. Hülsewig, and T. Wollmershäuser (2012). Loan supply shocks during the financial crisis: evidence for the Euro Area. *Journal of International Money and Finance 31*(3), 569–592.

Kilian, L. and H. Lütkepohl (2018). *Structural Vector Autoregressions*. Cambridge University Press.

Krippner, L. (2013). Measuring the stance of monetary policy in zero lower bound environments. *Economics Letters 118*, 135–138.

Meinen, P. and O. Röhe (2018). To sign or not to sign? On the response of prices to financial and uncertainty shocks. *Economics Letters 171*(October), 189–192.

Moccero, D., M. Darracq-Paries, and L. Maurin (2014). Financial conditions index and identification of credit supply shocks for the Euro Area. *International Finance 17*(3), 297–321.

Mumtaz, H., G. Pinter, and K. Theodoridis (1998). What do VARs tell us about the impact of a credit supply shocks? *International Economic Review 59*, 625–646.

Peersman, G. (2011). Macroeconomic effects of unconventional monetary policy in the Euro Area. Working Paper Series 1397, European Central Bank.

Sims, C. and T. Zha (1998). Bayesian methods for dynamic multivariate models. *International Economic Review 39*, 949–968.

Wu, J. C. and F. D. Xia (2016). Measuring the macroeconomic impact of monetary policy at the zero lower bound. *Journal of Money, Credit, and Banking 48*(2-3), 253–291.

Appendix A: Data

- Real GDP

  Gross domestic product at market prices, chain linked volume, calendar and seasonally adjusted data. Source: Eurostat. Downloaded from the ECB's Statistical Data Warehouse (SDW).

- GDP Deflator

  Gross domestic product at market prices, deflator (index), calendar and seasonally adjusted data. Source: Eurostat. Downloaded from the SDW.

- MFI loans to non-financial corporations

  We construct an index of notional stocks, using the outstanding amounts at the end of the period, financial transactions (flows) and, after they become available, financial transactions (flows) which are adjusted for sales and securitisations; data is neither seasonally nor working day adjusted. For details on the construction of notional stocks, see European Central Bank (2012a). Source: ECB (Balance sheet indicators - BSI). Downloaded from the SDW.

- Shadow short rate

  Shadow short rate from Wu and Xia (2016); we use observation for final month in quarter; backward extension of data with EONIA. Downloaded from https://sites.google.com/view/jingcynthiawu/

- Lending rate

  Interest rate loans other than revolving loans and overdrafts, convenience and extended credit card debt; loans of credit and other institutions to non-financial corporations, new business; we use observation for final month in quarter; backward extended using the Area Wide Model Database. Source: ECB (MFI interest rate statistics - MIR). Downloaded from the SDW.

- Five year government bond yield

  5-year benchmark bond yield; average of observations through period. Source: ECB. Downloaded from the SDW.

- Equity

  Non-financial corporations - liabilities, equity - non-consolidated. We construct an index of notional stocks using the closing balance sheet information and the trans-

action amounts (see above); data is neither seasonally nor working day adjusted. Source: ECB and Eurostat. Downloaded from the SDW.

- Debt securities

  Non-financial corporations - liabilities, debt securities - non-consolidated. We construct an index of notional stocks using the closing balance sheet information and the transaction amounts (see above); data is neither seasonally nor working day adjusted. Source: ECB and Eurostat. Downloaded from the SDW.

- Non-bank loans

  Non-financial corporations - liabilities, loans - non-consolidated. We construct an index of notional stocks using the closing balance sheet information and the transaction amounts (see above); data is neither seasonally nor working day adjusted. We subtract from this series, which includes MFI loans, the series for MFI loans (see above). Source: ECB and Eurostat. Downloaded from the SDW.

- Trade credit

  Non-financial corporations - liabilities, trade credit and advances - non-consolidated. We construct an index of notional stocks using the closing balance sheet information and the transaction amounts (see above); data is neither seasonally nor working day adjusted. We subtract from this series, which includes MFI loans, the series for MFI loans (see above). Source: ECB and Eurostat. Downloaded from the SDW.

Appendix B: Tables

Euro Area

horizon	4 quarters				8 quarters				16 quarters			
shock	EQ	Debt	NBL	TC	EQ	Debt	NBL	TC	EQ	Debt	NBL	TC
LS	0.38	0.21	0.46	0.89	0.20	0.16	0.38	0.90	0.20	0.24	0.18	0.76
AD	0.26	0.30	0.50	0.86	0.24	0.32	0.40	0.77	0.29	0.31	0.26	0.74
AS	0.44	0.30	0.41	0.82	0.31	0.25	0.37	0.83	0.24	0.26	0.25	0.78
MP	0.48	0.31	0.39	0.82	0.42	0.28	0.39	0.85	0.29	0.32	0.30	0.79

Germany

horizon	4 quarters				8 quarters				16 quarters			
shock	EQ	Debt	NBL	TC	EQ	Debt	NBL	TC	EQ	Debt	NBL	TC
LS	0.57	0.54	0.43	0.55	0.54	0.47	0.41	0.51	0.56	0.42	0.39	0.52
AD	0.46	0.47	0.40	0.58	0.47	0.44	0.40	0.52	0.54	0.43	0.42	0.48
AS	0.58	0.51	0.47	0.60	0.53	0.45	0.43	0.54	0.58	0.42	0.37	0.54
MP	0.49	0.50	0.46	0.53	0.46	0.50	0.42	0.54	0.49	0.48	0.43	0.53

France

horizon	4 quarters				8 quarters				16 quarters			
shock	EQ	Debt	NBL	TC	EQ	Debt	NBL	TC	EQ	Debt	NBL	TC
LS	0.38	0.41	0.67	0.76	0.36	0.46	0.71	0.72	0.42	0.47	0.65	0.69
AD	0.36	0.41	0.68	0.71	0.39	0.45	0.66	0.72	0.38	0.44	0.68	0.72
AS	0.57	0.56	0.68	0.70	0.47	0.54	0.75	0.70	0.42	0.48	0.67	0.68
MP	0.42	0.39	0.60	0.72	0.33	0.32	0.80	0.81	0.42	0.48	0.68	0.74

Italy

horizon	4 quarters				8 quarters				16 quarters			
shock	EQ	Debt	NBL	TC	EQ	Debt	NBL	TC	EQ	Debt	NBL	TC
LS	0.34	0.46	0.69	0.69	0.23	0.45	0.69	0.70	0.21	0.37	0.68	0.64
AD	0.40	0.54	0.60	0.61	0.33	0.51	0.67	0.54	0.28	0.40	0.71	0.61
AS	0.45	0.49	0.61	0.62	0.28	0.43	0.66	0.63	0.20	0.37	0.69	0.66
MP	0.41	0.46	0.61	0.60	0.18	0.44	0.68	0.72	0.12	0.37	0.71	0.69

Spain

horizon	4 quarters				8 quarters				16 quarters			
shock	EQ	Debt	NBL	TC	EQ	Debt	NBL	TC	EQ	Debt	NBL	TC
LS	0.55	0.48	0.57	0.80	0.42	0.44	0.55	0.78	0.34	0.48	0.53	0.81
AD	0.46	0.47	0.53	0.78	0.41	0.47	0.50	0.79	0.34	0.46	0.52	0.81
AS	0.52	0.52	0.51	0.74	0.44	0.48	0.50	0.79	0.32	0.45	0.52	0.84
MP	0.55	0.58	0.51	0.80	0.44	0.55	0.57	0.81	0.30	0.51	0.57	0.76

Share of draws from posterior distribution of impulse responses to identified shocks for which bank loans and alternative financing source respond with identical sign. AD: aggregate demand shock, AS: aggregate supply shock, LS: loan supply shock, MP: monetary policy shock, EQ: equity, Debt: debt securities, NBL: non-bank loans, TC: trade credit.

Table B.1: Proportion of draws with impulse responses of bank loans and alternative financing source of identical sign

Appendix C: Results from full MCMC algorithm for Euro Area

elasticities

horizon	4 quarters				8 quarters				16 quarters			
shock	EQ	Debt	NBL	TC	EQ	Debt	NBL	TC	EQ	Debt	NBL	TC
LS	-0.05	**-1.28**	-0.23	**1.20**	**-0.07**	**-0.85**	-0.13	**0.77**	**-0.06**	**-0.60**	**-0.17**	**0.48**
AD	**-0.04**	**-1.08**	-0.15	**1.12**	**-0.06**	**-0.87**	-0.13	**0.78**	**-0.06**	**-0.60**	**-0.17**	**0.45**
AS	-0.04	**-0.99**	-0.16	**1.07**	**-0.06**	**-0.87**	-0.14	**0.78**	**-0.06**	**-0.62**	**-0.18**	**0.48**
MP	-0.04	**-1.05**	-0.16	**1.09**	-0.07	**-0.83**	-0.13	**0.75**	**-0.07**	-0.64	**-0.17**	**0.49**

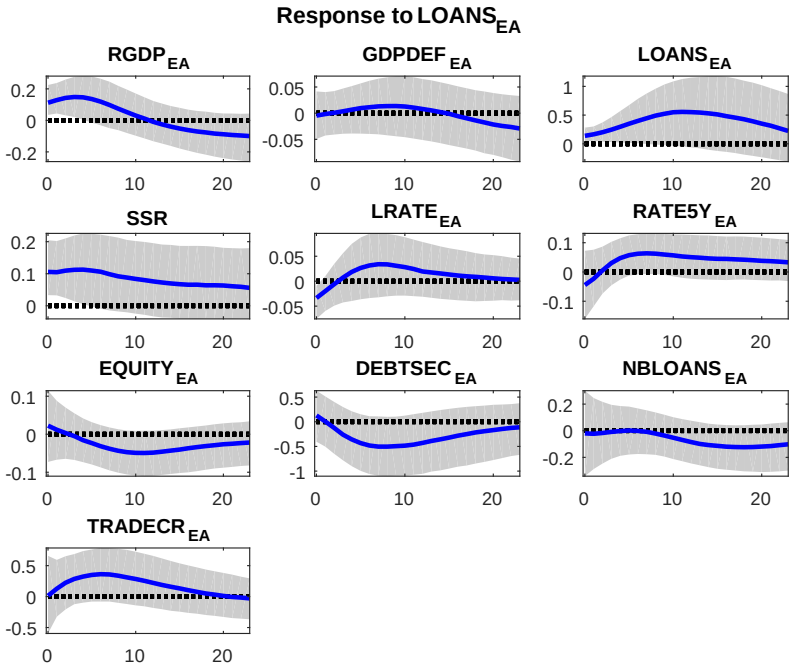
proportion of draws with IRF of identical sign with IRF of bank loans

horizon	4 quarters				8 quarters				16 quarters			
shock	EQ	Debt	NBL	TC	EQ	Debt	NBL	TC	EQ	Debt	NBL	TC
LS	0.38	0.22	0.44	0.84	0.22	0.17	0.38	0.88	0.20	0.24	0.20	0.76
AD	0.26	0.30	0.52	0.82	0.25	0.33	0.40	0.76	0.29	0.30	0.26	0.74
AS	0.44	0.31	0.41	0.79	0.32	0.26	0.36	0.82	0.25	0.26	0.25	0.77
MP	0.49	0.31	0.39	0.79	0.44	0.30	0.38	0.84	0.30	0.35	0.33	0.77

Top panel: elasticity of deviation of volume of financing from baseline with respect to the deviation in bank loans from baseline. Estimated slope coefficients of OLS-regression of impulse responses of alternative financing source on impulse response of bank loans. Regression includes constant. AD: aggregate demand shock, AS: aggregate supply shock, LS: loan supply shock, MP: monetary policy shock, EQ: equity, Debt: debt securities, NBL: non-bank loans, TC: trade credit. Elasticities with posterior-odds ratios for positive or negative comovement above 2:1 in bold.
Bottom panel: Share of draws from posterior distribution of impulse responses to identified shocks for which bank loans and alternative financing source respond with identical sign.
AD: aggregate demand shock, AS: aggregate supply shock, LS: loan supply shock, MP: monetary policy shock, EQ: equity, Debt: debt securities, NBL: non-bank loans, TC: trade credit.

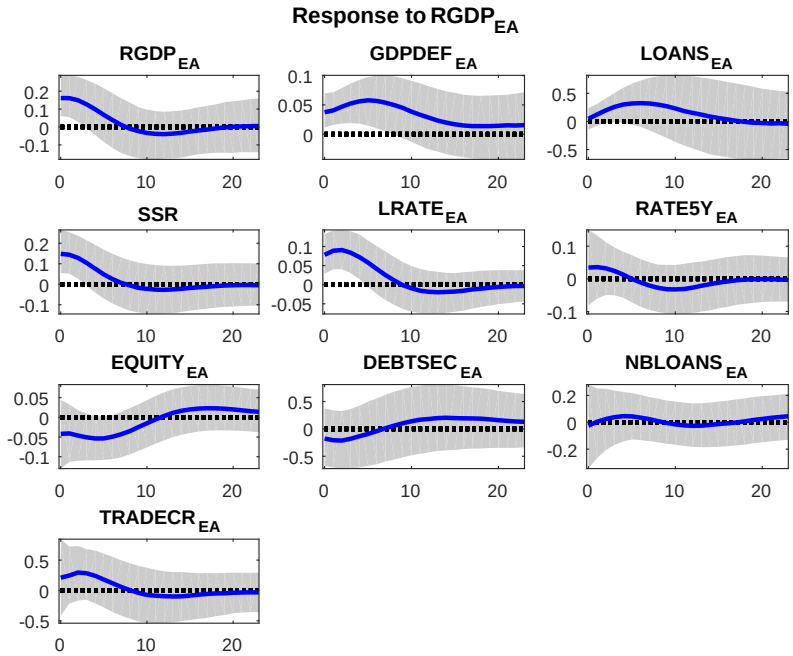
Table C.1: Estimated impulse response elasticities of alternative financing sources with respect to bank loans and proportion of draws with impulse responses of bank loans and alternative financing source of identical sign - full MCMC algorithm

Figure C.1: Impulse responses to loan supply shock - Euro Area



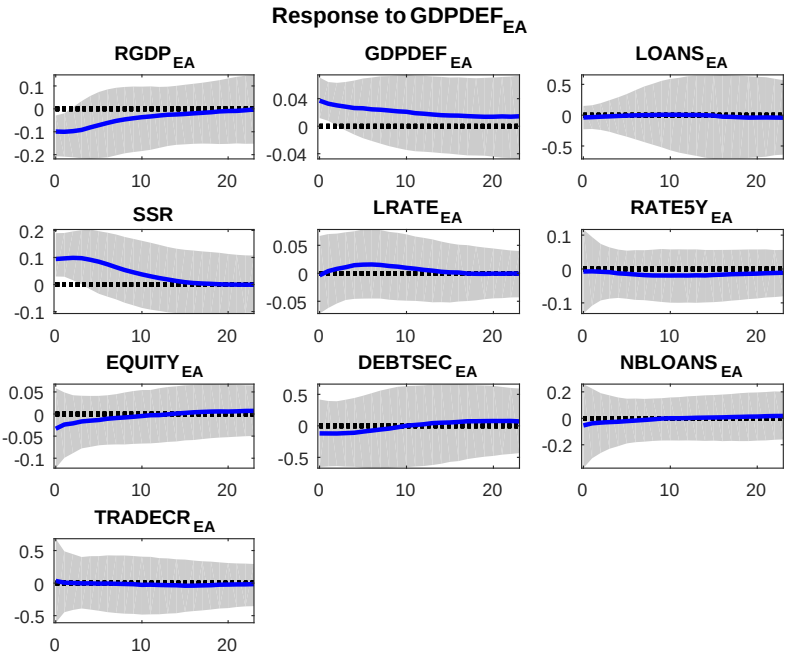
Median and 16- and 84% percentiles of marginal posterior distribution of impulse responses.

