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The impact of credit supply shocks in the euro area: market-based financing versus loans

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Abstract

Using a novel quarterly dataset on debt financing of non-financial corporations, this paper provides the first empirical evaluation of the relative importance of loan and market-based finance (MBF) supply shocks on business cycles in the euro area as a whole and in its five largest countries. In a Bayesian VAR framework, the two credit supply shocks are identified via sign and inequality restrictions. The results suggest that both loan supply and MBF supply play an important role for business cycles. For the euro area, the explanatory power of the two credit supply shocks for GDP growth variations is comparable. However, there is heterogeneity across countries. In particular, in Germany and France, the explanatory power of MBF supply shocks exceeds that of loan supply shocks. Since MBF is mostly provided by non-bank financial intermediaries, the findings suggest that strengthening their resilience — such as through an enhanced macroprudential framework — would support GDP growth.

JEL codes: C32, E32, E44, E51, G2

Keywords: debt securities, loan, credit supply, VAR, business cycles, non-bank financial intermediation.

Non-technical summary

During the global financial crisis (GFC), the supply of credit was significantly disrupted, and economies across the globe experienced deep recessions. Since then, a number of studies have estimated the effects of credit supply on business cycles, typically focusing on credit provided to non-financial corporations (NFCs) via bank loans. However, credit to NFCs has been increasingly supplied via debt securities, i.e. through market-based debt financing. In the euro area (EA), market-based finance (MBF) has doubled from around 10% of total external credit to NFCs in 1999 to 20% in recent years. This structural shift raises the question of the extent to which MBF to NFCs, and disruptions in the supply of such credit, plays a role in explaining business cycles — a topic for which there is little empirical evidence so far.

To help fill this gap, our paper distinguishes between loan supply shocks and MBF supply shocks, and quantifies their impact on GDP growth in the EA. We do so for the EA as a whole and also separately for the five largest EA economies, namely Germany, France, Italy, Spain and the Netherlands.

We draw from a novel quarterly dataset of loan and MBF data for EA NFCs. These data capture a variety of financing sources for EA NFCs, including financing from various EA sectors (e.g. bank versus non-bank financing) and from the rest of the world. To conduct the analysis at country level, we extend the dataset by compiling the same type of data for the five largest EA countries.

In line with the literature, we use a Bayesian vector autoregression (VAR) model that incorporates growth in both loans and debt securities, along with four other standard macroeconomic variables (real GDP growth, inflation, the corporate bond spread and the one-year nominal interest rate). To identify credit supply shocks, we apply sign restrictions consistent with the recent macroeconomic literature. To distinguish between the two *types* of credit supply shocks, i.e. loan supply shocks and MBF supply shocks, we impose inequality restrictions.

Our results suggest that MBF supply shocks play an important role in explaining GDP growth in the EA and one that is comparable to that of loan supply shocks. Despite some differences, MBF supply shocks are found to be important in explaining GDP growth in all five of the largest EA countries. In Germany and France, where corporate debt markets are relatively well developed, the explanatory power of MBF supply shocks exceeds that of loan supply shocks. Their impact on GDP growth in these two countries is also found to be more persistent and

stronger than in the three other large EA economies (Italy, Spain and the Netherlands), with Italy and Spain in particular continuing to rely heavily on bank-based financial systems.

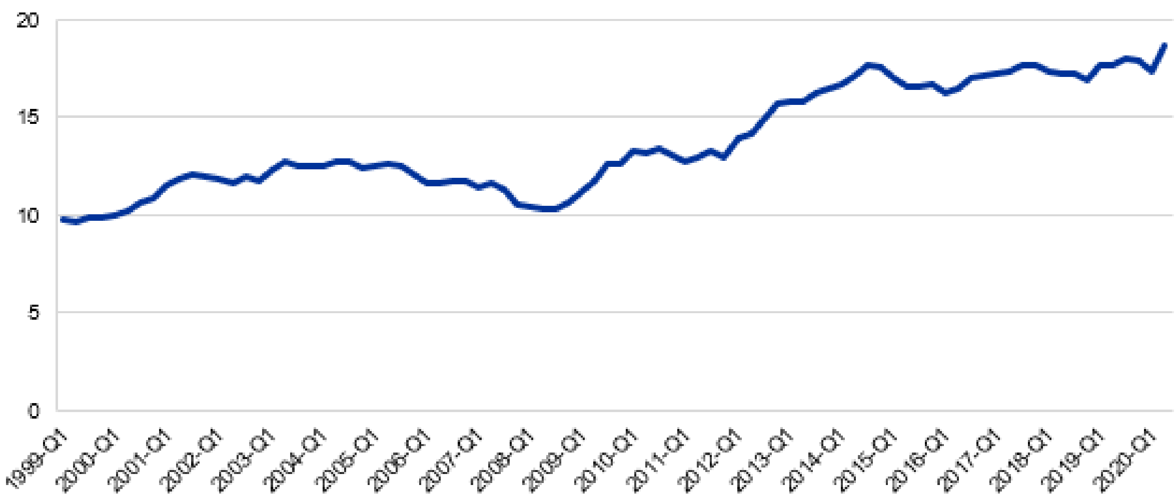
The historical decomposition for the EA also underscores that the two credit supply shocks explain a large portion of the fall in GDP during the GFC, with loan supply shocks accounting for slightly more of the GDP fall than MBF supply shocks. By contrast, the impact on GDP of the two credit supply shocks was less pronounced during the pandemic-induced recession in early 2020. The MBF supply shock appears to have had an adverse impact on GDP, explaining around a quarter of the contraction in EA GDP in the first quarter of 2020, whereas this was not the case for the loan supply shock. The lesser impact of credit supply shocks on GDP growth in the pandemic-induced recession compared with the GFC is in line with the non-financial origin of the 2020 recession.

Overall, our findings underline the importance of MBF for EA GDP growth in general and its adverse effects during crisis periods in particular. Since MBF is mostly provided by non-bank financial intermediaries, the findings also suggest that their resilience is important for GDP growth. In this respect, enhancing the macroprudential framework for non-banks would strengthen the resilience of MBF, while also supporting GDP growth. For instance, in March 2020 non-banks shed assets on a large scale and market-based debt financing dried up, while NFCs continued to benefit from loans and credit lines provided by banks. Several factors supported the flow of bank credit to NFCs during the turmoil, including government guarantees and moratoria on loans, together with liquidity provided to banks by central banks. Nevertheless, the regulatory reforms of the banking system after the GFC, including macroprudential measures, also made banks more resilient to shocks. From this perspective, our results call for more regulatory attention to be paid to non-banks going forward.

1 Introduction

Since the global financial crisis (GFC), the role of credit supply in business cycles has attracted particular attention and an increasing number of studies have estimated the effects of credit supply shocks on aggregate variables such as output growth, inflation and interest rates. These studies typically focus on the effects of credit provided to non-financial corporations (NFCs) via bank loans. However, credit has been increasingly supplied to NFCs not only via loans but also via debt-securities, i.e. through market-based debt financing. In the euro area (EA), market-based finance (MBF)[1] to NFCs has doubled from around 10% of total external credit in 1999 to 20% in recent years (see Figure 1). This trend has gone hand-in-hand with strong growth in the EA non-bank financial sector, since investment funds, insurers and pension funds are the main buyers of the debt securities issued by EA NFCs (Cera et al., 2021; ECB, 2020). This structural shift raises the question of the extent to which MBF to NFCs, and disruptions in the supply of such credit, plays a role in business cycles — a topic for which there is little empirical evidence so far.

Figure 1 – MBF as a share of total external credit to EA NFCs (percentages)



Source: Authors' calculations using ECB and Eurostat data (EA accounts and MFI BSI statistics).

To help fill this gap, our paper distinguishes between loan supply shocks and MBF supply

[1] For simplicity, MBF is used interchangeably with market-based credit (i.e. market-based debt financing) throughout the paper.

shocks and quantifies their impact on the EA real economy. We do so for the EA as a whole and also separately for the five largest EA economies, namely Germany, France, Italy, Spain and the Netherlands.

To do so, we use a novel quarterly dataset on loan and market-based debt financing provided to EA NFCs, constructed internally in the ECB (Cera et al., 2021; ECB, 2020). The data are compiled from ECB and Eurostat sources: euro area accounts (EAA) and monetary financial institution balance sheet items (MFI BSI) statistics. To conduct the country-level analysis, we extend the dataset by compiling the same type of data for the five largest EA countries.

Throughout the paper, we use a Bayesian vector autoregression (VAR) model with six variables: nominal loan and debt securities growth, real GDP growth, inflation, the corporate bond spread and the one-year nominal interest rate. Abstracting from the novelty of two types of credit supply shock, our model draws on existing literature to identify the various shocks. It uses the sign restrictions approach in line with Faust (1998), Canova and De Nicolo (2002), Uhlig (2005) and Rubio-Ramirez et al. (2010), and follows Eickmeier and Ng (2015), Gambetti and Musso (2017) and Mumtaz et al. (2018) to distinguish credit supply shocks from other shocks. Specifically, an unexpected positive credit supply shock (loan or MBF supply shock) is associated with higher output growth, higher inflation, a higher one-year interest rate and a lower spread. A positive loan supply shock increases loan growth, while a positive MBF supply shock increases debt securities growth.

To distinguish between a loan supply shock and a MBF supply shock, we propose a novel identification scheme with inequality restrictions in line with Peersman (2005). Specifically, the contemporaneous response of loans (debt securities) is assumed to be the largest for the loan (MBF) supply shock.

We estimate the model using quarterly data from the first quarter of 1999 to the second quarter of 2020, paying particular attention to the extraordinary events caused by the coronavirus (COVID-19) pandemic. In the baseline model, we exclude the two quarters of 2020 from the sample in view of the very specific nature and extraordinary magnitude of the COVID-19 shocks. However, to estimate the impact of loan and MBF supply shocks during the pandemic-induced recession in early 2020, we incorporate a stochastic volatility framework into our Bayesian VAR model in the spirit of Lenza and Primiceri (2020) and Carriero et al. (2021).

Our results suggest that both credit supply shocks have a significant impact not only on the EA economy as a whole, but also on each of the five largest EA economies. Specifically, for the EA as a whole, a forecast error variance (FEV) decomposition of GDP growth, inflation, corporate bond spread and interest rate suggests that loan and MBF supply shocks make a comparable contribution to explaining variations in these variables. Looking at GDP growth in the five largest EA economies, we find that the MBF supply shock contributes more than the loan supply shock in Germany and France, but less in Italy and Spain. In the Netherlands, loan supply shock makes a marginally larger contribution.