Figure C.2: Impulse responses to aggregate demand shock - Euro Area



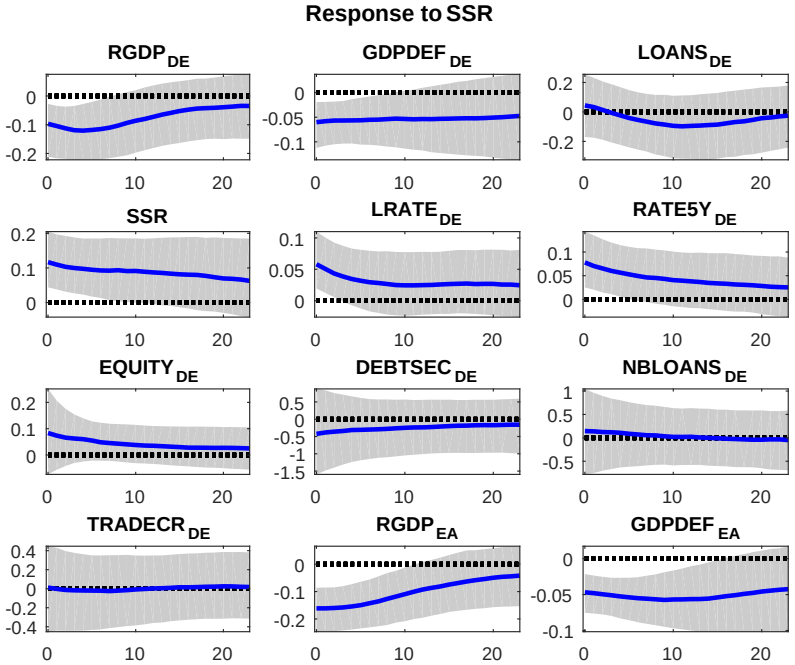
Median and 16- and 84% percentiles of marginal posterior distribution of impulse responses.

Figure C.3: Impulse responses to aggregate supply shock - Euro Area



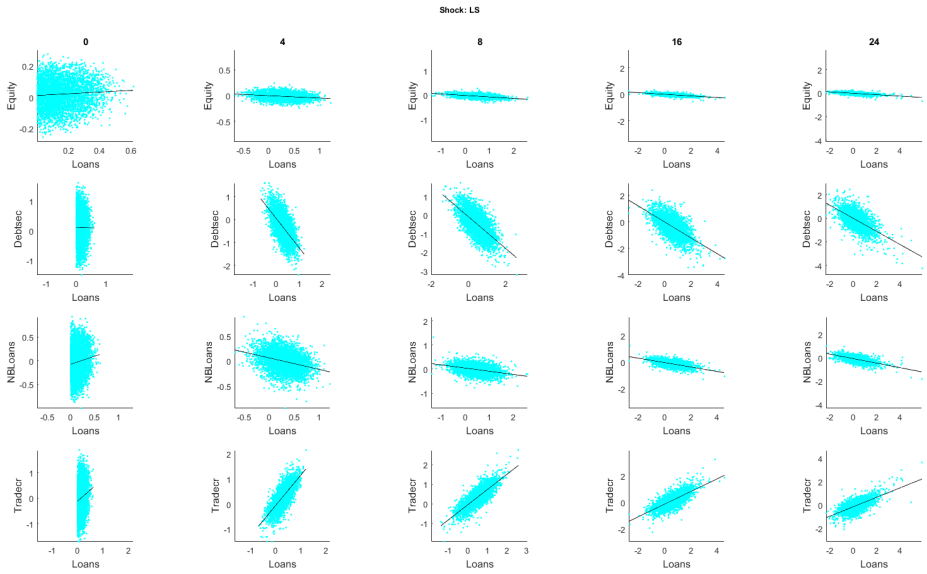
Median and 16- and 84% percentiles of marginal posterior distribution of impulse responses.

Figure C.4: Impulse responses to monetary policy shock - Euro Area



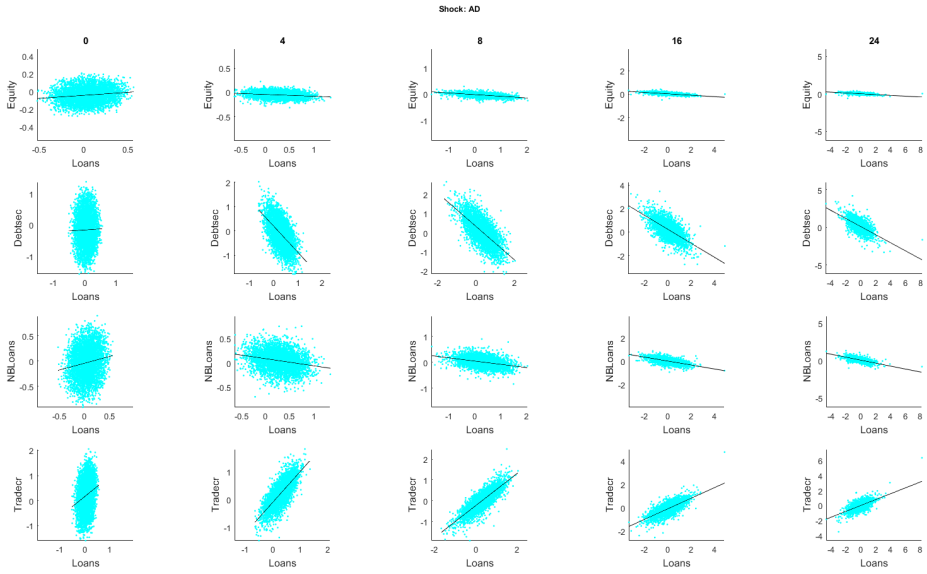
Median and 16- and 84% percentiles of marginal posterior distribution of impulse responses.

Figure C.5: Joint distribution of impulse responses of bank loans and alternative financing sources to loan supply - Euro Area



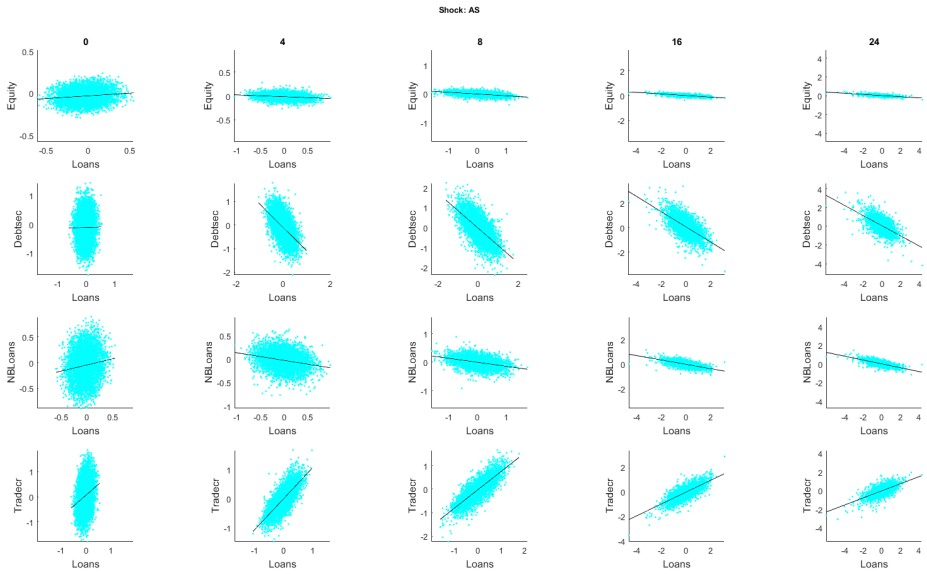
Scatter plots of impulse response of real MFI loans to non-financial corporations (horizontal axes) and impulse response of variable indicated (vertical axes). Columns indicate impulse response horizon. 0 is impact period. Black lines are obtained from linear regression of impulse response on vertical axes on impulse response on horizontal axes.

Figure C.6: Joint distribution of impulse responses of bank loans and alternative financing sources to aggregate demand shock - Euro Area



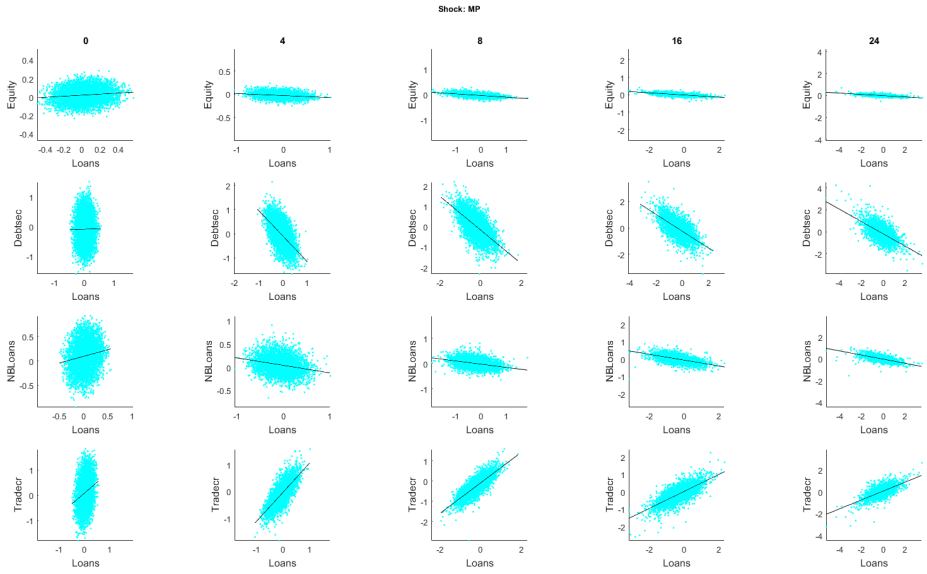
Scatter plots of impulse response of real MFI loans to non-financial corporations (horizontal axes) and impulse response of variable indicated (vertical axes). Columns indicate impulse response horizon. 0 is impact period. Black lines are obtained from linear regression of impulse response on vertical axes on impulse response on horizontal axes.

Figure C.7: Joint distribution of impulse responses of bank loans and alternative financing sources to aggregate supply shock - Euro Area



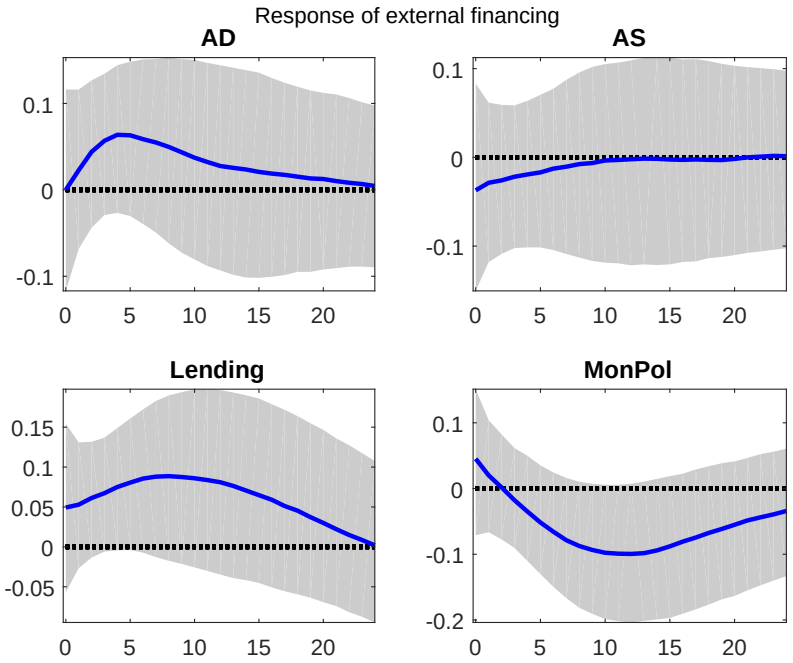
Scatter plots of impulse response of real MFI loans to non-financial corporations (horizontal axes) and impulse response of variable indicated (vertical axes). Columns indicate impulse response horizon. 0 is impact period. Black lines are obtained from linear regression of impulse response on vertical axes on impulse response on horizontal axes.

Figure C.8: Joint distribution of impulse responses of bank loans and alternative financing sources to monetary policy shock - Euro Area



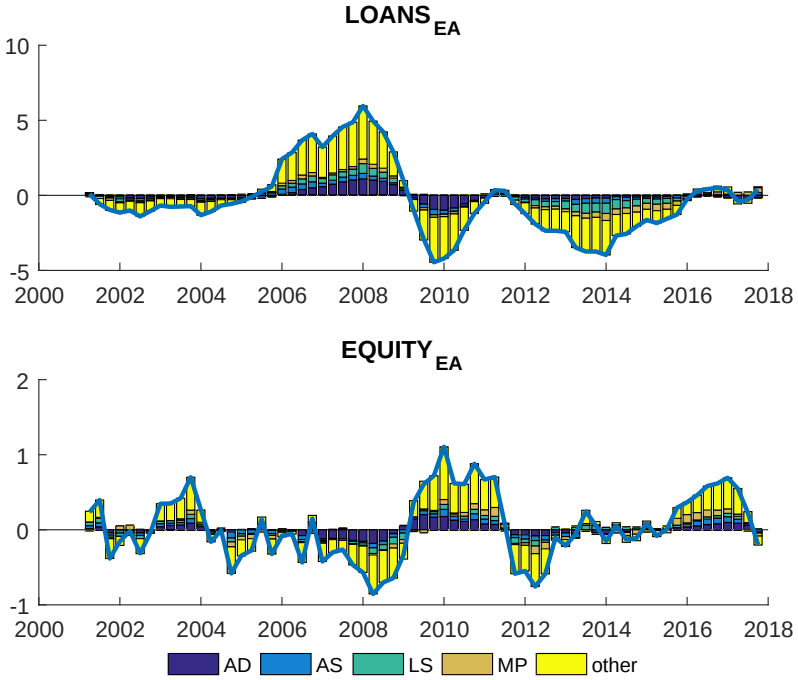
Scatter plots of impulse response of real MFI loans to non-financial corporations (horizontal axes) and impulse response of variable indicated (vertical axes). Columns indicate impulse response horizon. 0 is impact period. Black lines are obtained from linear regression of impulse response on vertical axes on impulse response on horizontal axes.

Figure C.9: Impulse responses of external financing to identified shocks - Euro Area



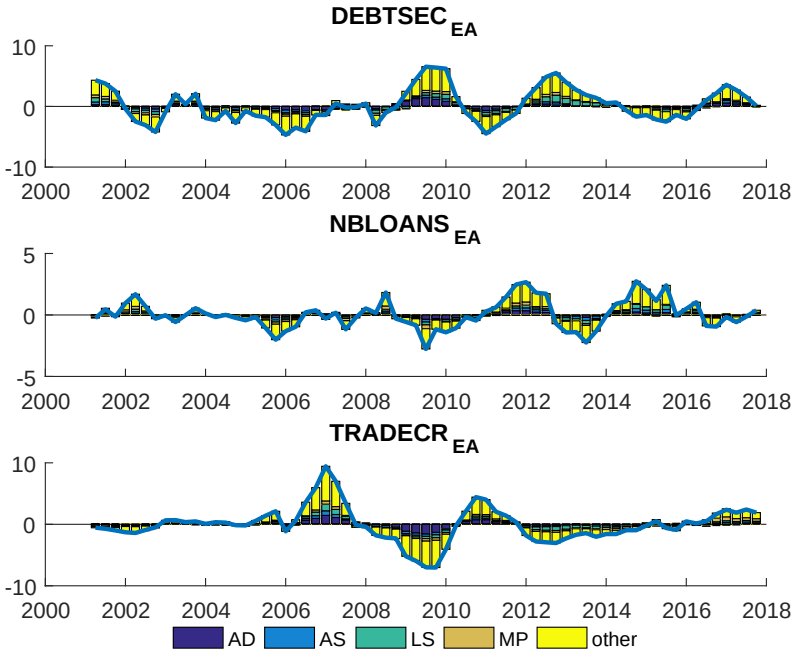
Median and 16- and 84% percentiles of marginal posterior distribution of impulse responses. AD: aggregate demand shock, AS: aggregate supply shock, Lending: loan supply shock, MonPol: monetary policy shock. AD and Lending shocks increase output, AS and MonPol shocks reduce output.

Figure C.10: Historical decomposition of bank loans and equity financing - Euro Area



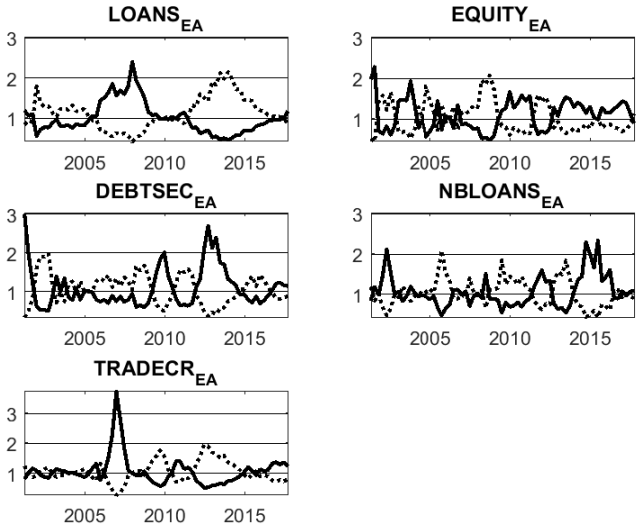
Annual growth rates. Median contributions of identified shocks to deviation from unconditional forecast. AD: aggregate demand shock, AS: aggregate supply shock, LS: loan supply shock, MP: monetary policy shock.