Related literature. Our paper contributes to and combines two strands of literature. It adds to the relatively large strand of literature on the impact of credit supply shocks on the real economy by introducing and evaluating a new type of credit supply shock: a MBF supply shock. Moreover, it significantly expands the recently emerging literature on the economic importance of the growing share of market-based and/or non-bank financing in the EA. In particular, it is the first paper – to our knowledge – that evaluates the relative importance of loan and MBF supply shocks on business cycles in the EA and the five largest EA countries.

Regarding the strand of literature on the impact of credit supply shocks on the real economy, a number of papers, including Gilchrist et al. (2009), Tamási et al. (2011), Abildgren (2012), Houssa et al. (2013), Bijsterbosch and Falagiarda (2014), Barnett and Thomas (2014), Gilchrist and Mojon (2018) and Mumtaz et al. (2018), analyse general credit supply shocks. Other authors study the role of credit supply shocks, in particular bank loan supply, in private non-financial sectors (see, for example, Hristov et al., 2012; Moccero et al., 2014; Eickmeier and Ng, 2015; Gambetti and Musso, 2017). To identify credit supply shocks, most of these papers impose sign restrictions on impulse responses in a VAR framework.

Our paper follows a similar approach and is most related to recent papers by Eickmeier and Ng (2015), Gambetti and Musso (2017) and Mumtaz et al. (2018). Specifically, Eickmeier and Ng (2015) use a global VAR (GVAR) model to study the impact of US credit supply shocks on the US economy and other economies for the period 1983-2009. Using a broad measure of real private credit, the credit supply shocks are identified based on the theoretically motivated contemporaneous sign restrictions. In brief, a negative credit supply shock contemporaneously decreases or has no effect on GDP or the volume of credit (≤ 0). At the same time, the volume of credit is restricted to decrease more than GDP. The corporate bond rate, the spread between corporate bond and long-term government bond rates, and the spread between corporate bond and short-term interest rates are restricted to increase or not be affected at all (≥ 0). The authors find that negative US credit supply shocks have a strong negative impact on GDP, not only in the US economy but also in other economies. Specifically, US credit supply shocks are estimated to contribute around 20% to a one-year-ahead FEV of output in the United States and 10% to the FEV of output in the EA and United Kingdom. Similarly, Gambetti and Musso (2017) use a VAR model that incorporates loans to the non-financial private sector and a composite lending rate and then identify credit supply shocks by using sign restrictions consistent with recent macroeconomic literature. To identify a loan supply shock, the authors assume that an expansionary shock leads to an increase in real GDP, inflation, the short-term interest rate and the loan volume and to a decrease in the lending rate.[2] Gambetti and Musso (2017) find that loan supply shocks have significant effects in all three areas analysed (the EA, the United Kingdom and the United States) for the period 1980-2011, with the impact increasing towards the end of the sample. Loan supply shocks are found to explain about 16%-21% of the variance of real GDP growth and appear to be the most important during recessions. In their baseline model, Mumtaz et al. (2018) use a structural VAR for the US economy, including five endogenous variables (GDP growth, CPI inflation, lending growth to households and private NFCs, spread and three-month T-bill) with sign restrictions in the spirit of Gertler and Karadi (2011), together with a constraint on the FEV. The sign restrictions are in line with the aforementioned papers. Similarly to Gambetti and Musso (2017), the authors find that credit supply shocks were important during the GFC, accounting for around 50% of the decline in output growth in the United States.

With respect to the literature on the growing share of market-based and non-bank financing in the EA, Aldasoro and Unger (2017) use a VAR framework to compare flows of bank loans with flows of other sources of external financing (equity, debt securities and loans from non-banks) to the non-financial private sector in the EA (NFCs, private households and non-profit institutions serving households). Bank loan shocks and other external financing shocks are distinguished by the substitution assumption where an adverse bank loan supply shock decreases the flow of bank loans and increases the flow of other sources of financing. We, in contrast, distinguish the two credit supply shocks by inequality restrictions, which has the advantage of letting the data decide whether the two types of financing sources are complements or substitutes. In addition, instead of a relatively broad category of "types of financing other than bank loans", we use more granular measures of sources of financing to the non-financial private sector. The measures are

[2] These authors identify four shocks: a loan supply shock,an aggregate supply shock, an aggregate demand shock and a monetary policy shock.

either activity-based (loans versus debt securities in the baseline model) or entity-based (bank versus non-bank debt financing in the robustness checks).

The rest of the paper is organised as follows. Section 2 describes the construction of our dataset and the stylised facts about loans and MBF provided to EA NFCs. Section 3 introduces the model, while Section 4 presents the results of the baseline EA model and the main findings for each of the five largest EA economies, including a number of robustness checks. Finally, Section 5 presents our concluding remarks.

2 Data

We use a novel dataset on external credit provided to EA NFCs, which includes data on both loans and MBF (i.e. marketable debt securities as opposed to loans). The dataset was constructed internally in the ECB (Cera et al., 2021; ECB, 2020) and covers the period from the first quarter of 1999 to the second quarter of 2020. The dataset is built from ECB and Eurostat sources, specifically the EAA and MFI BSI statistics.[3] It contains information on various sources of debt financing to NFCs, including debt financing from EA sectors and the rest of the world. Thanks to the quarterly frequency, we can combine these data in estimations with other standard macroeconomic variables, such as output and inflation, in a VAR framework.

In our baseline model specification, we use two baseline measures of external debt financing to NFCs: (i) loans to EA NFCs and (ii) MBF to EA NFCs. Loans to EA NFCs include loans from EA banks, loans from EA non-bank financial entities (investment funds, insurance corporations and pensions funds, other financial institutions (OFIs)) and loans from the rest of the world. Three issues about this choice are worth pointing out. First, loans from EA NFCs to EA NFCs are not included because there is no breakdown between intra-group and extra-group loans, and we expect most of these loans to be intra-group loans in line with Cera et al. (2021) and ECB (2020). Second, regarding loans from OFIs, these entities can belong to banking groups or be set up and owned by NFCs. The former case is likely to be external financing, while the latter case is likely to be intra-group NFC financing. Since there is no information available to distinguish between the external and internal nature of OFI financing, we first calculate two measures of

[3] Since we extend the dataset to country-level data for the five largest EA countries, slightly different to Cera et al. (2021) and ECB (2020), we do not use data on non-retained securitised loans from the financial vehicle corporation statistics. However, the volumes of non-retained securities loans are fairly small compared with the volumes of other sources of debt financing to NFCs.

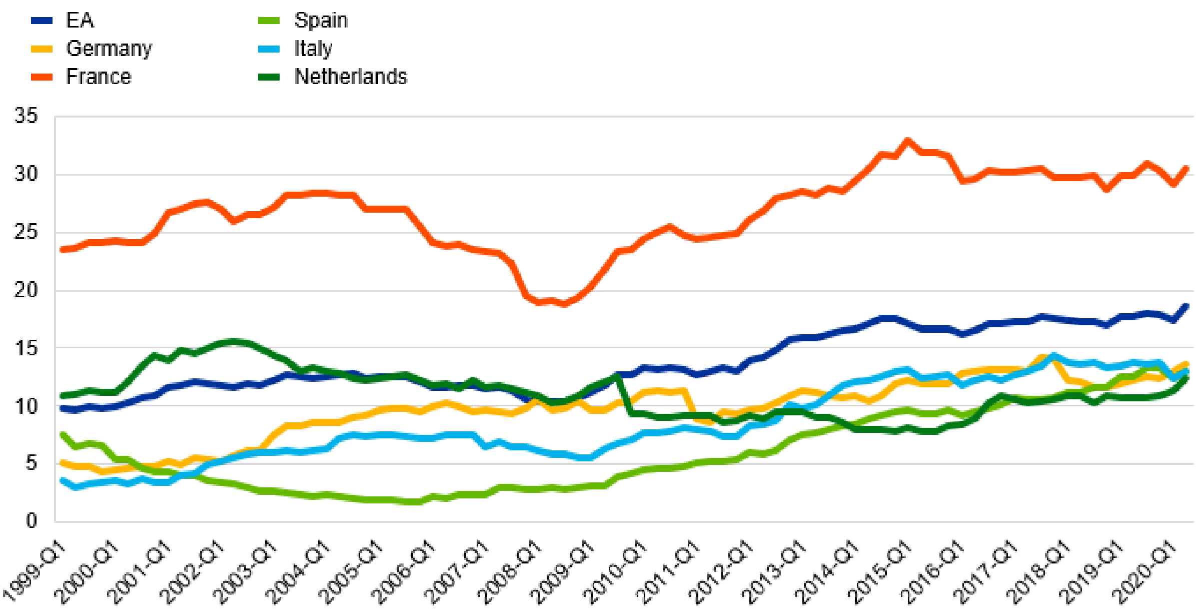
loan volume – one with and one without OFI loans – and then use the average of two measures. Third, since there is no sector breakdown for loans to EA NFCs from the rest of the world, we include all foreign loans in our baseline loan measure. Given that about 85% of total financing to EA NFCs is provided by EA sectors, this assumption is unlikely to significantly affect our results. Regarding MBF to EA NFCs, our baseline measure refers to marketable debt securities issued by EA NFCs, regardless of the holder sector. Hence, these debt securities can be held by both EA sectors (MFIs, investment funds, OFIs, insurance corporations and pensions funds, and non-financial sectors) and the rest of the world.

In addition to the distinguishing between loans and MBF based on activity, the dataset also allows us to determine the entity that provides the funding. In particular, we can distinguish between funding provided by the non-bank financial sector (insurance corporations and pension funds, investment funds and OFIs) and that provided by the banking sector (MFIs). Since most loans are granted by banks and most debt securities are held by non-banks, the entity-based distinction yields two measures of external NFC financing (bank and non-bank financing) that are similar – but not identical – to our two activity-based baseline measures (loans and MBF).