Figure C.11: Historical decomposition of debt securities, non-bank loans and trade credit - Euro Area



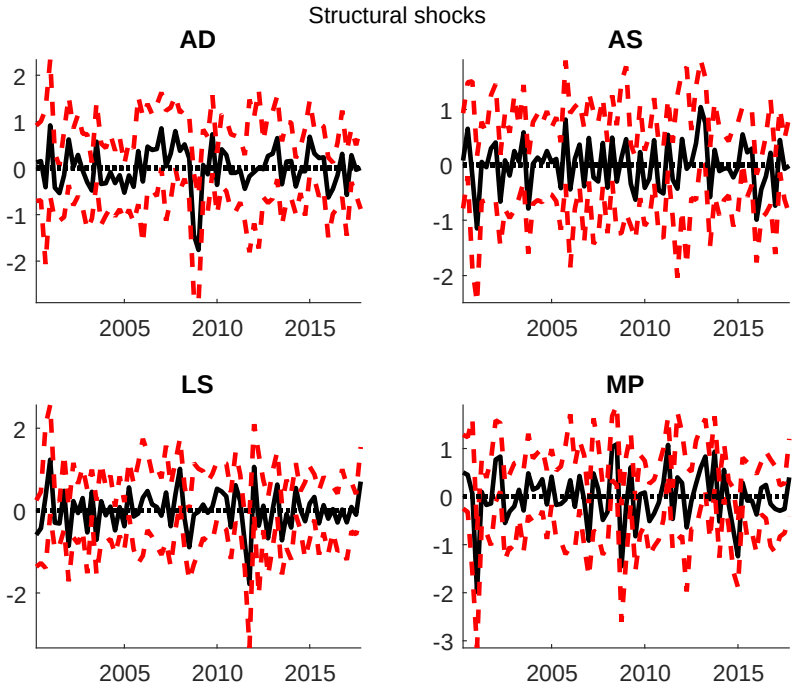
Annual growth rates. Median contributions of identified shocks to deviation from unconditional forecast. AD: aggregate demand shock, AS: aggregate supply shock, LS: loan supply shock, MP: monetary policy shock.

Figure C.12: Posterior-odds ratio for contribution of loan supply shocks - Euro Area



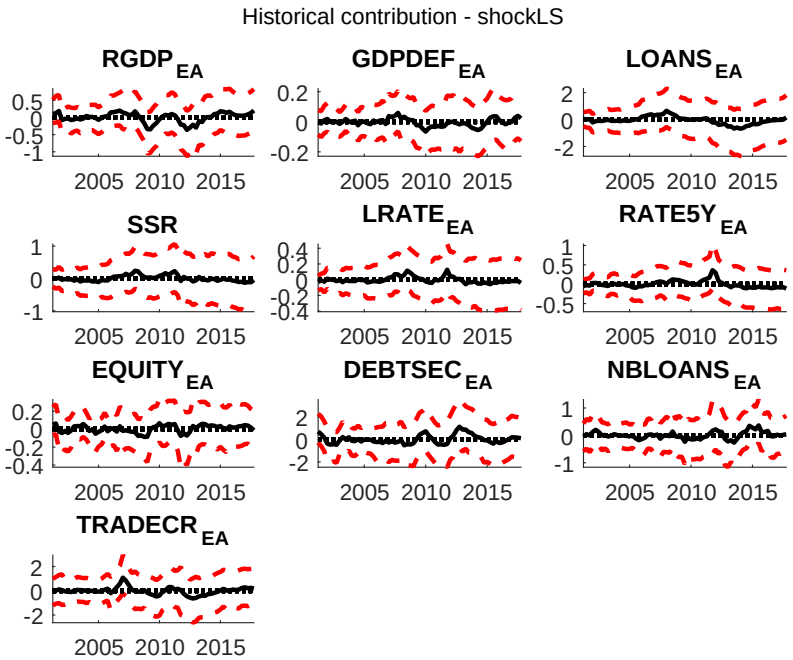
Contribution to annual growth rates of variable. Posterior-odds ratio for positive (solid) and negative (dashed) contribution of loan supply shock to deviation from unconditional forecast.

Figure C.13: Posterior distribution of identified shocks - Euro Area



Median and 16- and 84% percentiles of marginal posterior distribution of identified shocks.

Figure C.14: Effects of loan supply shocks - Euro Area

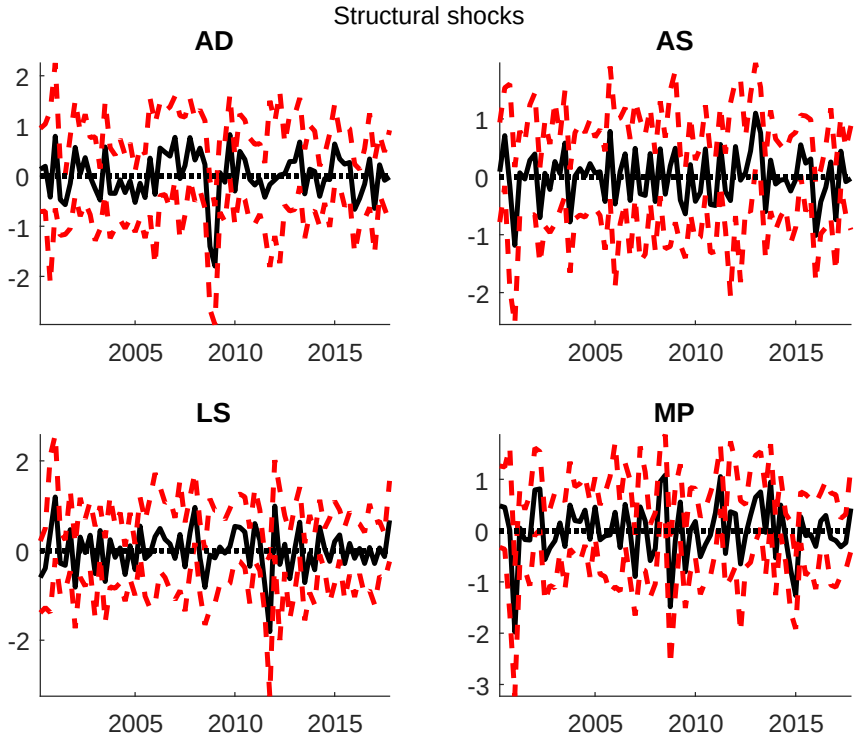


Annual growth rates. Median and 16- and 84% percentiles of marginal posterior distribution of contributions of identified loan supply shocks to deviation from unconditional forecast.

Appendix D: Figures

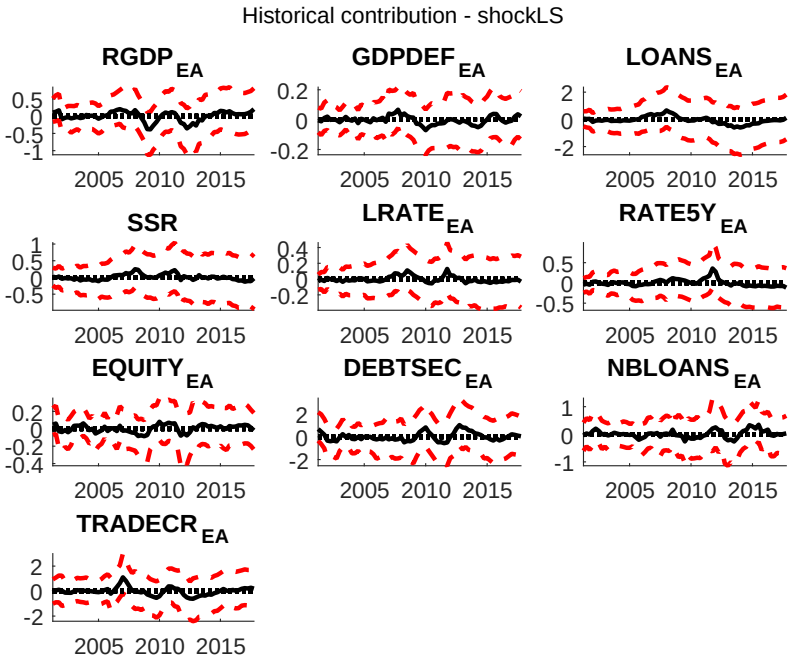
Euro Area

Figure D.1: Posterior distribution of identified shocks - Euro Area



Median and 16- and 84% percentiles of marginal posterior distribution of identified shocks.

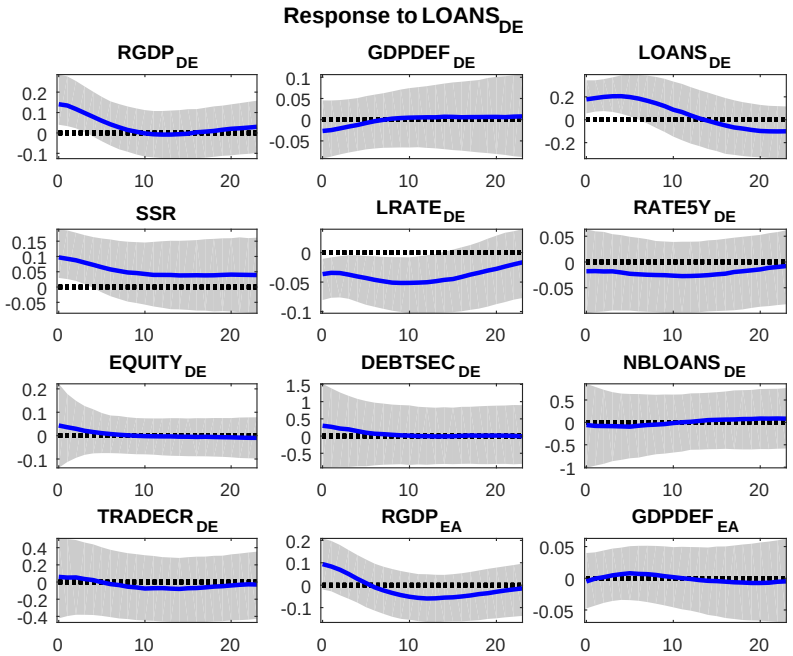
Figure D.2: Contribution of loan supply shocks to endogenous variables - Euro Area



Contribution to annual growth rates of variable. Median and 16- and 84% percentiles of marginal posterior distribution of contribution of structural shock to deviation from unconditional forecast.

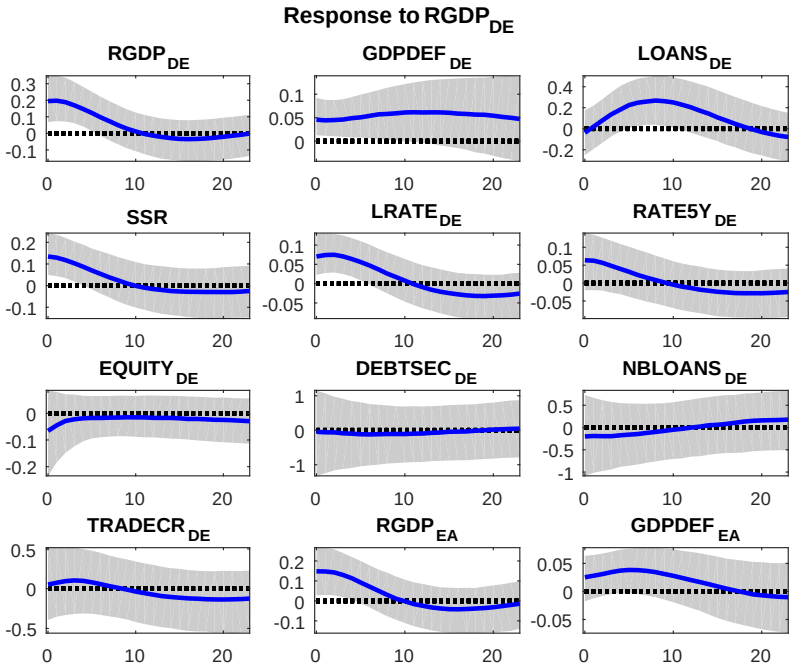
Germany

Figure D.3: Impulse responses to loan supply shock - Germany



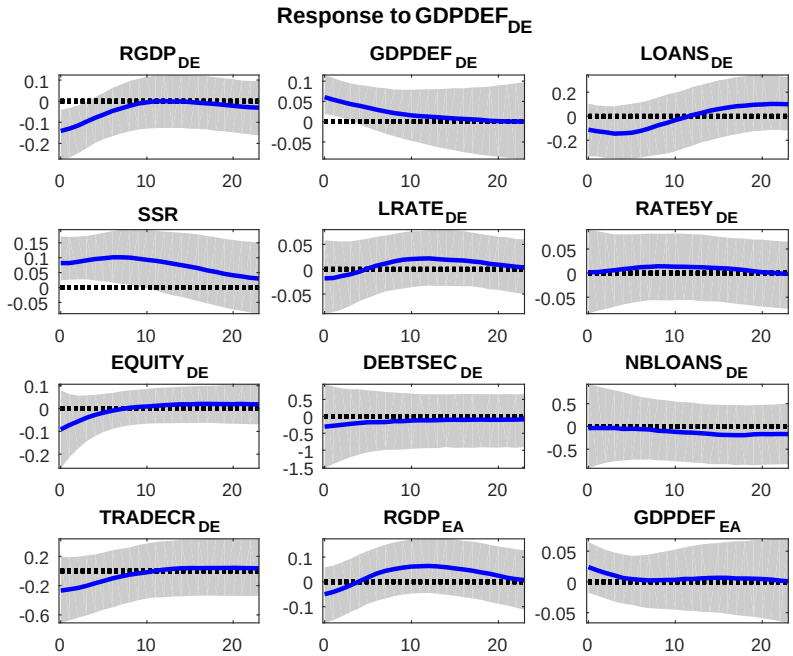
Median and 16- and 84% percentiles of marginal posterior distribution of impulse responses.

Figure D.4: Impulse responses to aggregate demand shock - Germany



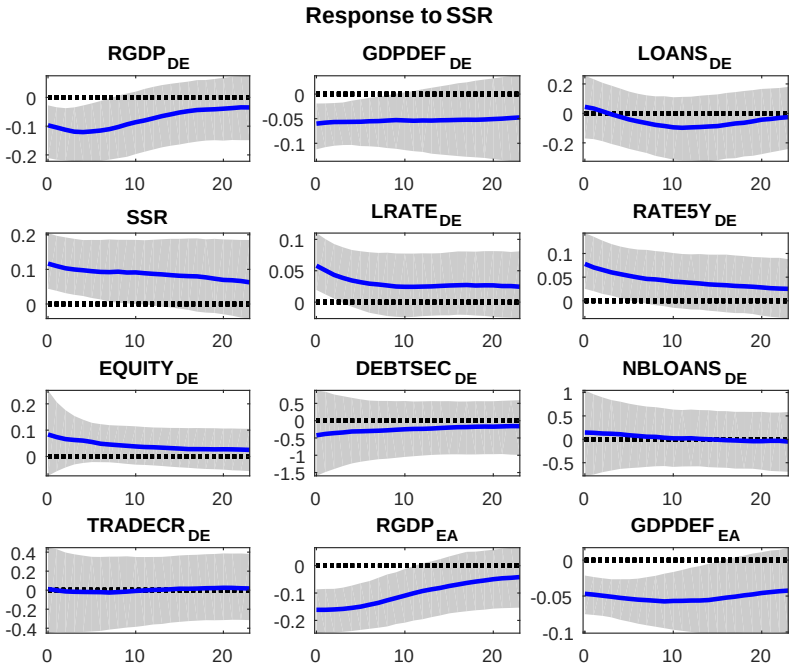
Median and 16- and 84% percentiles of marginal posterior distribution of impulse responses.

Figure D.5: Impulse responses to aggregate supply shock - Germany



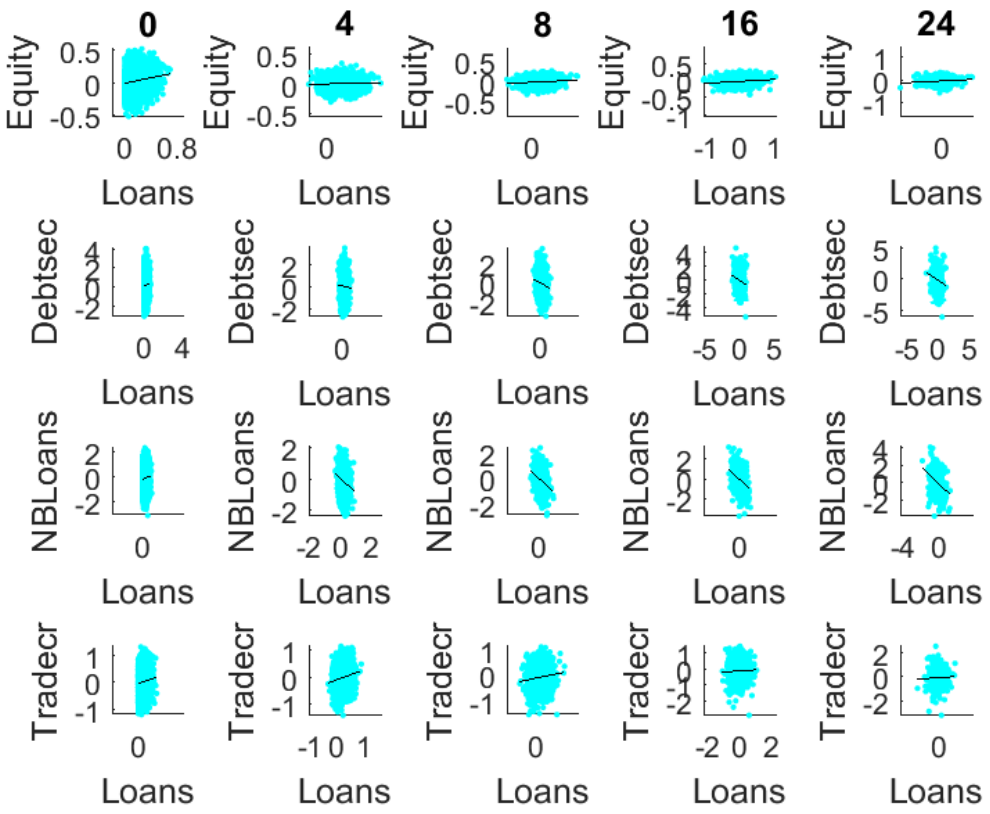
Median and 16- and 84% percentiles of marginal posterior distribution of impulse responses.

Figure D.6: Impulse responses to monetary policy shock - Germany



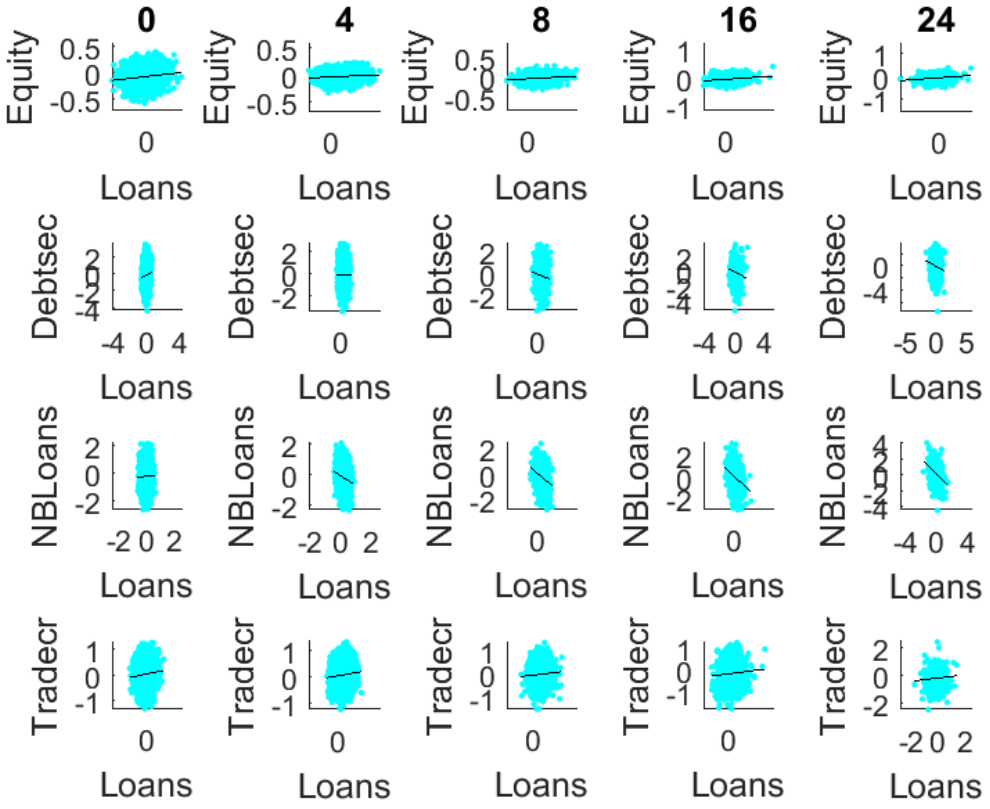
Median and 16- and 84% percentiles of marginal posterior distribution of impulse responses.

Figure D.7: Joint distribution of impulse responses of bank loans and alternative financing sources to loan supply shock - Germany



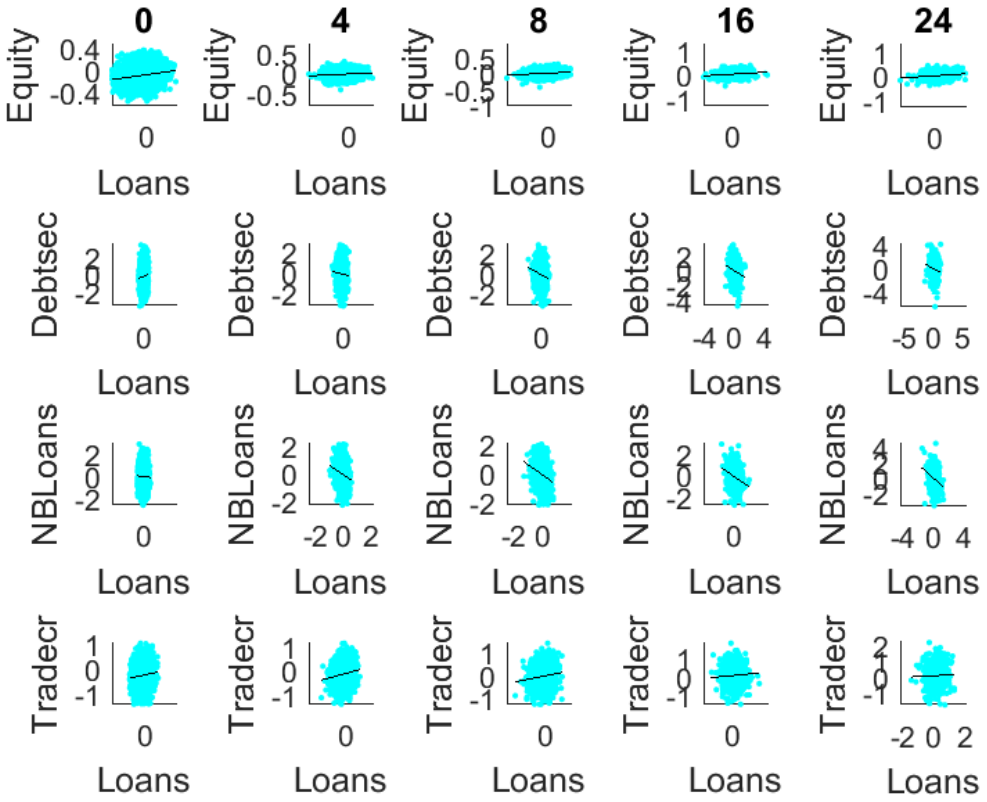
Scatter plots of impulse response of real MFI loans to non-financial corporations (horizontal axes) and impulse response of variable indicated (vertical axes). Columns indicate impulse response horizon. 0 is impact period. Black lines are obtained from linear regression of impulse response on vertical axes on impulse response on horizontal axes.

Figure D.8: Joint distribution of impulse responses of bank loans and alternative financing sources to aggregate demand shock - Germany



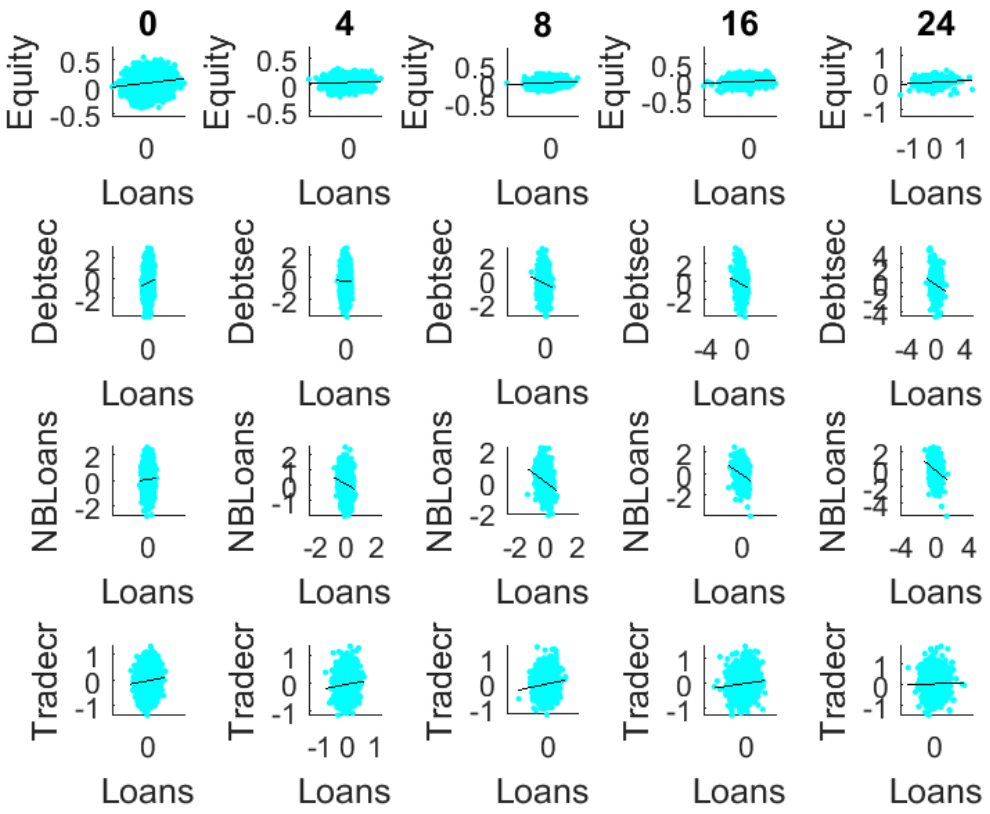
Scatter plots of impulse response of real MFI loans to non-financial corporations (horizontal axes) and impulse response of variable indicated (vertical axes). Columns indicate impulse response horizon. 0 is impact period. Black lines are obtained from linear regression of impulse response on vertical axes on impulse response on horizontal axes.

Figure D.9: Joint distribution of impulse responses of bank loans and alternative financing sources to aggregate supply shock - Germany



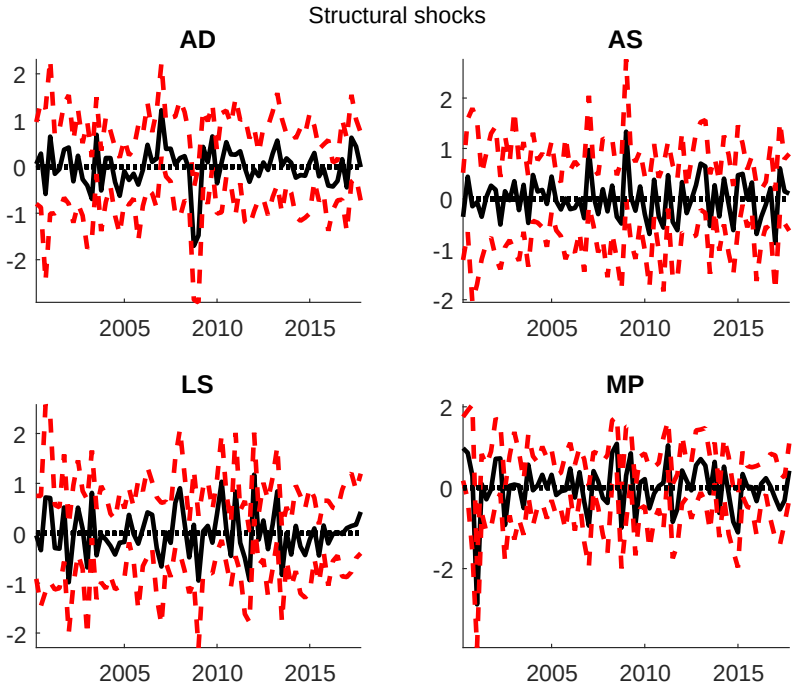
Scatter plots of impulse response of real MFI loans to non-financial corporations (horizontal axes) and impulse response of variable indicated (vertical axes). Columns indicate impulse response horizon. 0 is impact period. Black lines are obtained from linear regression of impulse response on vertical axes on impulse response on horizontal axes.

Figure D.10: Joint distribution of impulse responses of bank loans and alternative financing sources to monetary policy shock - Germany



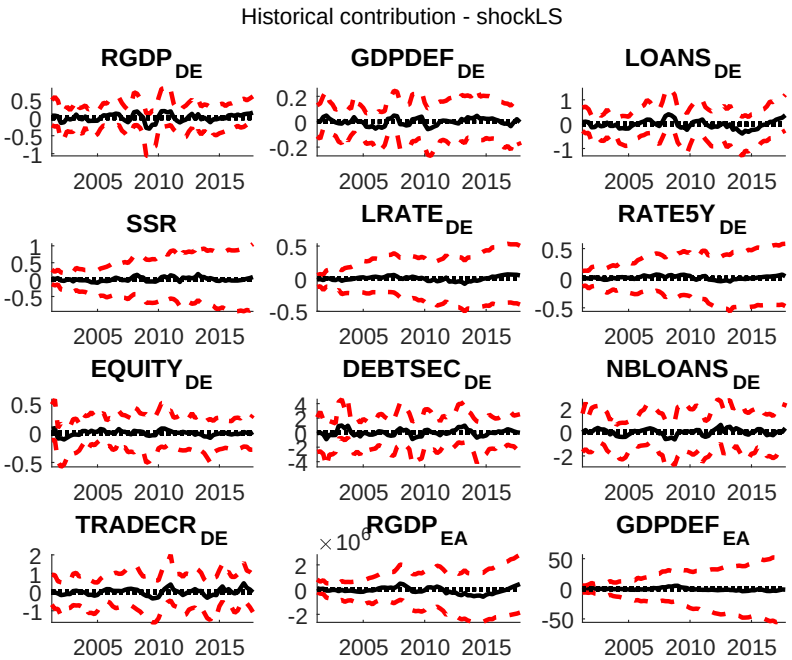
Scatter plots of impulse response of real MFI loans to non-financial corporations (horizontal axes) and impulse response of variable indicated (vertical axes). Columns indicate impulse response horizon. 0 is impact period. Black lines are obtained from linear regression of impulse response on vertical axes on impulse response on horizontal axes.

Figure D.11: Posterior distribution of identified shocks - Germany



Median and 16- and 84% percentiles of marginal posterior distribution of identified shocks.