We use these alternative measures for robustness checks rather than in our baseline model specification because their construction is subject to a number of limitations and assumptions. First, since the sector breakdown is generally available only within the EA, the measures are limited to NFC financing provided by EA banks and non-banks, while omitting financing from the rest of the world. Second, the time series for the breakdown of debt securities holdings by holding sector only start at the fourth quarter of 2013. Therefore, we follow Cera et al. (2021) and ECB (2020) to backcast the sector breakdown to the first quarter of 1999. We do so by splitting the time series for debt securities held by *all* EA sectors in proportion to the first sectoral distribution available (i.e. the sector breakdown in the fourth quarter of 2013). This method thus relies on the relatively strong assumption that the sector breakdown remained constant between the first quarter of 1999 and the fourth quarter of 2013. Third, in line with Cera et al. (2021) and ECB (2020), we apply a special treatment to isolate the debt securities held by money market funds (MMFs), since MMFs are included in the fourth quarter of 2013 under the MFI sector but are typically considered non-bank financial intermediaries. To break down MFI securities into those held by (commercial) banks and those held by MMFs, we use the MFI BSI statistics, where such breakdown is available as of the first quarter of 2006. For the data from the first quarter of 2006 onwards, we split the MFI holdings of NFC debt securities in proportion to the data available in the MFI BSI statistics. For the data between the first quarter of 1999 and the fourth quarter of 2005, we make the split in proportion to the first quarter of 2006 (sub)sectoral breakdown.

To investigate the heterogeneity across countries, we build the same type of measures for the five largest EA countries (i.e. Germany, France, Italy, Spain and the Netherlands) using the same sources and techniques described above. In line with the EA dataset, we collect information on loan and debt securities financing to NFCs in each country, including financing from EA sectors and the rest of the world.

Figure 2 – MBF as a share of total external credit to NFCs in the EA and five largest EA economies (percentages)



Source: Authors' calculations using ECB and Eurostat data (EAA and MFI BSI statistics)..

Figure 2 shows that the importance of MBF to NFCs has increased over time in the EA and four of the five largest EA economies. Specifically, for the EA as a whole, the MBF share of total external credit to NFCs doubled from around 10% in 1999 to almost 20% in 2020. Of the five largest economies, France stands out owing to its large share of MBF, which exceeds 20% throughout most of the sample period. The share increased from 23% in 1999 to more than 30% in 2020, although this uptrend was interrupted during the GFC, with the MBF share reaching a trough of around 19% in the first quarter of 2009. Germany's MBF share recorded a fairly steady increase, almost tripling from 5% in 1999 to around 14% by the end of our sample period. Similarly, Italy's MBF share increased steadily over the sample period, from 3% to 13%. Spain's MBF share declined from 7% in 1999 to less than 2% in 2005, but then rebounded to 13% in 2020. The Netherlands is the only country where the MBF share did not significantly increase over our sample period, fluctuating at around 11

Table 1 – Mean and standard deviation of quarter-on-quarter growth in real GDP, NFC loans and debt securities in three periods

	Full sample Q1 1999 - Q4 2019		Sub-sample Q1 1999 - Q4 2008		Sub-sample Q1 2009 - Q4 2019	
	Mean	Std	Mean	Std	Mean	Std
EA GDP growth	0.35	0.60	0.45	0.55	0.25	0.63
EA loan growth	0.94	1.47	1.65	1.07	0.30	1.49
EA debt sec. growth	1.79	2.33	1.95	2.32	1.65	2.35
DE GDP growth	0.33	0.87	0.32	0.75	0.34	0.97
DE loan growth	0.66	1.47	0.65	1.35	0.67	1.59
DE debt sec. growth	1.85	5.83	2.66	5.12	1.13	6.37
FR GDP growth	0.36	0.48	0.45	0.51	0.28	0.44
FR loan growth	1.12	1.30	1.69	1.43	0.61	0.92
FR debt sec. growth	1.57	3.28	1.14	3.49	1.96	3.06
IT GDP growth	0.10	0.68	0.23	0.73	-0.01	0.62
IT loan growth	0.74	1.67	1.99	1.43	-0.38	0.92
IT debt sec. growth	2.48	5.86	3.24	6.86	1.81	4.79
ES GDP growth	0.46	0.68	0.78	0.51	0.19	0.70
ES loan growth	1.39	3.12	4.15	1.98	-1.06	1.44
ES debt sec. growth	2.21	6.79	1.70	8.79	2.65	4.38
NL GDP growth	0.40	0.67	0.55	0.55	0.26	0.74
NL loan growth	1.00	1.42	1.29	1.48	0.74	1.32
NL debt sec. growth	0.97	5.66	1.28	4.47	0.68	6.58

Source: Authors' calculations using ECB and Eurostat data (EAA and MFI BSI statistics)..

In Table 1, we provide information on the mean and variance for quarter-on-quarter NFC loan and debt securities growth and real GDP growth in the EA and the five largest EA economies in three time windows: full sample (from the first quarter of 1999 to the fourth quarter of 2019) and two sub-samples (from the first quarter of 1999 to the fourth quarter of 2008 and from the first quarter of 2009 to the fourth quarter of 2019). Growth is found to be more volatile in MBF (debt securities) than loans, both in the EA and at country level. This holds regardless of the sample period. Both debt financing series are also substantially more volatile than real GDP growth. The EA's lacklustre GDP growth post-2009 is associated with weak growth in both loans and MBF, with average growth falling from 1.65% in the period 1999-2008 to 0.3% in 2009-2019 for loans and from 1.95% to 1.6% for MBF. However, the dynamics of debt financing to NFCs is heterogeneous across countries. Loan growth in the post-2009 period is weaker in most economies, except Germany, where it remains almost the same in both sub-samples. In Italy and Spain, loans to NFCs fall on average in the 2009-2019 sample period (negative growth rate of 0.38% and 1.06% respectively). The growth of MBF accelerates in the post-2009 period in Spain and France, but slows in Germany, Italy and the Netherlands.

Our model includes a number of other macroeconomic variables (see Section 3). EA and country-specific data on GDP growth and inflation are taken from Eurostat. Corporate bond spreads for the EA, Germany, France, Italy and Spain are taken from Gilchrist and Mojon (2018), while the corporate bond spread data for the Netherlands are from internal ECB calculations. One-year interest rates are proxied by one-year government bond yields for the EA and each country, which are taken from Datastream. The advantage of using a longer-term rate than the ECB policy rate is that it incorporates the impact of forward guidance and hence remains a valid measure of monetary policy stance during the period, while the policy rate is constrained by the effective lower bound (Jarociński and Karadi, 2020).

3 Model

To estimate the impact of credit supply shocks, we follow the literature and use a VAR model as follows:

$$A_0 X_t = B_0 + \sum_{i=1}^{q} B_i X_{t-i} + \epsilon_t \quad (1)$$

where X_t is the vector of six endogenous variables: NFC nominal loan growth, NFC nominal debt securities growth, real GDP growth, inflation, the corporate bond spread and the one-year nominal interest rate. For other notations, q is the lag length,B_0 deterministic terms, B_i a 6×6 matrix of parameters, A_0 a 6×6 matrix of parameters capturing the contemporaneous relationships between the endogenous variables, and ϵ_t a 6×6 vector of orthogonal structural shocks with a Gaussian distribution of mean zero and identity covariance matrix.

The reduced-form representation implied by the structural model (1) is

$$X_t = C_0 + \sum_{i=1}^{q} C_i X_{t-i} + u_t \tag{2}$$

where $C_0 = A_0^{-1}B_0$, $C_i = A_0^{-1}B_i$ and $u_t = A_0^{-1}\epsilon_t$. It is known that the reduced-form estimation does not provide enough information to identify even one column of A_0. To overcome this, we follow Faust (1998), Canova and De Nicolo (2002), Uhlig (2005) and Rubio-Ramirez et al. (2010) and apply sign restrictions for identifications. Specifically, to identify credit supply shocks we follow similar sign restrictions to those in Mumtaz et al. (2018), Gambetti and Musso (2017) and Eickmeier and Ng (2015). We summarise all these restrictions in Table 2.

Table 2 – Contemporaneous sign restrictions in the baseline model

	Loan supply shock	MBF supply shock
GDP growth	<= 0	<= 0
Inflation	<= 0	<= 0
Spread	>= 0	>= 0
1Y interest rate	<= 0	<= 0
Loan growth	<= 0	
Debt securities growth		<= 0
Other restrictions	(absolute) response of loans growth is largest	(absolute) response of debt securities growth is largest

Note: The table lists signs of responses of endogenous variables (in the first column) to negative loan and MBF supply shocks respectively.

Our main assumptions for the contemporaneous sign restrictions are standard. An unexpected negative credit supply shock (loan or MBF) is associated with non-positive responses of GDP growth, inflation and the one-year interest rate, and with non-negative responses in the spread. Moreover, a negative loan supply shock also leads to a contemporaneous non-positive impact on loan growth, while a negative MBF supply shock leads to a non-positive response in debt securities growth.

Nevertheless, these sign restrictions do not distinguish between a loan and an MBF supply shock. We therefore impose additional inequality restrictions along the lines of Peersman (2005) by assuming that loan growth has the largest response (in absolute terms) to a loan supply shock compared with the other variables. Similarly, we assume that debt securities growth has the largest response to an MBF supply shock compared with the other variables.

In line with the literature on sign-identified VAR models, we apply Bayesian methods for inference. We set priors using dummy observations, as in Banbura et al. (2010). Then, we use a Gibbs sampling approach and draw A_0^{-1} directly in each iteration by using the efficient algorithm proposed by Rubio-Ramirez et al. (2010). In a nutshell, given the draw of $var(u_t) = \Omega$, the Cholesky decomposition of $\Omega = \tilde{A}_0' \tilde{A}_0$ is computed. This matrix $\tilde{A}_0$ is multiplied by an orthogonal rotation matrix Q_t, generating a draw of $A_0^{-1} = Q_t \tilde{A}_0$. We only retain those draws that satisfy the aforementioned sign and inequality restrictions and estimate the impulse responses to loan and MBF supply shocks.

In addition to the baseline model, we consider a number of alternative identification schemes and robustness checks. For instance, we apply the inequality restrictions to the FEV decomposition instead of to the impulse response (see subsection 4.3). In our baseline model specification, we use two lags of endogenous variables, but we test the robustness of this choice in the online appendices A.1.1 and A.1.2. We also use an entity-based rather than activity-based measure of NFC funding (see Section 2 and subsection 4.4). Furthermore, in our baseline analysis, we exclude from the sample the early 2020 pandemic-induced recession, given the different nature and extraordinary magnitude of the COVID-19 shocks. However, to study the role of the two credit supply shocks during the pandemic-induced recession, we extend our VAR model to incorporate stochastic volatility in order to account for the exceptionally large shocks in early 2020, following Lenza and Primiceri (2020) and Carriero et al. (2021), while maintaining the identification scheme with sign and inequality restrictions, as discussed above (see subsection 4.5).