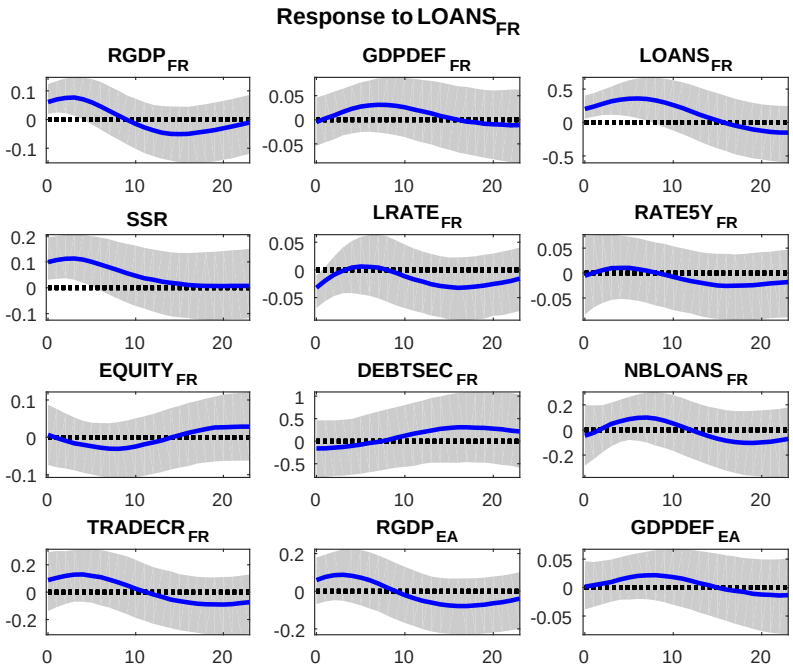
Figure D.12: Effects of loan supply shocks - Germany



Annual growth rates. Median and 16- and 84% percentiles of marginal posterior distribution of contributions of identified loan supply shocks to deviation from unconditional forecast.

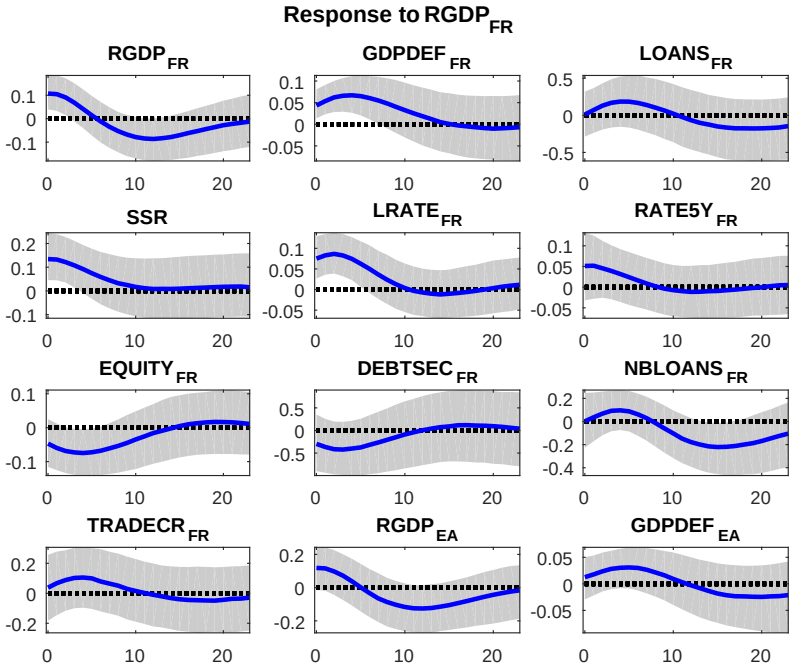
France

Figure D.13: Impulse responses to loan supply shock - France



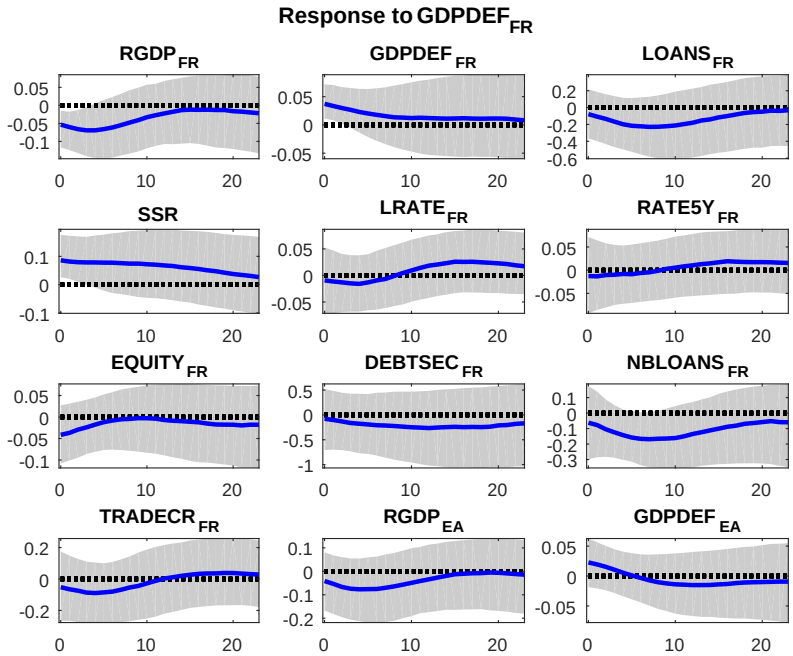
Median and 16- and 84% percentiles of marginal posterior distribution of impulse responses.

Figure D.14: Impulse responses to aggregate demand shock - France



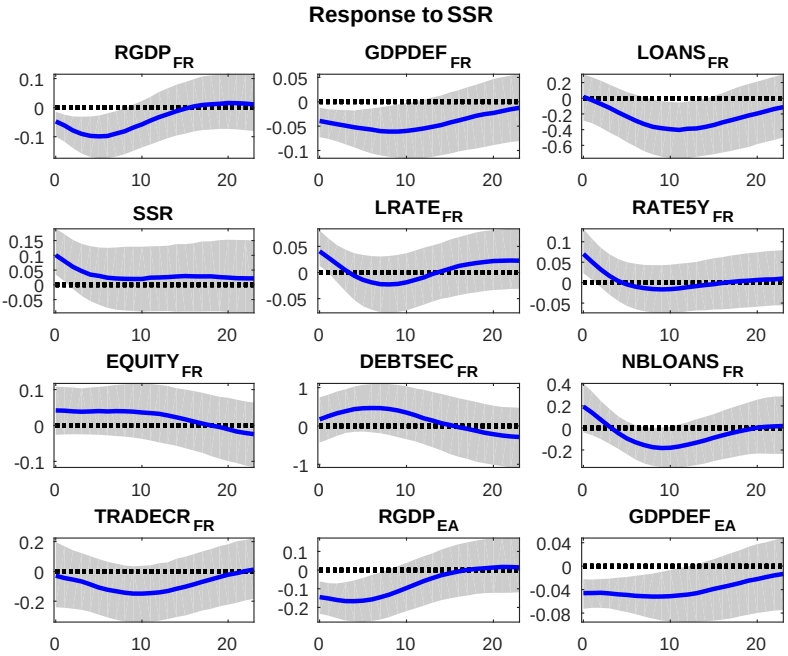
Median and 16- and 84% percentiles of marginal posterior distribution of impulse responses.

Figure D.15: Impulse responses to aggregate supply shock - France



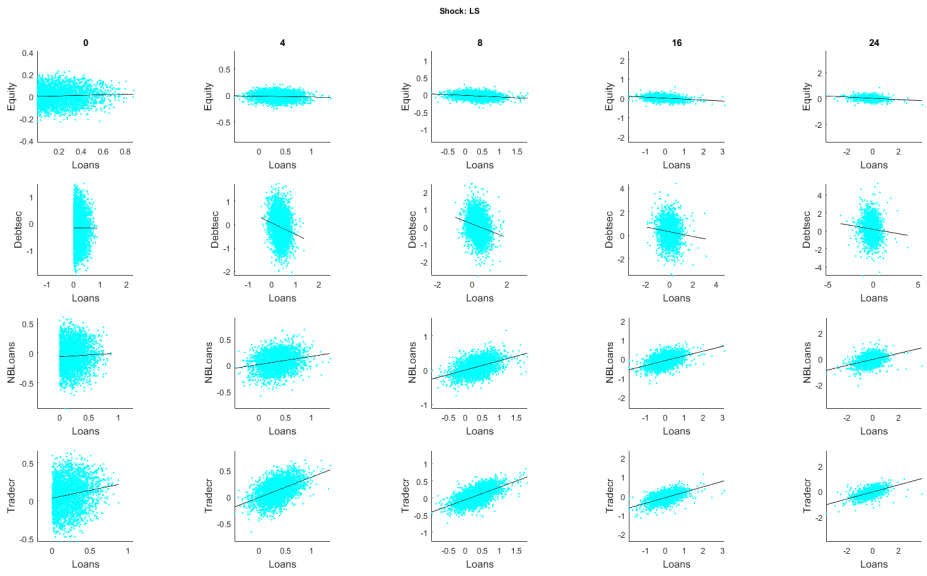
Median and 16- and 84% percentiles of marginal posterior distribution of impulse responses.

Figure D.16: Impulse responses to monetary policy shock - France



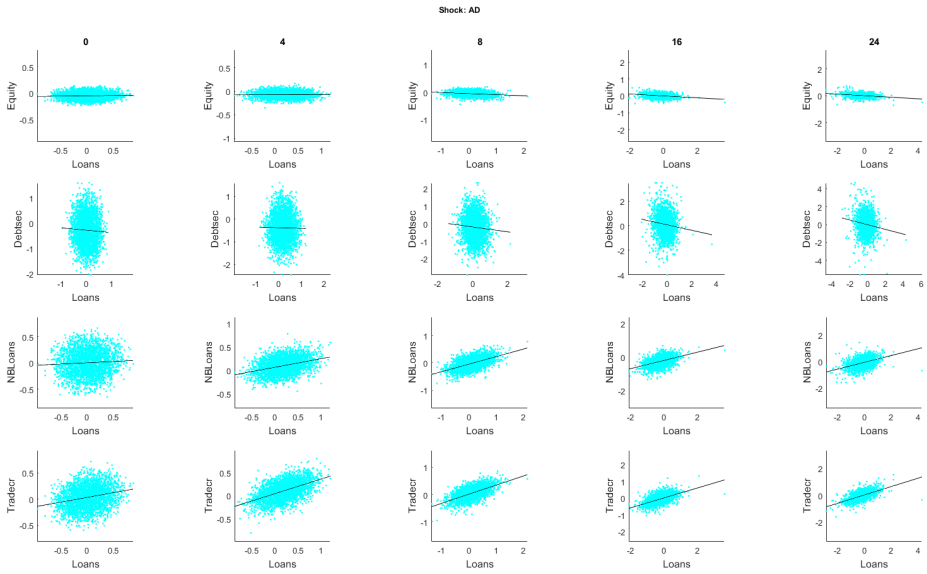
Median and 16- and 84% percentiles of marginal posterior distribution of impulse responses.

Figure D.17: Joint distribution of impulse responses of bank loans and alternative financing sources to loan supply shock - France



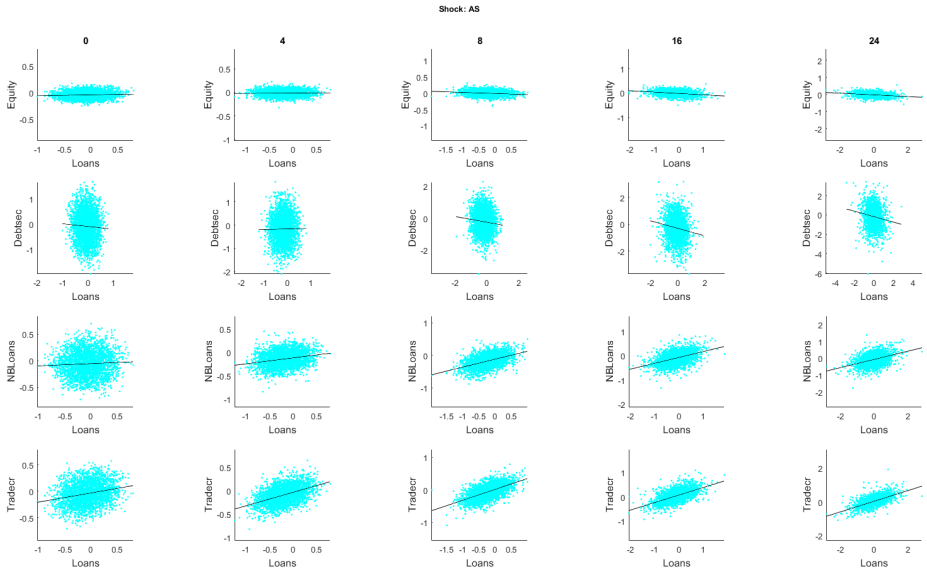
Scatter plots of impulse response of real MFI loans to non-financial corporations (horizontal axes) and impulse response of variable indicated (vertical axes). Columns indicate impulse response horizon. 0 is impact period. Black lines are obtained from linear regression of impulse response on vertical axes on impulse response on horizontal axes.

Figure D.18: Joint distribution of impulse responses of bank loans and alternative financing sources to aggregate demand shock - France



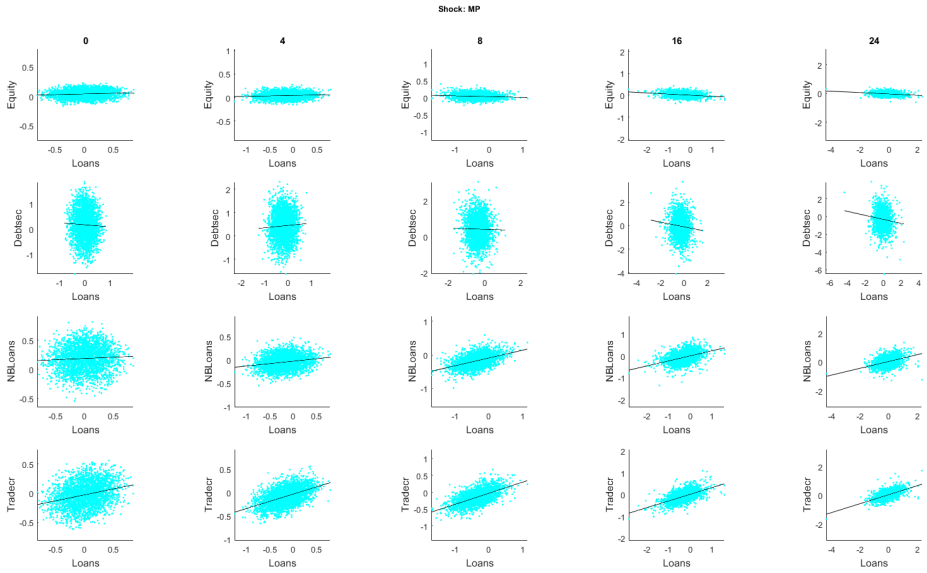
Scatter plots of impulse response of real MFI loans to non-financial corporations (horizontal axes) and impulse response of variable indicated (vertical axes). Columns indicate impulse response horizon. 0 is impact period. Black lines are obtained from linear regression of impulse response on vertical axes on impulse response on horizontal axes.

Figure D.19: Joint distribution of impulse responses of bank loans and alternative financing sources to aggregate supply shock - France



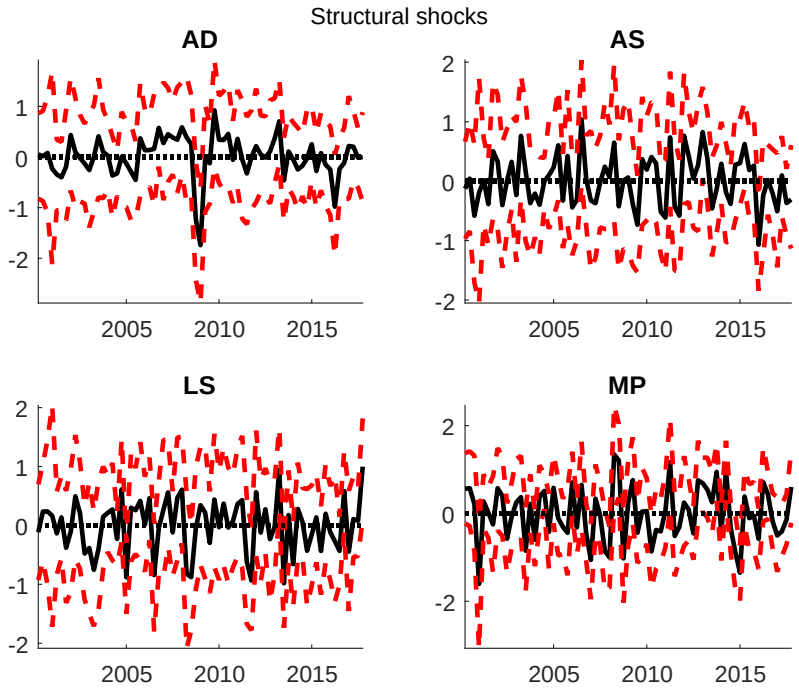
Scatter plots of impulse response of real MFI loans to non-financial corporations (horizontal axes) and impulse response of variable indicated (vertical axes). Columns indicate impulse response horizon. 0 is impact period. Black lines are obtained from linear regression of impulse response on vertical axes on impulse response on horizontal axes.