4 Results

This section presents the estimates of loan and MBF supply shocks on different economic variables including output, inflation, corporate bond spread, one-year interest rate, loan growth and debt securities growth. We first present the baseline results for the EA (subsection 4.1) and the five largest EA countries (subsection 4.2), and then extend the discussion in several important dimensions. In particular, we perform robustness checks by controlling for monetary policy shocks, using a richer identification scheme of shocks (identifying five different shocks), using the pre-unconventional monetary policy sample (until the second quarter of 2014), excluding restrictions on interest rate and inflation, and using alternative inequality restrictions (subsection 4.3). We extend our analysis to investigate bank versus non-bank credit supply shocks instead of loan versus MBF supply shocks (subsection 4.4). Finally, we extend our analysis by incorporating stochastic volatility framework into our Bayesian VAR model to deal with the COVID-19-related sample and then analyse the impacts of loan and MBF supply shocks in the context of the COVID-19 crisis (subsection 4.5).

4.1 Baseline

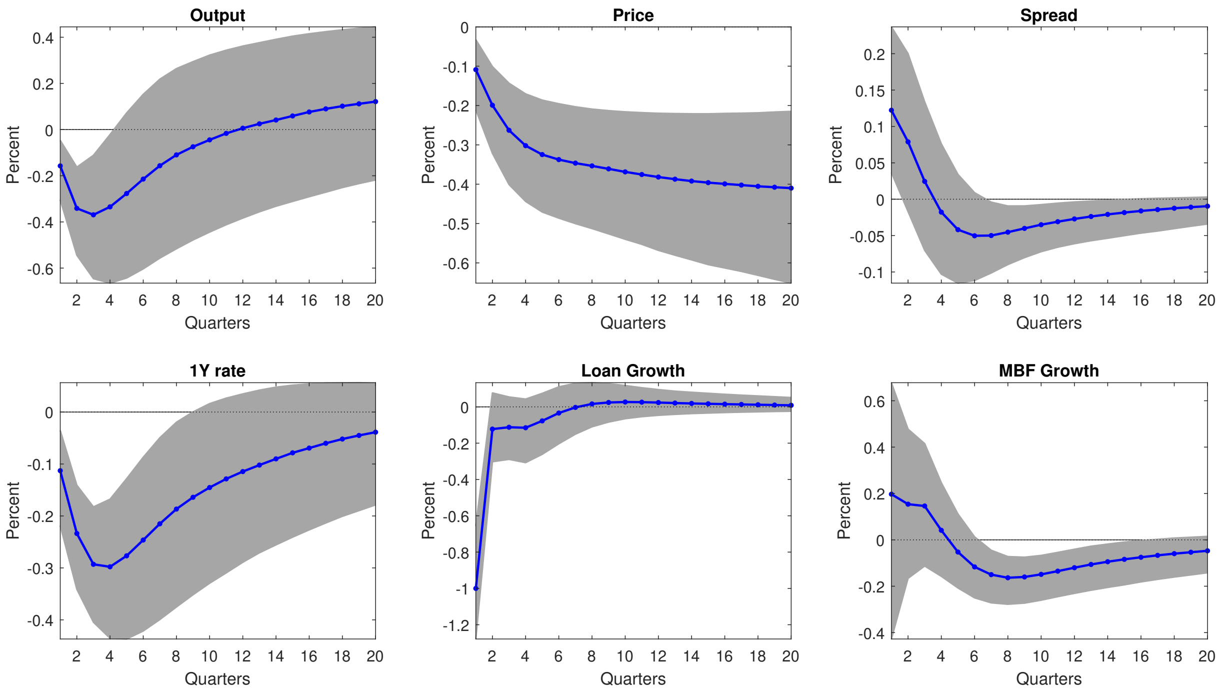
4.1.1 Impulse responses

We start by analysing the baseline results for the EA model. Figure 3 presents the impulse responses of the EA variables to a loan shock, equivalent to a 1% decrease in loan growth.[4] This shock has a significant negative impact on the EA economy. More specifically, output, i.e. the cumulative response of output growth, decreases by nearly 0.2% on impact, reaches a trough of -0.4% in the third quarter, and then gradually returns to zero. The impact is short lasting (for a year) and then becomes insignificant. At the same time, price, i.e. the cumulative response of inflation, decreases gradually, but appears long lasting and reaches -0.4% after five years. The corporate bond spread increases by 0.12% but this is short-lived. The interest rate appears to follow a Taylor rule-based reaction function, which falls when both output and price decrease. The rate reduction lasts slightly more than two years, reaching a trough of -0.3 percent after a year. Such a slow response by the interest rate reflects the persistent decline in prices. Finally, we capture an increase in debt securities growth on impact, indicating a possible substitution effect, although it is insignificant. We also observe a decline in MBF growth after two years which partly reflects the decrease in credit demand due to output contraction.

Figure 4 presents the impulse responses of EA variables to a negative MBF shock, equivalent to a 1% decrease in debt securities growth. The shock decreases EA output by about 0.3% after a year. This result is short lasting and significant for up to six quarters. At the same time, the price decreases gradually, which remains long lasting. The corporate bond spread increases by 0.11% and then returns to zero. Compared with the loan supply shock, the interest rate responds by a smaller reduction of ten basis points, which can be explained by smaller decreases in output

[4] As shown in online appendix A.1.3, our results are almost identical when additionally imposing an orthogonality condition on two credit supply shocks, i.e. we only retain the draws of the two credit supply shocks without a statistically significant correlation.

Figure 3 – Impulse responses to a negative 1% loan supply shock



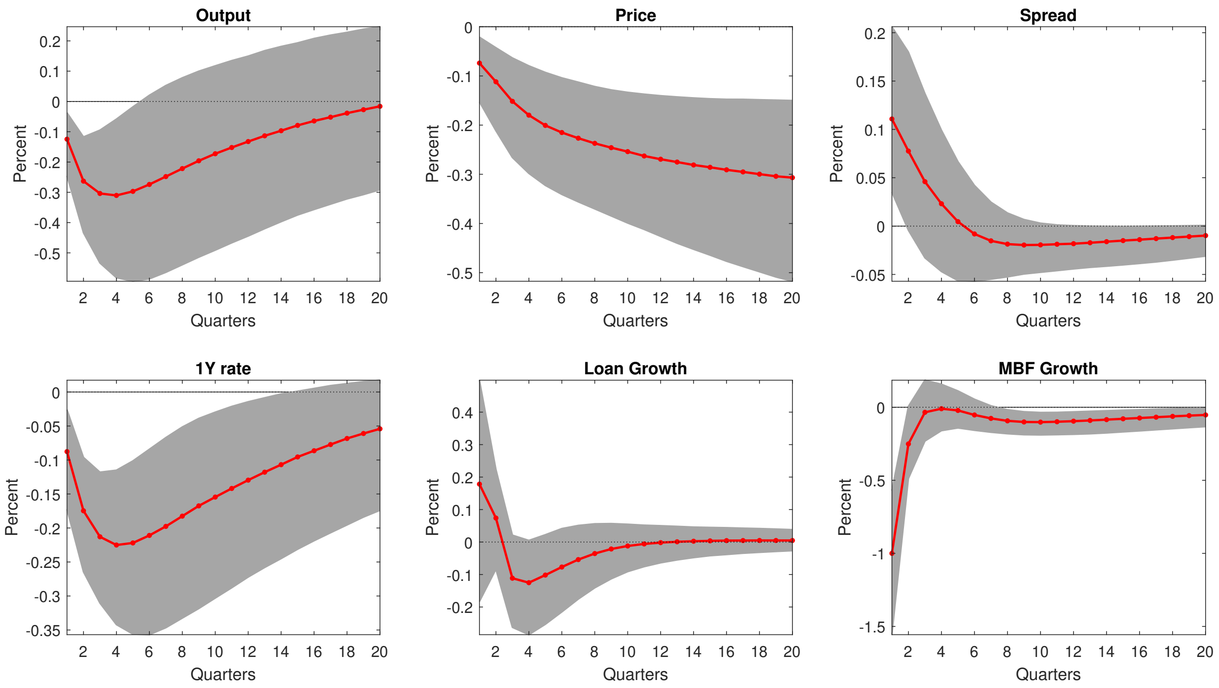
Note: Impulse responses to a loan supply shock that reduces (median) loan growth by 1% on impact. The solid line is the median response and the shaded area represents the 16th and 84th bounds. The responses of output and prices are the cumulated responses of GDP growth and inflation respectively.

and price in response to the MBF shock. The negative impact lasts for 3.5 years, reaches -0.23% in the fourth quarter and gradually returns to zero afterwards. Finally, the model also records a positive response by loan growth on impact in line with a substitution effect, although this effect is insignificant.

4.1.2 FEV Decomposition

One interesting question is how much of the FEV is accounted for by these credit supply shocks. The answer is shown in Table 3 which presents the FEV decomposition for one, four and eight quarters ahead for all six variables in our VAR model: GDP growth, inflation, spread, interest rate, loan growth and debt securities growth. For the FEV of the first four variables, the contribution of both loan supply and MBF supply shocks is relatively similar, although with some noticeable differences. Loan supply shocks appear to have marginally larger explanatory power for GDP and inflation, especially over the longer horizons (one and two years ahead),

Figure 4 – Impulse responses to a negative 1% MBF supply shock



Note: Impulse responses to an MBF supply shock that reduces (median) MBF growth by 1% on impact. The solid line is the median response and the shaded area represents the 16th and 84th bounds of responses. The responses of output and prices are the cumulated responses of GDP growth and inflation respectively.

whereas MBF supply shocks have slightly greater explanatory power for the spread.

More specifically, the contribution of a loan supply shock to the FEV of output growth and inflation is estimated to be about 20% for each, increasing with longer horizons. This shock contributes 19.5% to the FEV of the spread at the one-quarter horizon, although this decreases to 14% at the one and two year horizons.

The contribution of MBF supply shocks to output growth is similar at all horizons (about 17%) with a slightly larger contribution in the short term (one-quarter). Their contribution to inflation is around 14%-15%, smaller than the corresponding contribution of loan supply shock. The contribution of MBF supply shocks to the FEV of the spread is also found to have significant explanatory power, equal to 21.8% in the short-run and then decreasing to 15% in a two-year horizon. MBF supply shocks contribute slightly less than loan supply shocks to the EA interest rate.

Finally, loan supply shocks explain a large portion of the FEV of loan growth (44% in quarter 1 and 30% after two years) while MBF supply shocks contribute only 10% to this variable.