Figure D.20: Joint distribution of impulse responses of bank loans and alternative financing sources to monetary policy shock - France



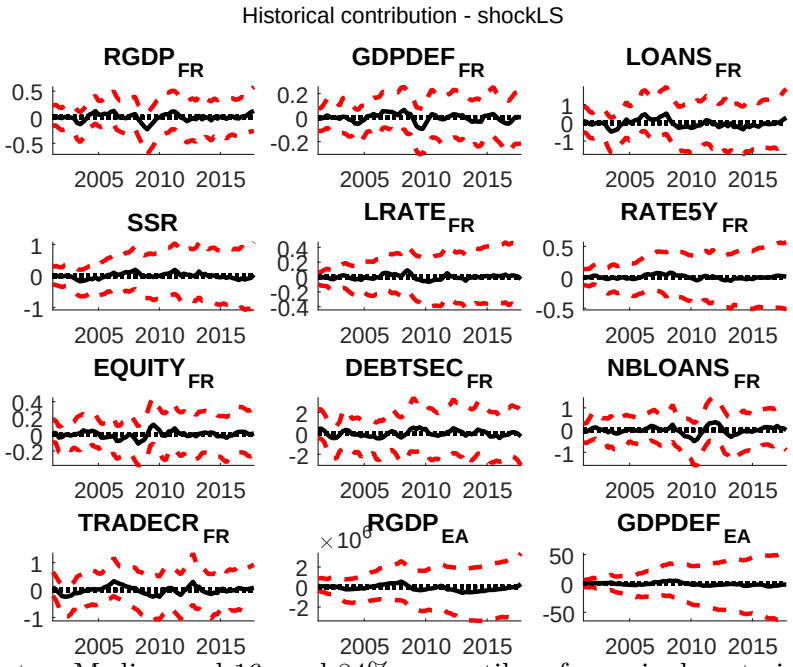
Scatter plots of impulse response of real MFI loans to non-financial corporations (horizontal axes) and impulse response of variable indicated (vertical axes). Columns indicate impulse response horizon. 0 is impact period. Black lines are obtained from linear regression of impulse response on vertical axes on impulse response on horizontal axes.

Figure D.21: Posterior distribution of identified shocks - France



Median and 16- and 84% percentiles of marginal posterior distribution of identified shocks.

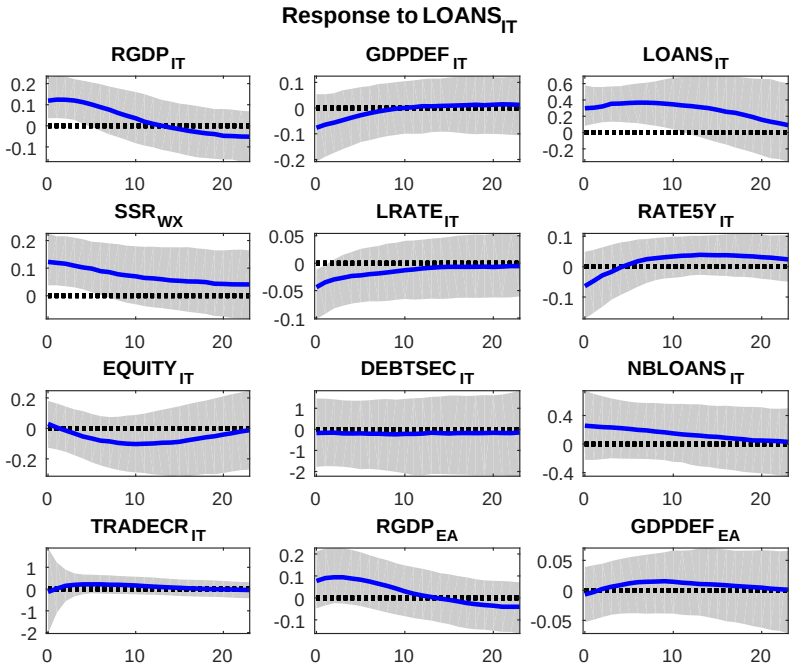
Figure D.22: Effects of loan supply shocks - France



Annual growth rates. Median and 16- and 84% percentiles of marginal posterior distribution of contributions of identified loan supply shocks to deviation from unconditional forecast.

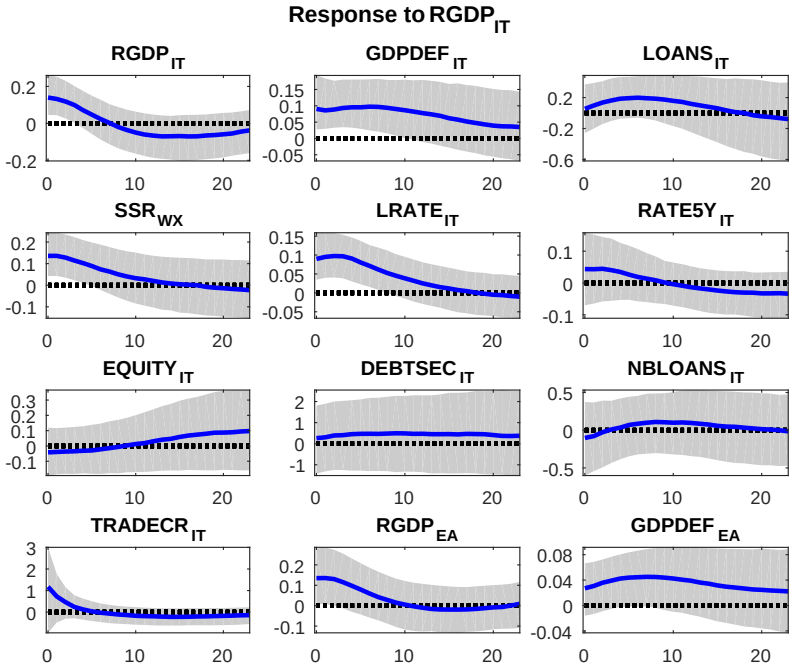
Italy

Figure D.23: Impulse responses to loan supply shock - Italy



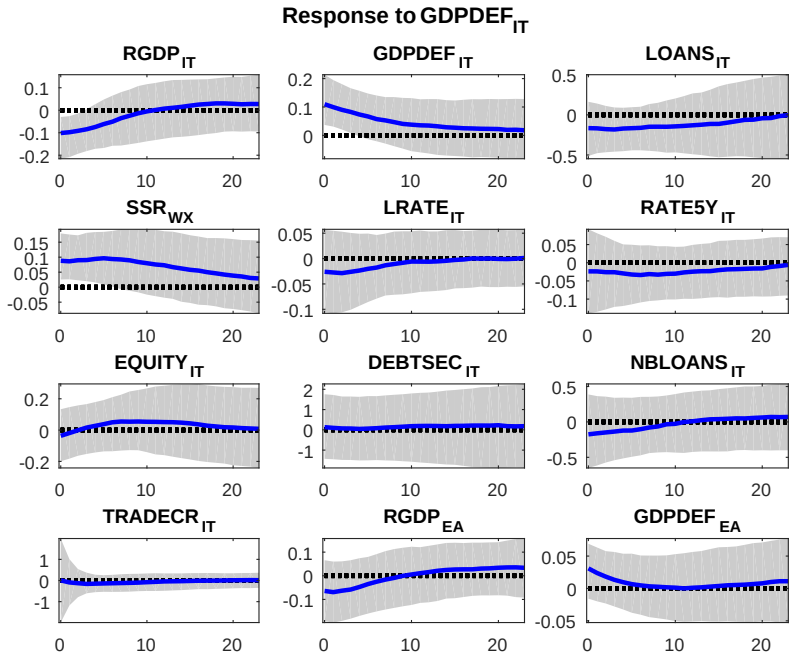
Median and 16- and 84% percentiles of marginal posterior distribution of impulse responses.

Figure D.24: Impulse responses to aggregate demand shock - Italy



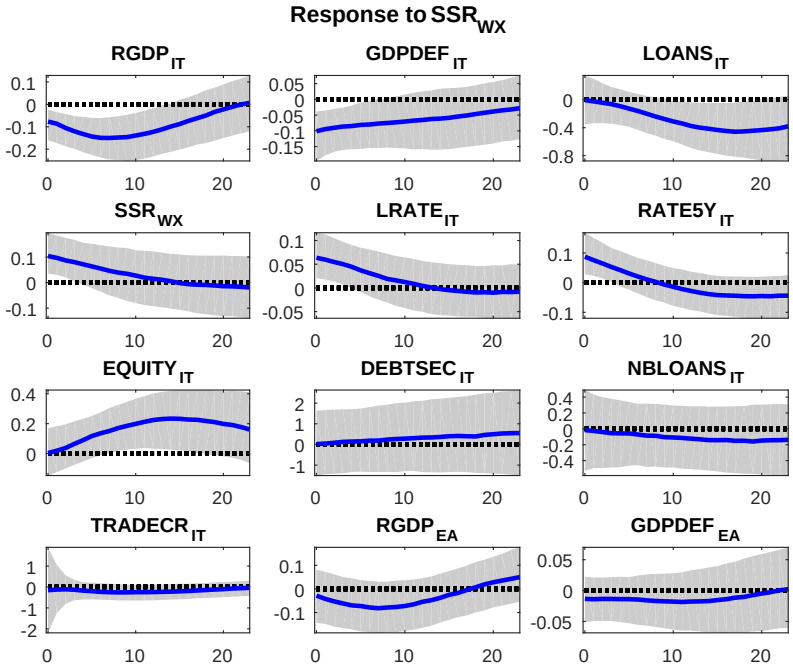
Median and 16- and 84% percentiles of marginal posterior distribution of impulse responses.

Figure D.25: Impulse responses to aggregate supply shock - Italy



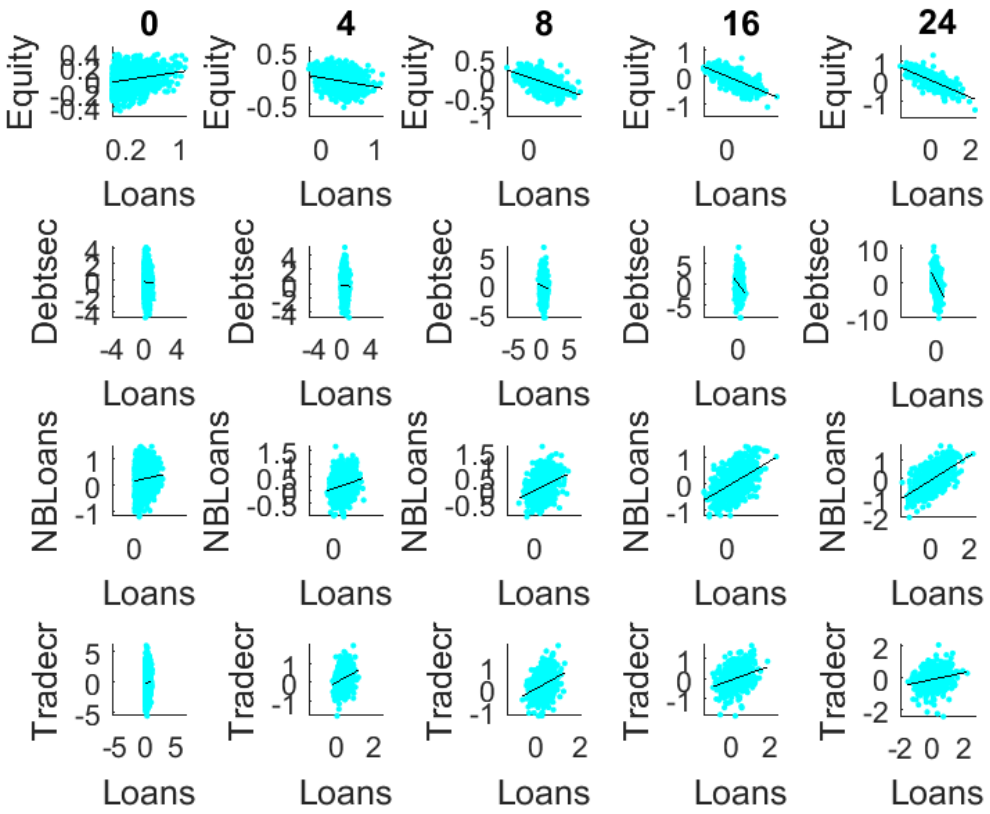
Median and 16- and 84% percentiles of marginal posterior distribution of impulse responses.

Figure D.26: Impulse responses to monetary policy shock - Italy



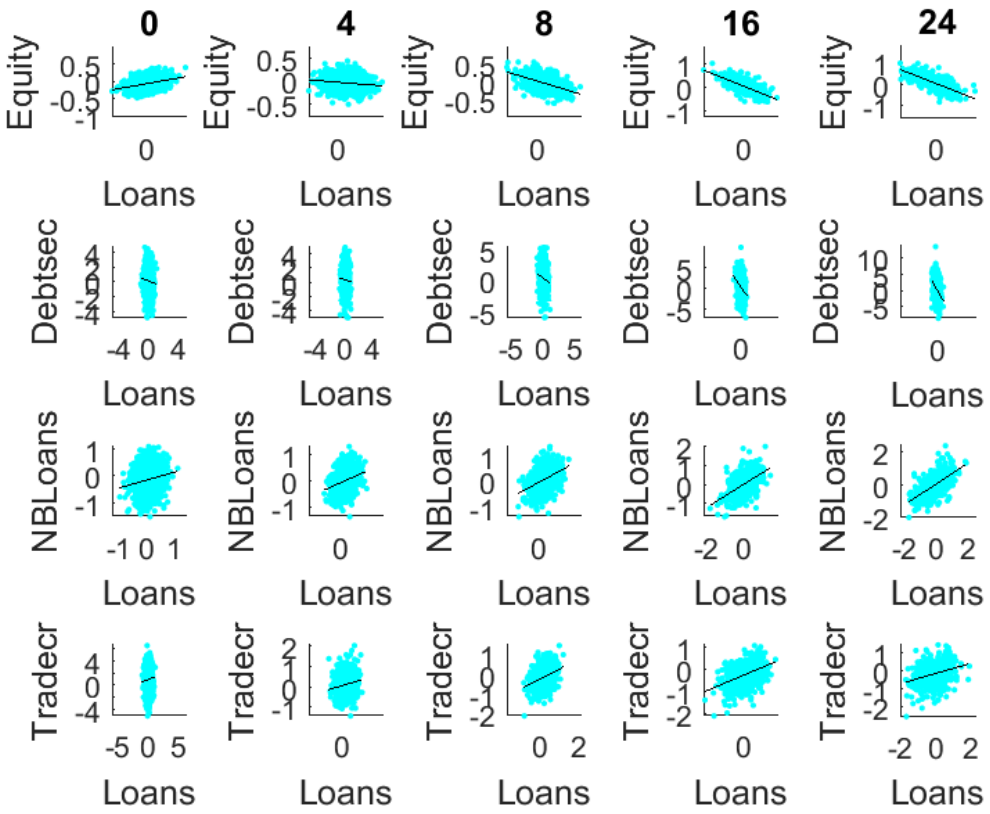
Median and 16- and 84% percentiles of marginal posterior distribution of impulse responses.