Table 3 – FEV decomposition for one, four and eight quarters ahead

Variable	Horizon	Loan supply shock	MBF supply shock	Other shocks
Output growth	1	18.29%	17.37%	64.34%
	4	18.30%	16.77%	64.93%
	8	19.08%	16.27%	64.65%
Inflation	1	18.50%	14.11%	67.39%
	4	22.63%	15.00%	62.37%
	8	22.12%	15.22%	62.66%
Spread	1	19.54%	21.80%	58.66%
	4	14.23%	16.28%	69.50%
	8	14.86%	15.06%	70.08%
1Y interest rate	1	20.46%	18.71%	60.83%
	4	26.95%	22.71%	50.34%
	8	22.46%	21.53%	56.01%
Loan growth	1	43.65%	8.41%	47.94%
	4	35.42%	10.44%	54.15%
	8	30.53%	11.07%	58.40%
Debt securities growth	1	3.74%	23.96%	72.30%
	4	5.65%	22.26%	72.09%
	8	6.61%	21.71%	71.68%

Note: The table shows the FEV decomposition of variables in the baseline for loan supply shocks, MBF supply shocks, and other shocks.

Conversely, MBF supply shocks contribute, at up to 24%, significantly more than loan supply shocks to debt securities growth at the one-quarter horizon.

In total, these two credit supply shocks explain a large amount of the FEV of output growth, at about 35%, indicating their importance for business cycles as found in the recent literature. Our results also add new insights to the literature on the relative contributions of the two types of credit supply shocks.

4.1.3 Historical decomposition

In order to investigate how much these credit supply shocks explain the historically observed fluctuations in the VAR variables, we perform a historical decomposition and plot this in Figure 5. The impact of credit supply shocks on EA GDP growth, inflation, spread, interest rate, loan and debt securities growth is represented by the blue lines. The blue lines represent the counterfactual changes in the absence of both loan supply and MBF supply shocks (first column), when excluding only loan supply shocks (middle column), and when excluding only MBF credit supply shocks (third column).

The results for the impact on GDP growth (first row in Figure 5) indicate that both credit supply shocks played an important role, particularly during the recession. In the aftermath of the GFC in 2009, loan supply shocks accounted for a larger portion of the decrease in GDP than MBF supply shocks. Specifically, in the fourth quarter of 2009, the two credit supply shocks accounted for about 50% of the decrease in EA quarter-on-quarter output growth. Loan supply shocks were responsible for 28% of total contraction and the MBF supply shock for 22%. Our results for loan supply shocks are in line with those documented in Hristov et al. (2012) and Gambetti and Musso (2017). Similarly, for the United States, Mumtaz et al. (2018) document that the trough of the decline in GDP growth in 2009 would have halved in the absence of credit supply shocks.

Regarding other variables, loan supply shocks had a larger impact on inflation, particularly before and during the recession in 2008-2009) (second row in Figure 5). MBF supply shocks also negatively impacted inflation during the recession, but with a smaller magnitude. Spreads and interest rates (third and fourth rows in Figure 5) were impacted more by loan supply shock during the recession, while MBF supply shocks seems to have had marginally higher impact on these variables before 2008 and from 2015 onwards. Finally, the last two rows in Figure 5 reflect the impact of loan supply shocks on loan growth and of MBF supply shocks on debt securities. They also show that a significant portion of loan growth and MBF growth is driven by shocks other than the corresponding supply shocks.

4.2 Country perspectives

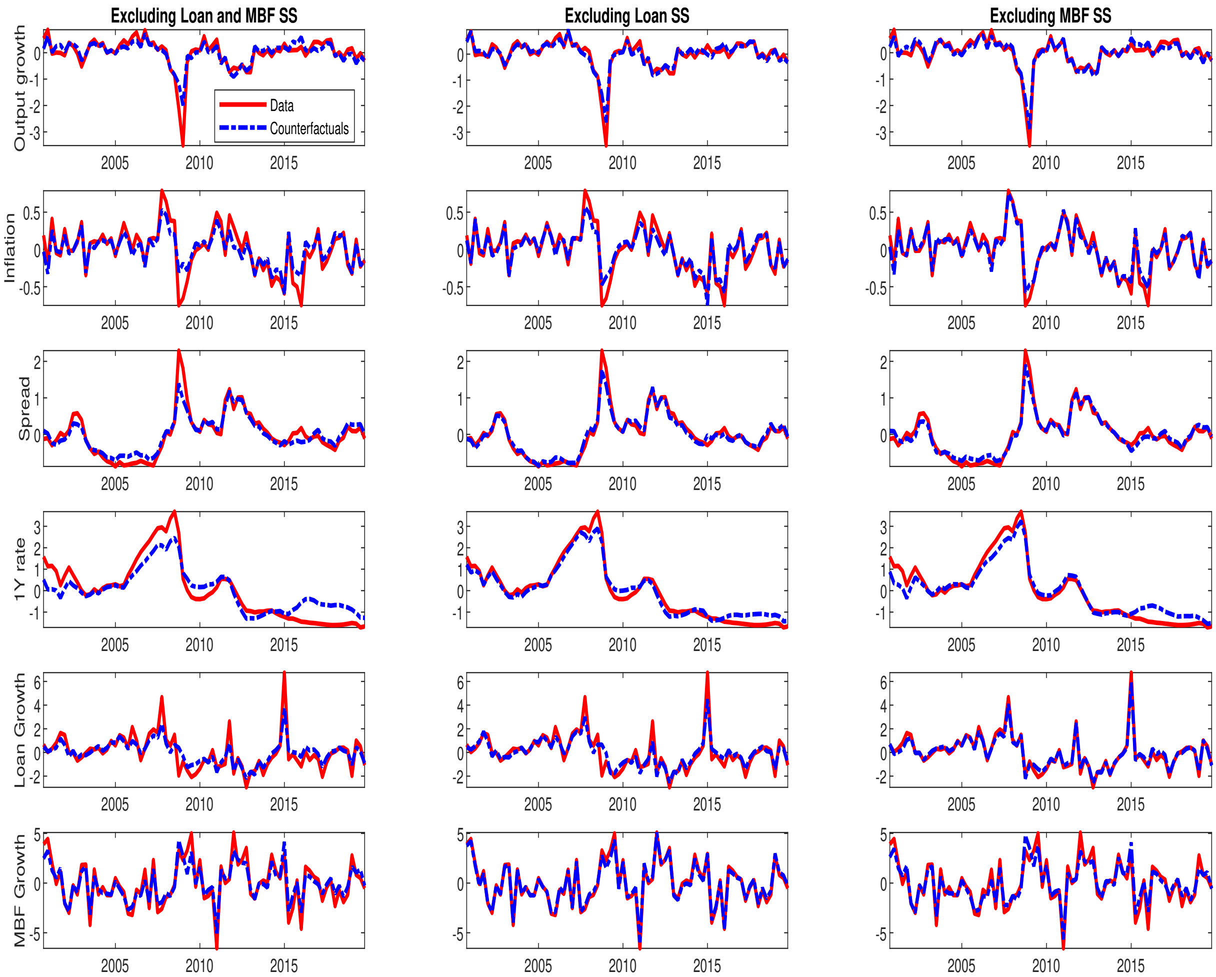
This section investigates the impact of the two credit supply shocks at country level. Specifically, we estimate and identify the shocks with sign restrictions for each of the five largest EA countries: Germany, France, Italy, Spain, and the Netherlands.

4.2.1 Impulse responses

The impulse responses, as presented in Figure. 6 and Figure 7, are in line with those discussed for the EA baseline model, i.e. decreases in both credit supply shocks have a negative impact on economic activity in each of the five economies. Nevertheless, the size of contraction with respect for each type of credit supply shocks is heterogeneous.

A negative loan supply shock has a large impact on Italy' and Spain's output and price

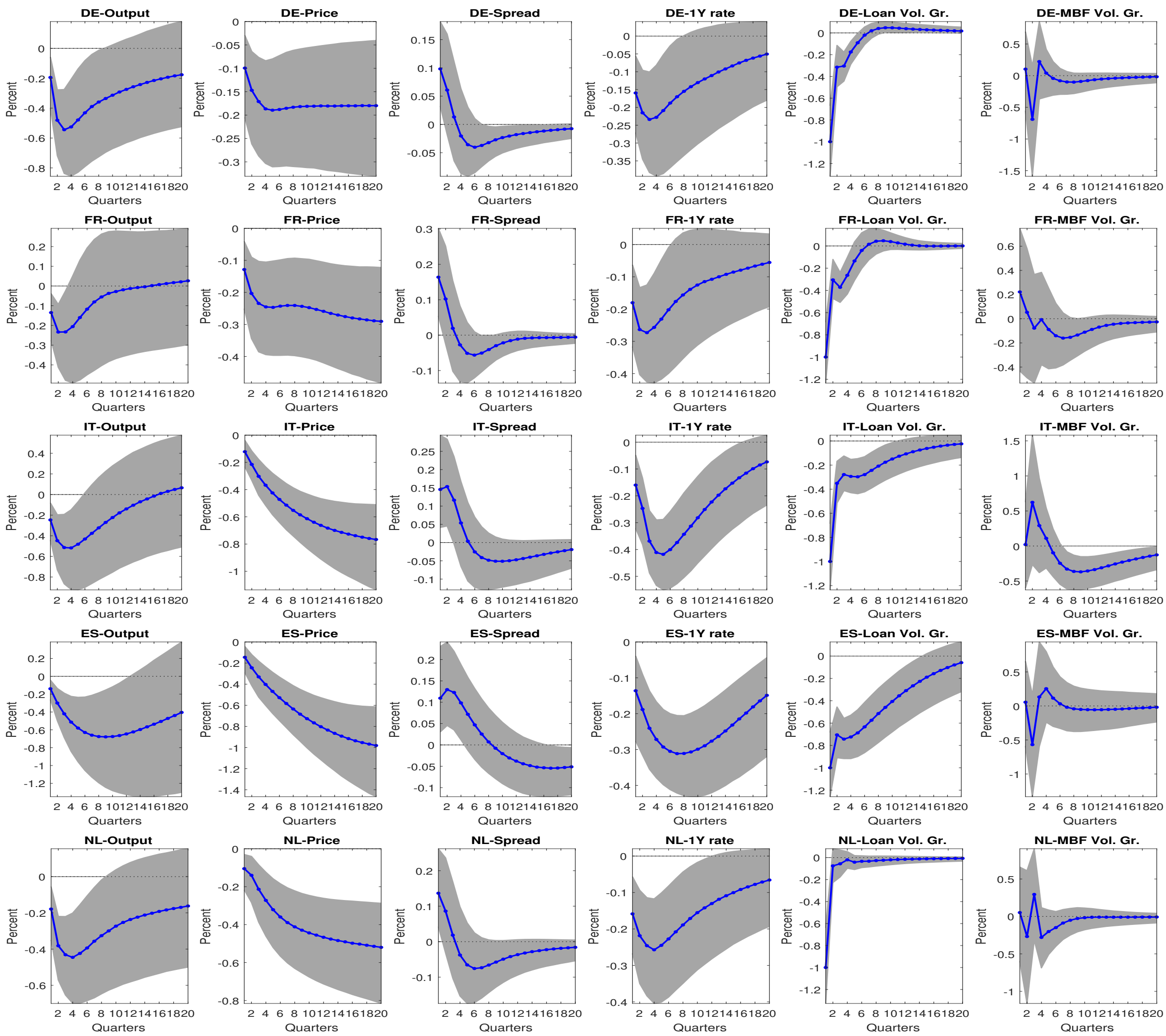
Figure 5 – Historical decomposition



Notes: Figure shows the data (red solid lines) and counterfactual changes (blue dashed lines) when (i) excluding both loan and MBF supply shocks ("Excluding Loan and MBF SS" in first column); (ii) excluding loan supply shocks ("Excluding Loan SS" in second column); and (iii) excluding MBF supply shocks ("Excluding MBF SS" in third column).

(as seen in the third and fourth rows in Figure 6). A 1% negative loan supply shock causes Italy's GDP and price to fall by 0.55% and 0.8% respectively, and Spain's output and price to fall by 0.7% and 1.0% respectively. In Germany, France and the Netherlands, however, output growth decreases by 0.55%, 0.25%, and 0.45% respectively, and prices by 0.18%, 0.3%, and 0.5% respectively. The impact on corporate bond spreads is short lasting and similar in all countries, increasing the spread by 0.1%-0.15%. The declines in interest rates are larger and more persistent in Italy and Spain – reflecting the depth of contraction in both output and price in these two countries – than in Germany, France and the Netherlands. The impact of loan supply shocks on debt securities growth is insignificant for all countries.

Figure 6 – Country impulse responses to a negative 1% loan supply shock



Notes: Impulse responses to a loan supply shock that reduces (median) loan growth by 1% on impact. The solid line is the median response and the shaded area represents the 16th and 84th bounds. The responses of output and prices are the cumulated responses of GDP growth and inflation respectively.

Figure 7 plots the impulse responses of each country's variables to a negative MBF supply shock. The biggest and most persistent impact on GDP is in France with a decrease of 0.3 percent, followed by Germany with a decrease by 0.21, while the other three countries experience smaller contractions of 0.1% and 0.15%. The larger effect in France is in line with the fact that the country's MBF share is larger than that of the other economies as shown above. The effect on price is persistent in all countries, resulting in a decrease of 0.25% in France and around 0.1% in the other four countries. The spread's response is short-lived and varies from 0.04% to 0.12%, with the strongest impact on France's corporate bond spread. The decline in interest rate in Germany, France and the Netherlands remains statistically significant for longer than in Italy and Spain. Interestingly, for Germany and the Netherlands, we capture a short-lived but significant increase in loan growth one quarter ahead, indicating a substitution effect. In summary, we find that the MBF supply shock has a more persistent and stronger impact on Germany and France than the other three major EA economies.

4.2.2 FEV decomposition

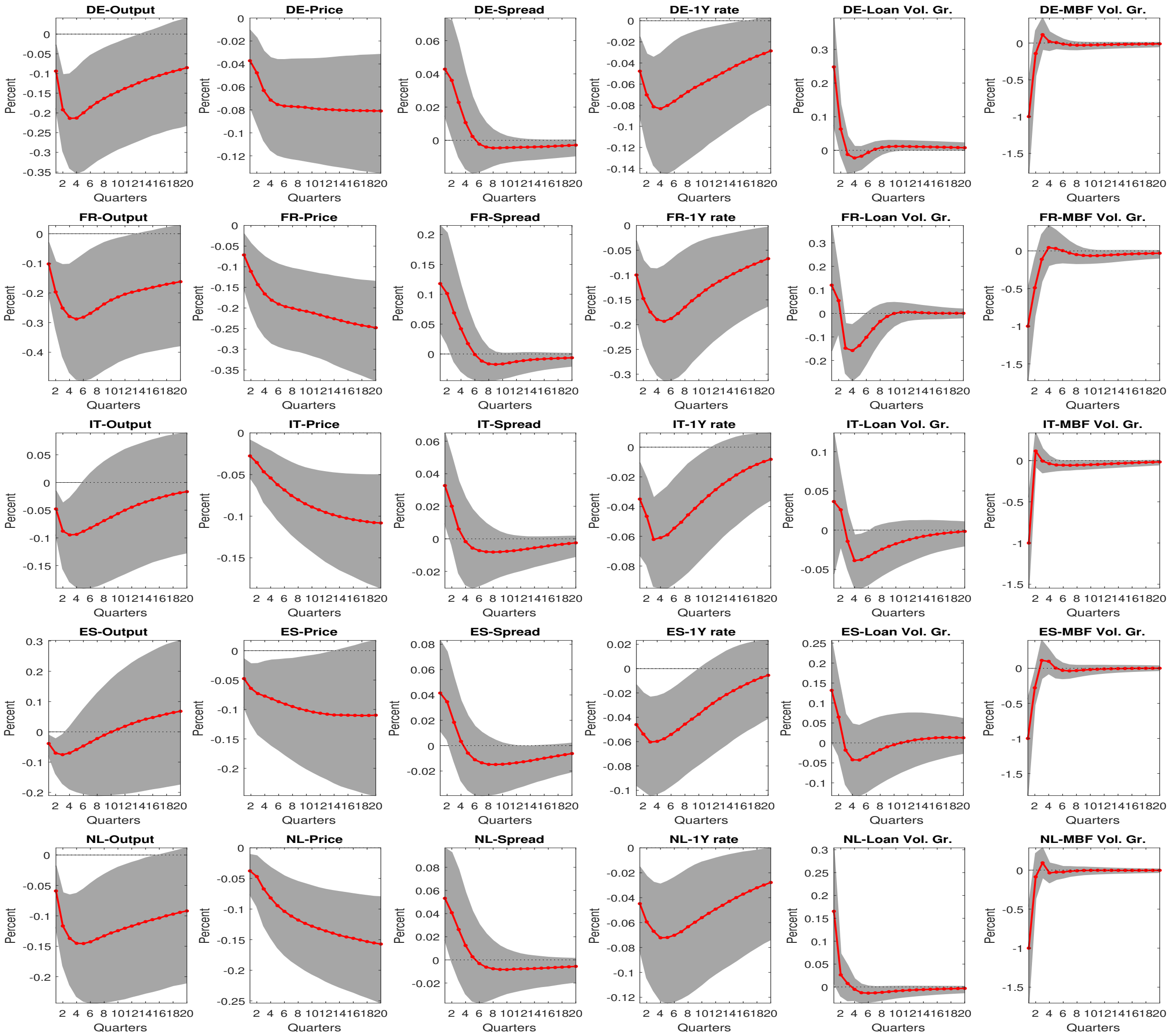
As in the case of the EA baseline, we are interested in the explanatory power of these credit shocks for the FEV of output growth in the five largest EA economies. As estimated in Table 4, the contribution of loan supply shocks to the FEV of GDP growth is larger in Italy and Spain (21%-24% at all horizons) than the other economies. In more detail, it explains 19% at the one and two-year horizons of the FEV of GDP growth in the Netherlands and up to 14% in Germany and France.

The contribution of MBF supply shocks to the FEV of GDP growth is estimated to be 15%-19% for all countries. They make a larger contribution than loan supply shocks in Germany and France, while the reverse is true in Italy and Spain. In the Netherlands both credit supply shocks contributes similarly, with a marginally larger contribution from loan supply shock.

These results are in line with the findings of such authors as Corbisiero and Faccia (2020) and Gilchrist and Mojon (2018). Corbisiero and Faccia (2020) find that during the European sovereign debt crisis, higher levels of non-performing loans ratios signalled weakness in banks balance sheets and thus a limited ability to grant loans, even to sound firms and particularly in periphery countries, including Italy and Spain. Gilchrist and Mojon (2018) show that bank credit spreads outperform non-financial credit spreads in explaining economic activity, particularly in Italy and Spain.

We find similar patterns in the contributions of both shocks to the FEV of other variables in each economy, as shown in the online appendix A.2. However, there are some interesting differences. First, both supply shocks make similar contributions to the FEV of inflation in Germany and the Netherlands, whereas loan supply shock contributes more in France. The contribution of MBF supply shock to the FEV of the spread is higher in these three countries.

Figure 7 – Countries impulse responses to a negative 1% MBF supply shock



Notes: Impulse responses to an MBF supply shock that reduces (median) MBF growth by 1% on impact. The solid line is the median response and the shaded area represents the 16th and 84th bounds of responses. The responses of output and prices are the cumulated responses of GDP growth and inflation respectively.

In Italy and Spain, loan supply shocks explain a larger share of inflation and spread variations. Regarding interest rates, loan supply shocks explain a larger share of FEV in all countries.

4.2.3 Historical decomposition

We now discuss how much the two credit supply shocks explain the historical observations of output growth in these economies. Each row of Figure 8 presents the historical decomposition

Table 4 – Country results: FEV decomposition for output growth for one, four and eight quarters ahead

Country	Horizon	Loan supply shock	MBF supply shock	Other shocks
Germany	1	9.07%	14.12%	76.81%
	4	13.61%	15.73%	70.66%
	8	13.96%	15.74%	70.31%
France	1	14.01%	15.16%	70.83%
	4	13.26%	16.38%	70.36%
	8	14.02%	15.80%	70.18%
Italy	1	23.78%	19.66%	56.57%
	4	21.91%	17.95%	60.14%
	8	21.53%	17.19%	61.27%
Spain	1	20.95%	16.64%	62.41%
	4	24.41%	13.51%	62.08%
	8	22.08%	13.41%	64.50%
Netherlands	1	16.31%	16.66%	67.03%
	4	18.95%	17.49%	63.56%
	8	18.86%	17.08%	64.05%

Note: The table shows the FEV decomposition of output growth for loan supply shock, MBF supply shock, and other shocks for five EA countries.