Figure D.27: Joint distribution of impulse responses of bank loans and alternative financing sources to loan supply shock - Italy



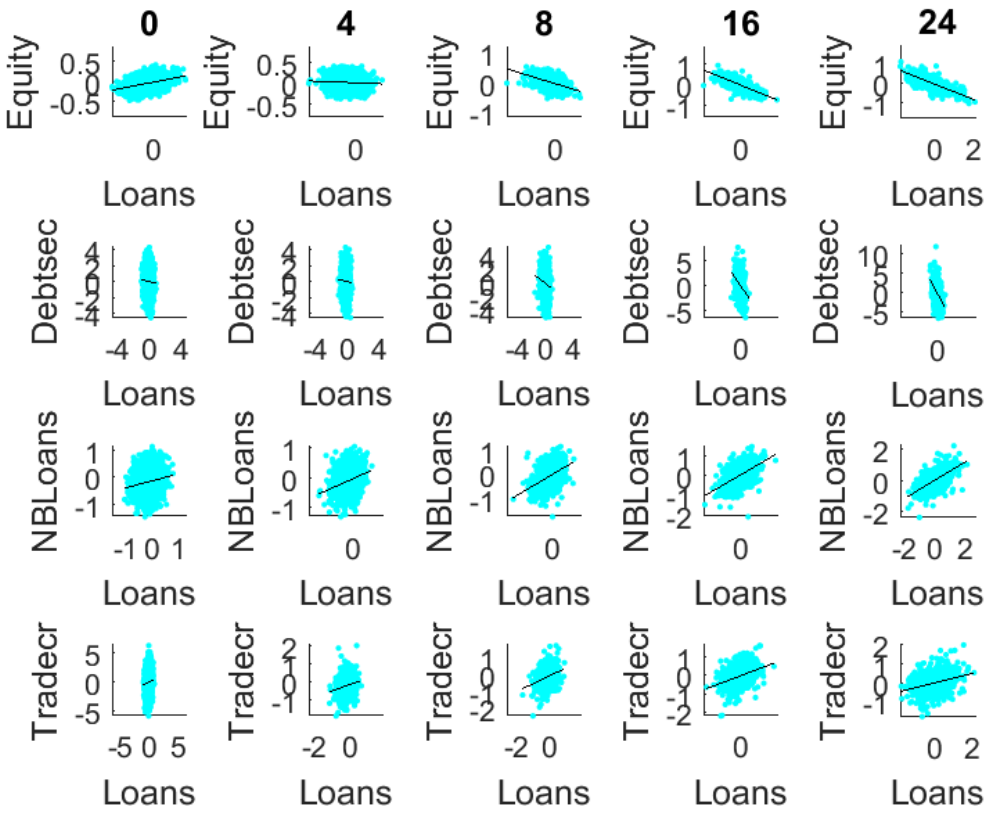
Scatter plots of impulse response of real MFI loans to non-financial corporations (horizontal axes) and impulse response of variable indicated (vertical axes). Columns indicate impulse response horizon. 0 is impact period. Black lines are obtained from linear regression of impulse response on vertical axes on impulse response on horizontal axes.

Figure D.28: Joint distribution of impulse responses of bank loans and alternative financing sources to aggregate demand shock - Italy



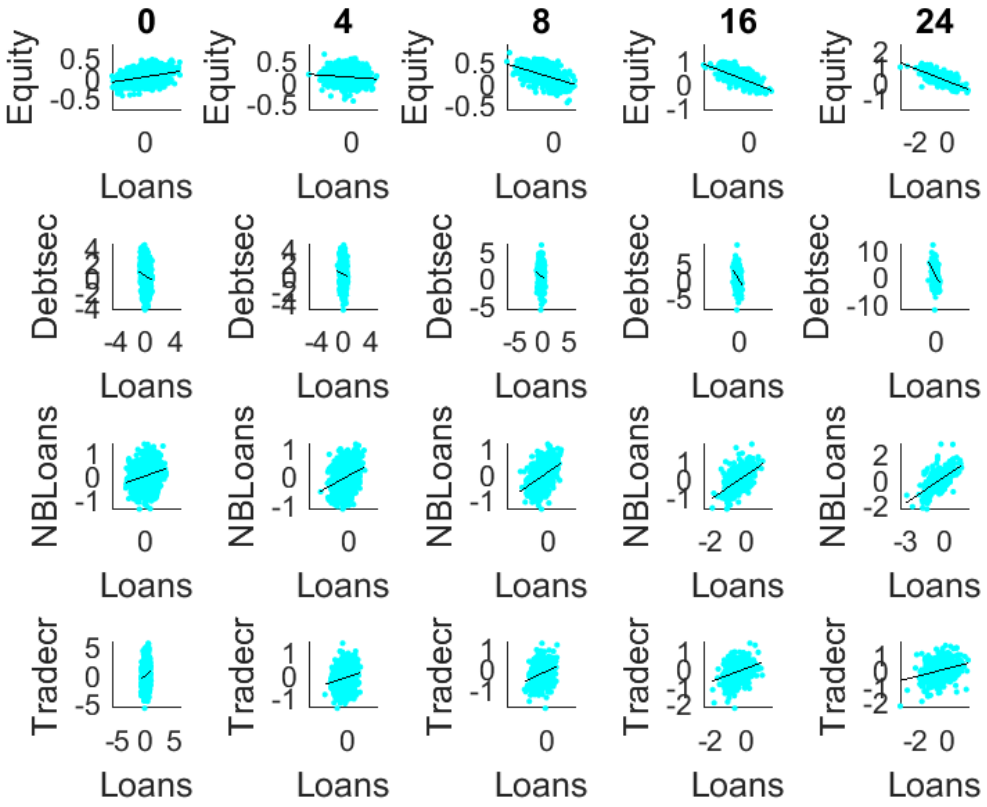
Scatter plots of impulse response of real MFI loans to non-financial corporations (horizontal axes) and impulse response of variable indicated (vertical axes). Columns indicate impulse response horizon. 0 is impact period. Black lines are obtained from linear regression of impulse response on vertical axes on impulse response on horizontal axes.

Figure D.29: Joint distribution of impulse responses of bank loans and alternative financing sources to aggregate supply shock - Italy



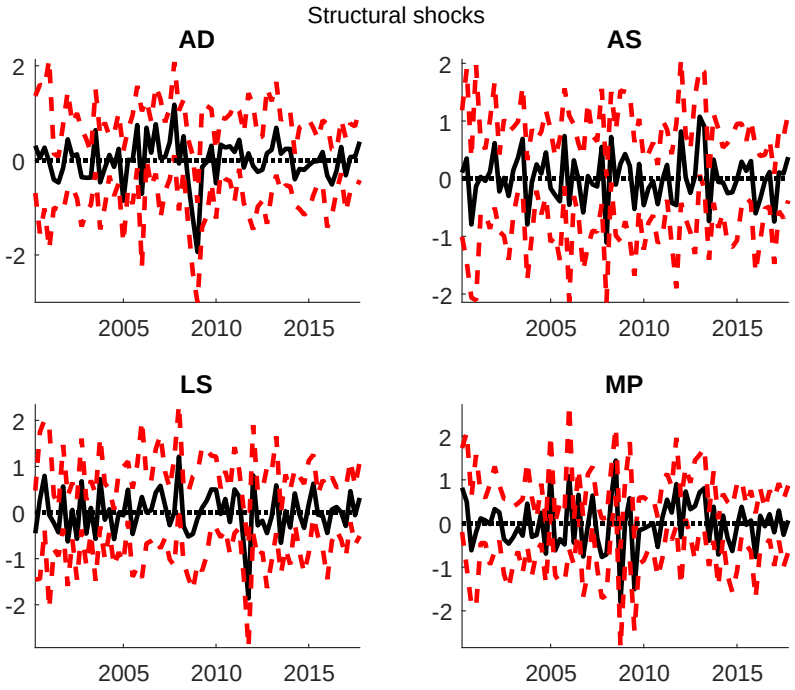
Scatter plots of impulse response of real MFI loans to non-financial corporations (horizontal axes) and impulse response of variable indicated (vertical axes). Columns indicate impulse response horizon. 0 is impact period. Black lines are obtained from linear regression of impulse response on vertical axes on impulse response on horizontal axes.

Figure D.30: Joint distribution of impulse responses of bank loans and alternative financing sources to monetary policy shock - Italy



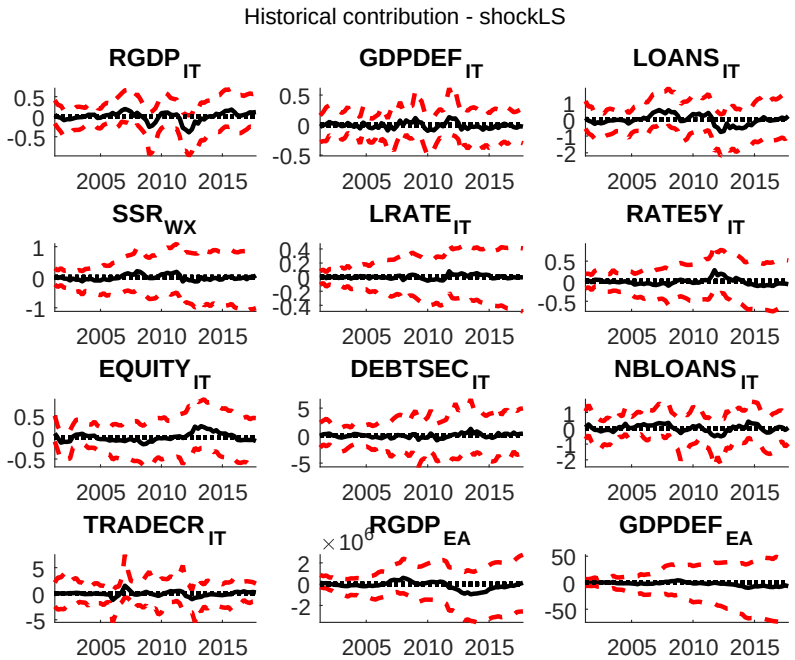
Scatter plots of impulse response of real MFI loans to non-financial corporations (horizontal axes) and impulse response of variable indicated (vertical axes). Columns indicate impulse response horizon. 0 is impact period. Black lines are obtained from linear regression of impulse response on vertical axes on impulse response on horizontal axes.

Figure D.31: Posterior distribution of identified shocks - Italy



Median and 16- and 84% percentiles of marginal posterior distribution of identified shocks.

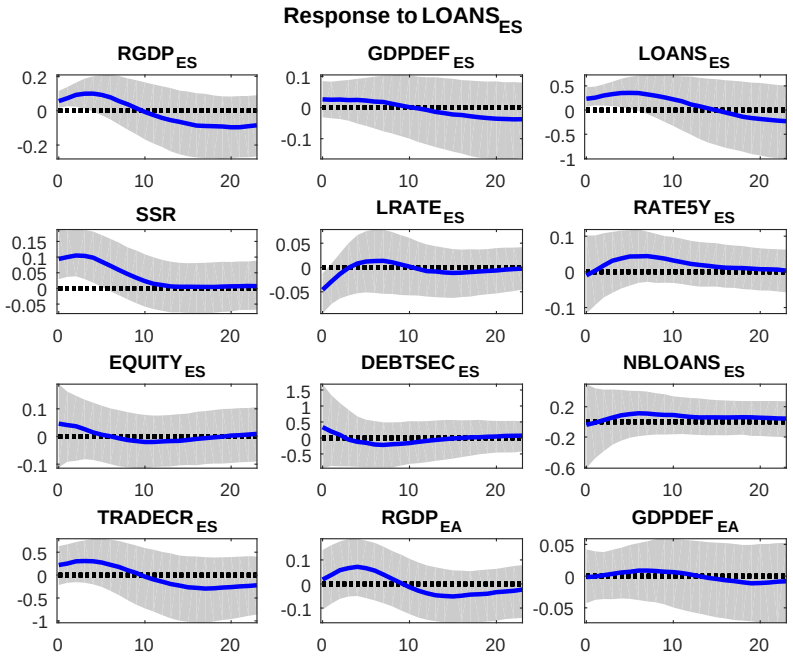
Figure D.32: Effects of loan supply shocks - Italy



Annual growth rates. Median and 16- and 84% percentiles of marginal posterior distribution of contributions of identified loan supply shocks to deviation from unconditional forecast.

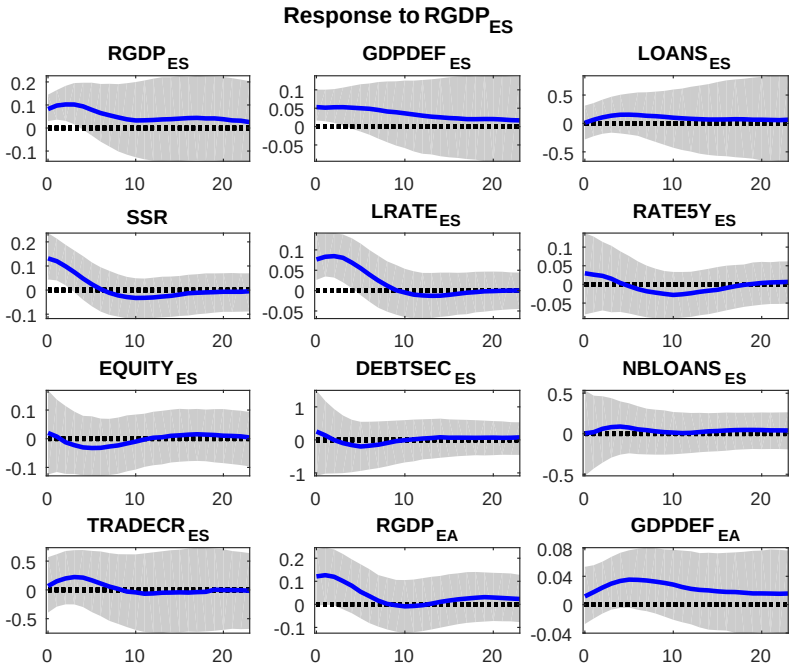
Spain

Figure D.33: Impulse responses to loan supply shock - Spain



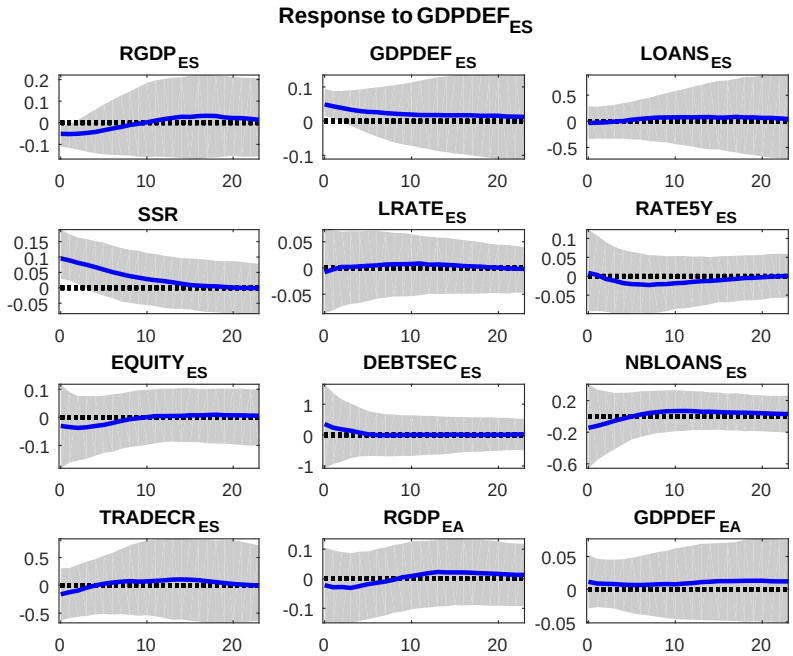
Median and 16- and 84% percentiles of marginal posterior distribution of impulse responses.

Figure D.34: Impulse responses to aggregate demand shock - Spain



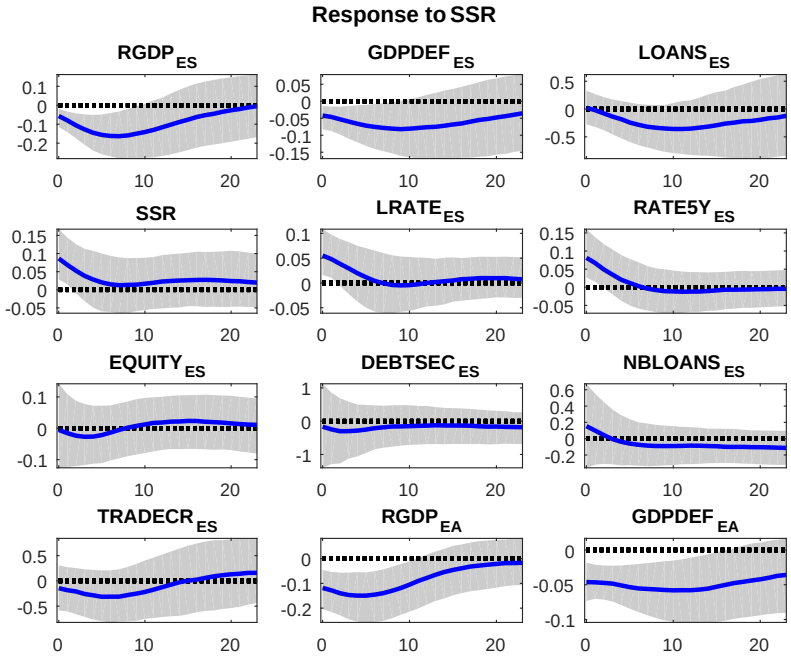
Median and 16- and 84% percentiles of marginal posterior distribution of impulse responses.