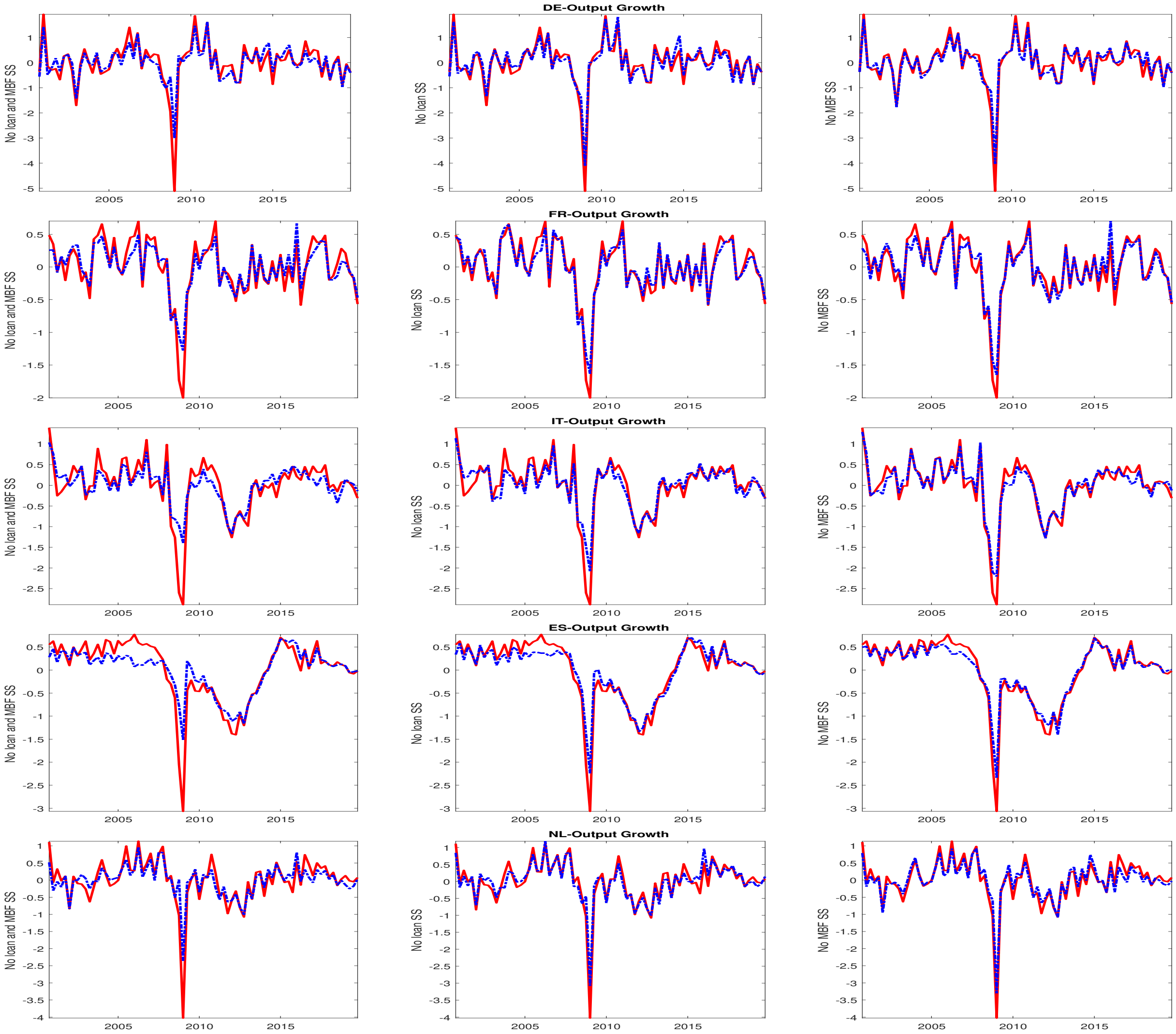
of output in each economy. In line with the EA baseline model, the historical decomposition highlights the significant impact of both credit supply shocks on GDP growth in all economies, particularly during the recession.

In all economies, these two shocks explain a large portion of output decline in the aftermath of the 2009 GFC. In Italy, Spain and the Netherlands, as in the baseline EA model, loan supply shocks account for a slightly larger portion of the GDP fall compared to MBF supply shocks. Specifically, in the fourth quarter of 2009, both credit supply shocks cause a decrease of about 1.5% in the quarter-on-quarter output growth of each of these three economies (equivalent to about 50% of total output contraction). In Italy, Spain and the Netherlands, loan supply shocks are responsible for drops in output of 0.81%, 0.82%, and 0.95% respectively, and the MBF supply shocks for 0.68%, 0.73%, and 0.72% of GDP contractions in each country respectively.

The picture is slightly different for Germany and France, where in 2009 both MBF supply shocks and loan supply shocks lead to a similar drop in output growth. In the fourth quarter of 2009, the two credit supply shocks account for 41% of total quarter-on-quarter GDP growth contraction in Germany (-2.12%) and for 36% in the output growth of France (-0.72%). Of the total impact of credit supply shocks on output contraction, MBF supply shock accounts for 52%

in Germany (-1.1%) and 49% in France (-0.35%).

Figure 8 – Country results: historical decomposition of output



Notes: Figure shows the data (red solid lines) and counterfactual changes (blue dashed lines) when (i) excluding both loan and MBF supply shocks ("Excluding Loan and MBF SS" in first column); (ii) excluding loan supply shocks ("Excluding Loan SS" in second column); and (iii) excluding MBF supply shocks ("Excluding MBF SS" in third column). Each row presents the historical decomposition for each country.

Interestingly, the historical decomposition of Spain's output (fourth row of Figure 8) captures the country's credit boom (positive credit supply shock) before the GFC in 2009, to which both loan and MBF supply shocks contribute. However, loan supply shock appears to contribute more than MBF sypply shock to this boom. This result is in line with Borio (2014).

4.3 Sensitivity analyses

In our baseline identification scheme, we identify two types of credit supply shocks of interests: loan supply shocks and MBF supply shocks. To assess the sensitivity of our identification, we consider several alternative identification schemes. First, we identify both credit supply shocks while controlling for monetary policy shocks. The latter are identified by sign restrictions, where a monetary policy shock raises interest rates and spreads, but reduces output growth and inflation, as documented in Christiano et al. (2010), Smets and Wouters (2007), and Bernanke et al. (1999). The identification strategy in this analysis is summarised in columns 2-4 of Table 5.

Table 5 – Sensitivity analyses: contemporaneous sign restrictions

	Loan sup. shock	MBF sup. shock	Mon. pol. shock	Agg. dem. shock	Agg. sup. shock
GDP growth	<= 0	<= 0	<= 0	<= 0	<= 0
Inflation	<= 0	<= 0	<= 0	<= 0	>= 0
Spread	>= 0	>= 0	<= 0		
1Y interest rate	<= 0	<= 0	>= 0	<= 0	
Loan growth	<= 0				
Debt securities growth		<= 0			
Other restrictions	response of loan volume growth. is largest (abs.)	response of MBF volume growth. is largest (abs.)			

Note: Signs imposed on the impulse response on impact of all variables for the case of a contractionary shock (i.e. a shock causing a decrease in output growth).

Second, we consider an identification strategy similar to that in Gambetti and Musso (2017) who identify $n-1$ shocks for a VAR system of n endogenous variables, and leave one of the reduced-form residual shock unidentified to act as a buffer and capture the effects of omitted variables and other shocks which are different from five identified shocks. This expansion is motivated by Paustian (2007) who argues that identifying other shocks helps identify the shocks of interest. Specifically, we identify five different shocks: an MBF supply shock, a loan supply shock, a monetary policy shock, an aggregate demand shock and an aggregate supply shock. The sign restrictions of three additional shocks are also only imposed on variables on impact and are summarised in Table 5. The monetary policy shock's restrictions are described above. An aggregate demand shock leads to the same sign responses of output growth, inflation and interest rate. These sign responses are the same as those of MBF and loan supply shocks. However, the inequality restrictions employed (i.e. the response of loans is the largest on impact (in absolute terms) for loan supply shock and the response of debt securities is the largest on impact for MBF supply shock) distinguish credit supply shocks and aggregate demand shocks. It is also worth noting that aggregate demand shocks include credit demand shocks, although jointly with other types of demand shock. However, we do not identify credit demand shocks because of the absence of a credible set of sign restrictions to separate credit demand shocks from other aggregate demand shocks. We assume that aggregate supply shocks lead to different signs in the responses of output and inflation, therefore allowing us to distinguish credit supply shocks and other shocks.

Our third sensitivity analysis follows Eickmeier and Ng (2015), who do not employ restrictions on the responses of inflation and policy interest rates. This approach comes from observations that with certain theoretical settings, policy rate and inflation responses to a credit supply shock may have different signs to those of output growth.[5] Therefore, with this sensitivity exercise, we remove the restrictions on inflation and interest rates from our baseline sign restrictions.

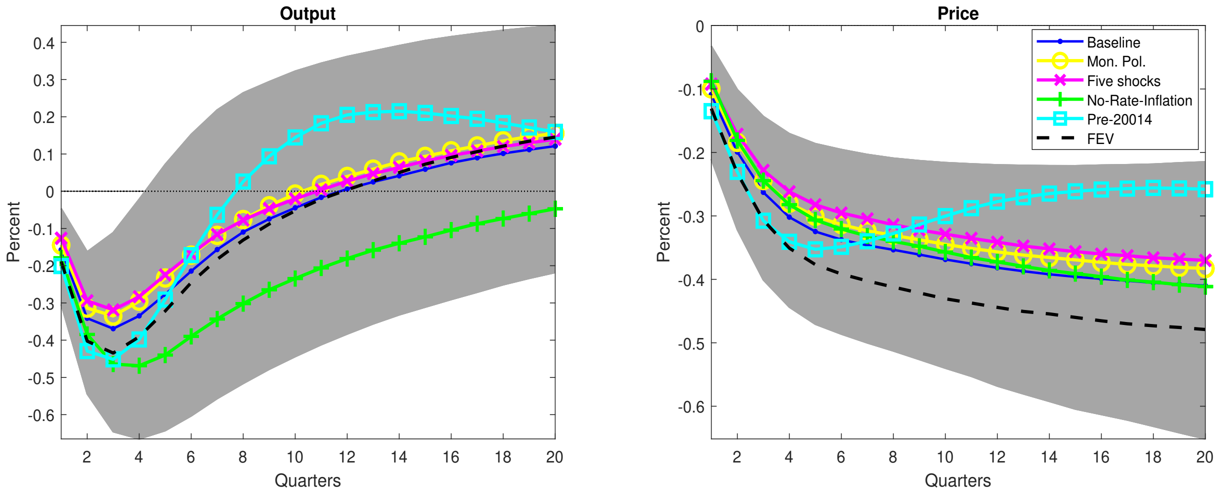
Next, we analyse whether our results are influenced by the introduction of unconventional monetary policy in the EA. In June 2014, the ECB introduced negative interest rates by lowering its deposit rate to -0.1% to stimulate the economy. The ECB also started large-scale asset purchase programmes in September 2014. As a sensitivity check, we exclude the post-second quarter of 2014 sample from the baseline and re-estimate our model.