Figure D.35: Impulse responses to aggregate supply shock - Spain



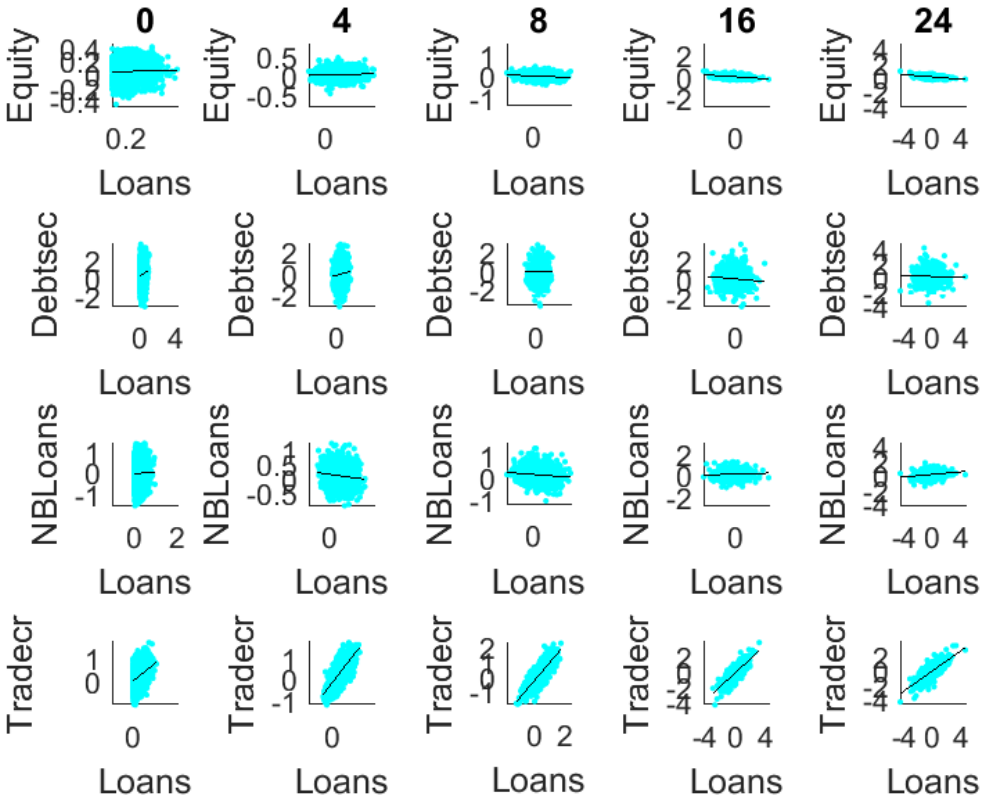
Median and 16- and 84% percentiles of marginal posterior distribution of impulse responses.

Figure D.36: Impulse responses to monetary policy shock - Spain



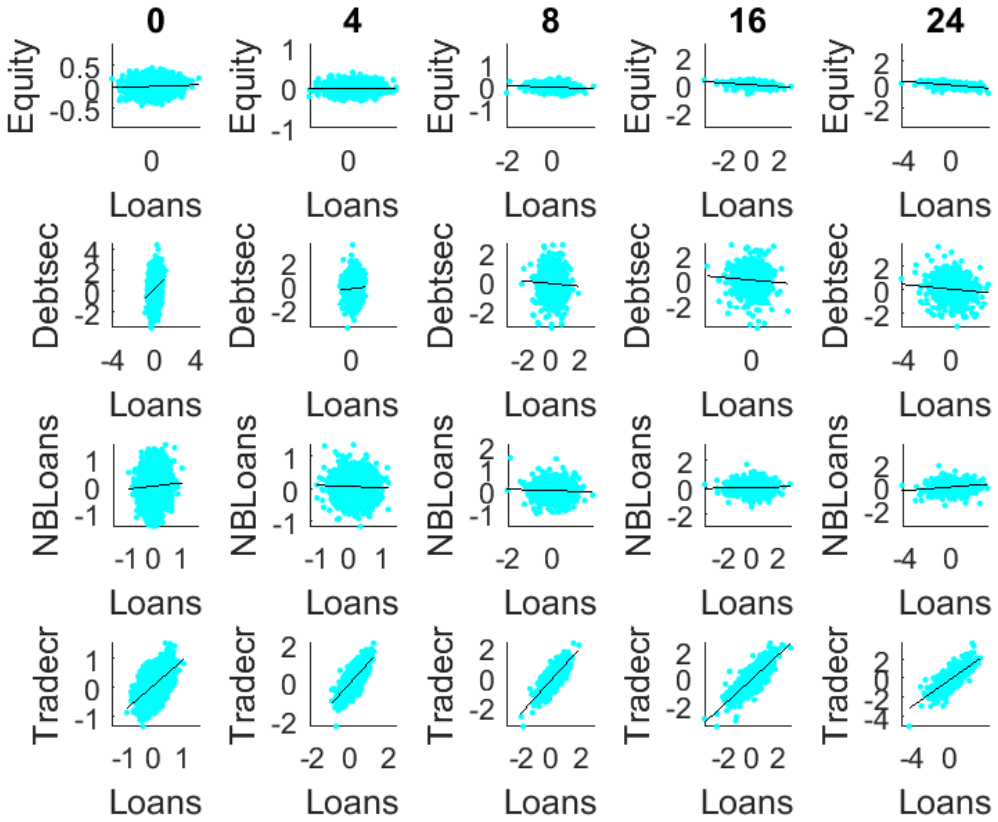
Median and 16- and 84% percentiles of marginal posterior distribution of impulse responses.

Figure D.37: Joint distribution of impulse responses of bank loans and alternative financing sources to loan supply shock - Spain



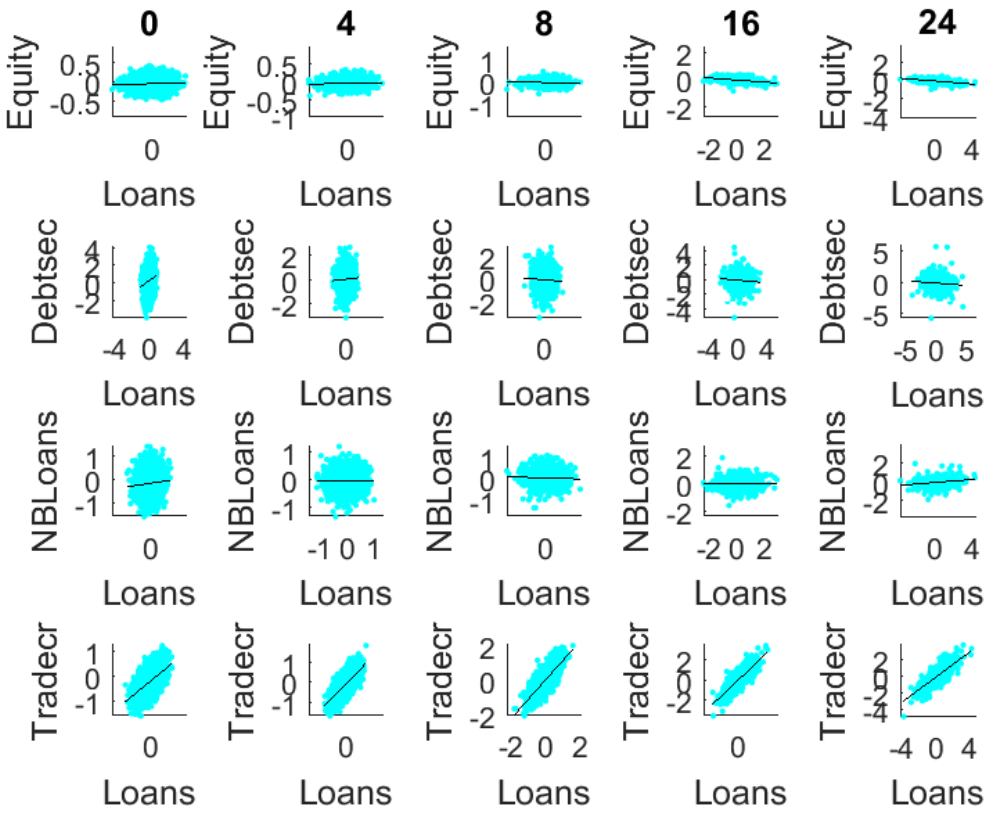
Scatter plots of impulse response of real MFI loans to non-financial corporations (horizontal axes) and impulse response of variable indicated (vertical axes). Columns indicate impulse response horizon. 0 is impact period. Black lines are obtained from linear regression of impulse response on vertical axes on impulse response on horizontal axes.

Figure D.38: Joint distribution of impulse responses of bank loans and alternative financing sources to aggregate demand shock - Spain



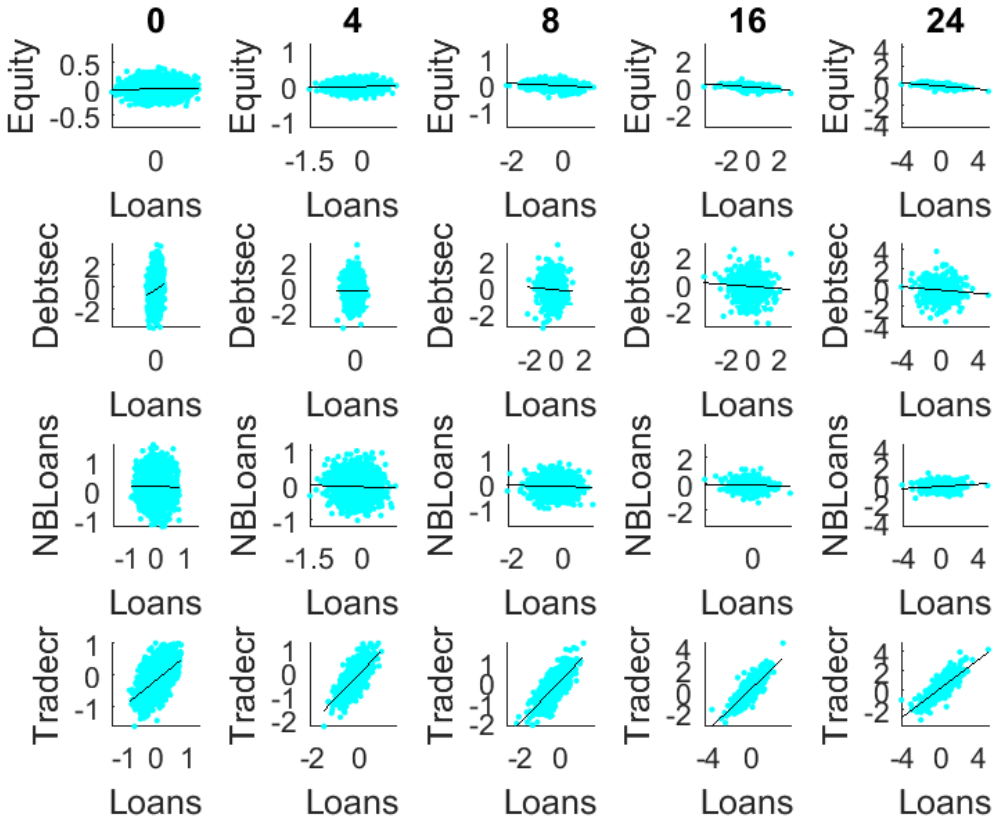
Scatter plots of impulse response of real MFI loans to non-financial corporations (horizontal axes) and impulse response of variable indicated (vertical axes). Columns indicate impulse response horizon. 0 is impact period. Black lines are obtained from linear regression of impulse response on vertical axes on impulse response on horizontal axes.

Figure D.39: Joint distribution of impulse responses of bank loans and alternative financing sources to aggregate supply shock - Spain



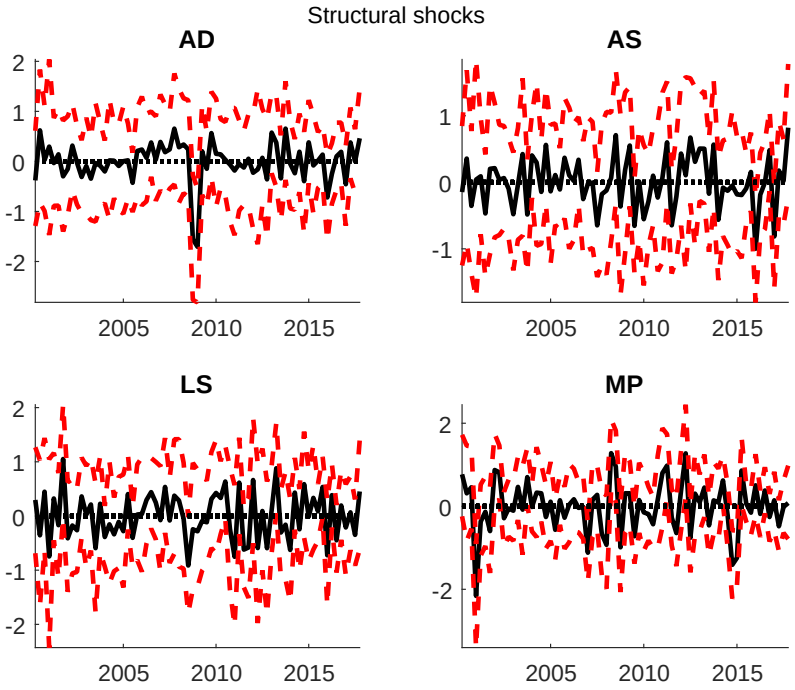
Scatter plots of impulse response of real MFI loans to non-financial corporations (horizontal axes) and impulse response of variable indicated (vertical axes). Columns indicate impulse response horizon. 0 is impact period. Black lines are obtained from linear regression of impulse response on vertical axes on impulse response on horizontal axes.

Figure D.40: Joint distribution of impulse responses of bank loans and alternative financing sources to monetary policy shock - Spain



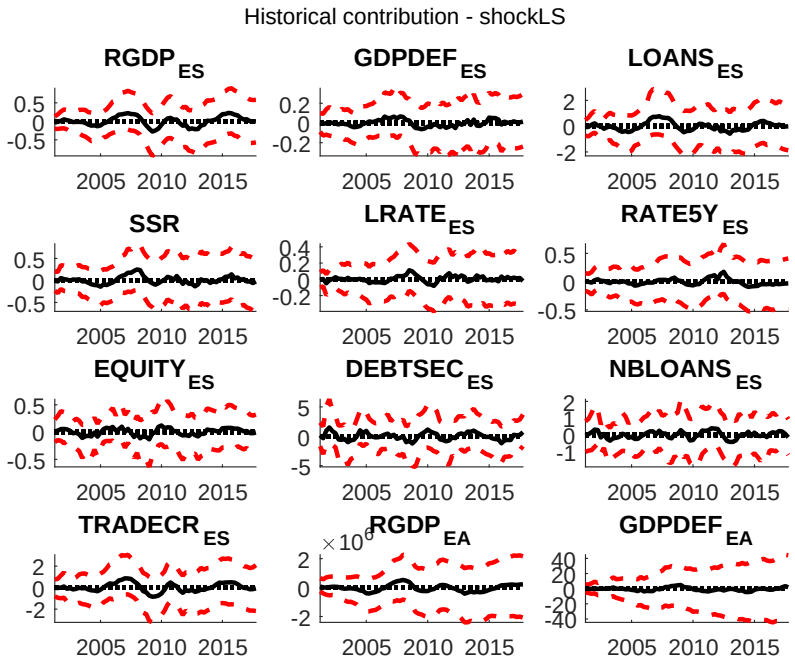
Scatter plots of impulse response of real MFI loans to non-financial corporations (horizontal axes) and impulse response of variable indicated (vertical axes). Columns indicate impulse response horizon. 0 is impact period. Black lines are obtained from linear regression of impulse response on vertical axes on impulse response on horizontal axes.

Figure D.41: Posterior distribution of identified shocks - Spain



Median and 16- and 84% percentiles of marginal posterior distribution of identified shocks.

Figure D.42: Effects of loan supply shocks - Spain



Annual growth rates. Median and 16- and 84% percentiles of marginal posterior distribution of contributions of identified loan supply shocks to deviation from unconditional forecast.