Last but not least, we conduct a sensitivity analysis with an alternative inequality restriction scheme. As discussed in Section 3, instead of setting the inequality restrictions on impulse responses to distinguish the two credit supply shocks, we place them on the first-quarter FEV decomposition of loan and debt securities. Specifically, loan supply shock is assumed to explain more of the FEV of loan growth than MBF supply shock at the first-quarter horizon. Conversely, the first-quarter FEV of debt securities growth is explained more by MBF supply shock than loan supply shock. The evidence in Table 3 provides empirical support for this alternative approach to distinguishing the two supply shocks while retaining other standard sign restrictions on the

[5] For instance, Christiano et al. (2010) find that a credit supply shock, i.e. bank funding shock, raises output, but reduce inflation and policy rates, while Gerali et al. (2010) show that output, inflation and policy rates have similar signs in response to credit supply shocks.

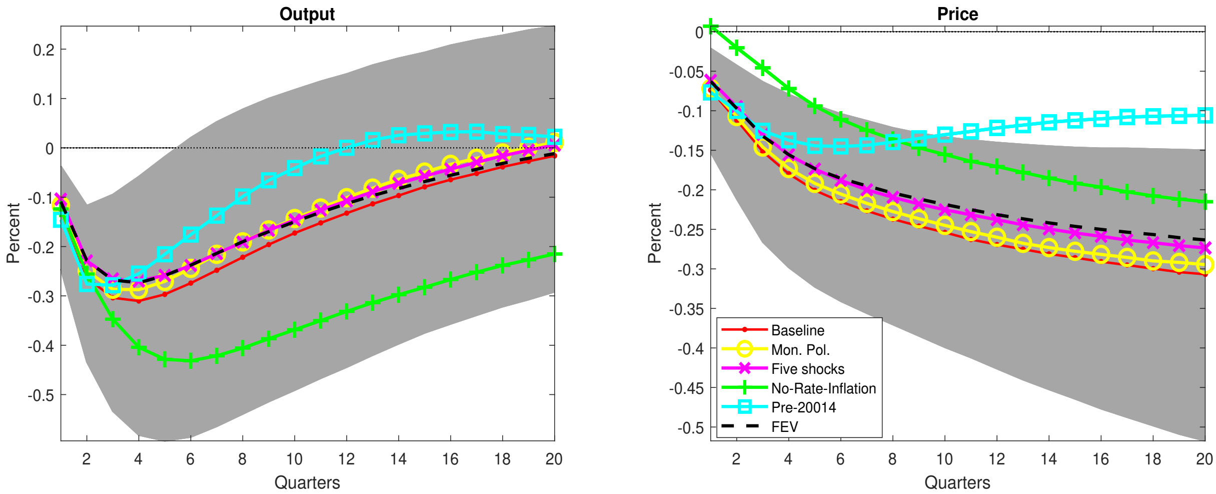
remaining variables.

Figure 9 – Sensitivity analyses: impulse responses to a negative 1% loan supply shock



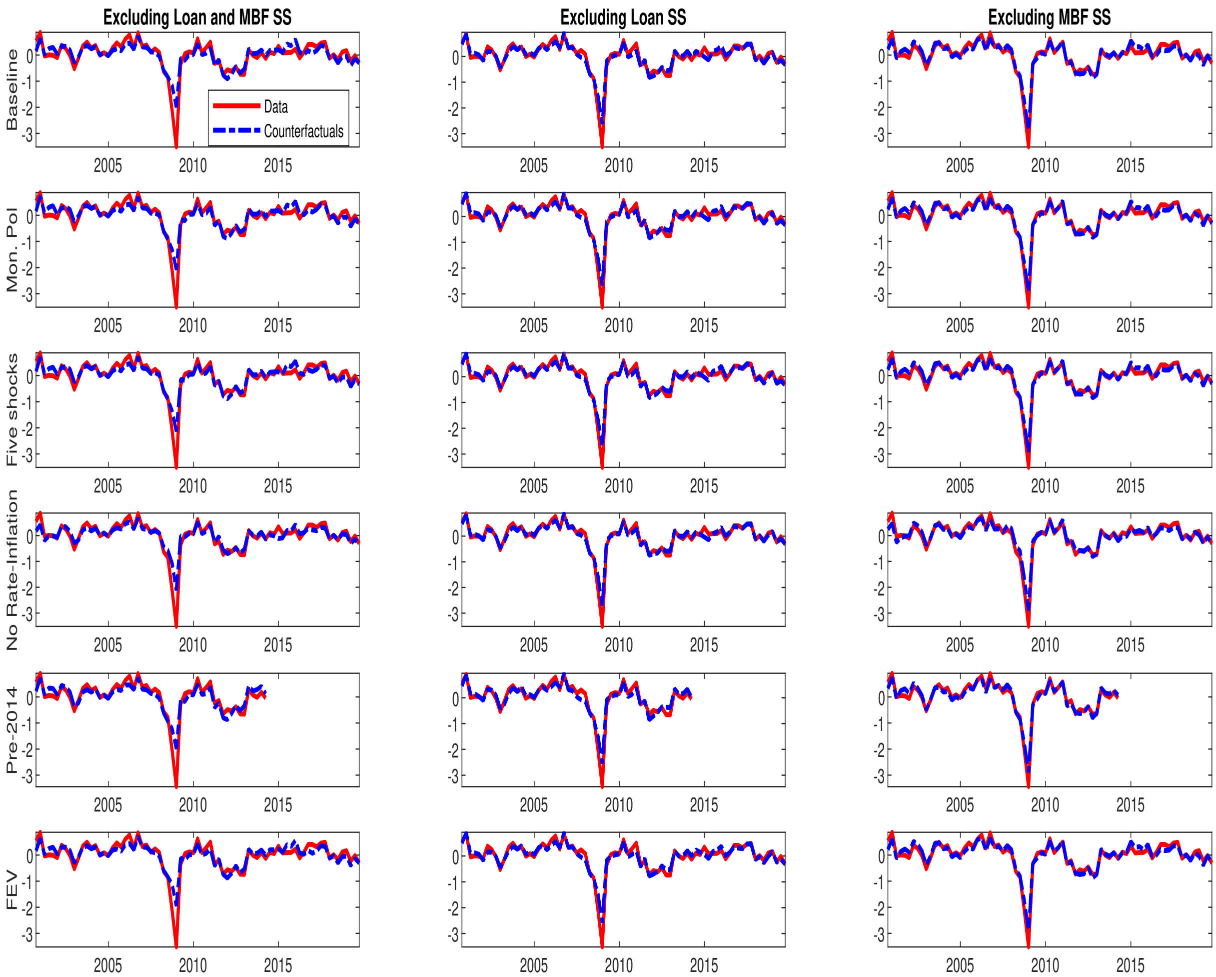
Notes: Impulse responses to a loan supply shock that reduces (median) loan growth by 1% on impact. The solid lines are the median responses and the shaded area represents the baseline 16th and 84th bounds of responses. "Mon. Pol" = controlling for monetary policy shocks; "Five shocks"= an identification with five shocks; "No Rate-Inflation" = no restrictions on interest rates and inflation; "Pre-2014"= excluding the post-second quarter of 2014 sample from the analysis; and "FEV" = using inequality restrictions on the variance.

Figure 10 – Sensitivity analyses: Impulse responses to a negative 1% MBF supply shock



Note: Impulse responses to a MBF supply shock that reduces (median) MBF growth by 1% on impact. The solid lines are the median responses and the shaded area represents the baseline 16th and 84th bounds of responses. "Mon. Pol" = controlling for monetary policy shocks; "Five shocks"= an identification with five shocks; "No Rate-Inflation" = no restrictions on interest rates and inflation; "Pre-2014"= excluding the post-second quarter of 2014 sample from the analysis; and "FEV" = using inequality restrictions on the variance.

Figure 11 – Sensitivity analyses: historical decomposition of output growth



Notes: Figure shows the data (red solid lines) and counterfactual changes (blue dashed lines) when (i) excluding both loan and MBF supply shocks ("Excluding Loan and MBF SS" in first column); (ii) excluding loan supply shocks ("Excluding Loan SS" in second column); and (iii) excluding MBF supply shocks ("Excluding MBF SS" in third column). The first row shows the baseline decomposition, and the other rows show the decompositions of alternative sensitivity analyses: "Mon. Pol" = controlling for monetary policy shocks; "Five shocks"= an identification with five shocks; "No Rate-Inflation" = no restrictions on interest rates and inflation; "Pre-2014"= excluding the post-second quarter of 2014 sample from the analysis; and "FEV" = using inequality restrictions on the variance.

Figure 9 shows the impulse responses of output and price to a loan supply shock.[6]Controlling for monetary policy shocks and adopting five-shock identification lead to similar responses. Removing restrictions on inflation and interest rates leads to a larger fall in output (about -0.5% after a year). The impact is also more persistent than the baseline. Nevertheless, even

[6]The impulse responses of all variables to both credit supply shocks, together with the historical decompositions of all variables for each of four alternative identification schemes separately, can be found in online Appendix A.3.

without a restriction on price, its response is in line with the baseline, indicating a decrease of price in response to a contractionary loan supply shock. The alternative inequality restrictions on FEV lead to slightly larger responses of output and price. Regarding the pre-unconventional monetary policy sample, the results show a larger fall in output (about -0.5% after 1.5 years). In addition, the impact on output and price is less persistent. Despite these differences, we find that all these point estimates stay in the baseline 16th-84th bounds, therefore corroborating our findings. We also find that the responses to an MBF supply shock are robust in alternative sensitivity analyses (see Figure 10). In most cases, the point estimates stay in the baseline 16th-84th bounds.

Table 6 – Sensitivity analyses: FEV decomposition of EA output growth and inflation for one, four and eight quarters ahead

Model	Horizon	FEV for EA output growth		FEV for EA inflation	
		loan sup. shocks	MBF sup. shocks	loan sup. shocks	MBF sup. shocks
Baseline	1	18.29%	17.37%	18.50%	14.11%
	4	18.30%	16.77%	22.63%	15.00%
	8	19.08%	16.27%	22.12%	15.22%
Control for monetary policy shocks	1	17.16%	16.12%	17.02%	13.67%
	4	16.95%	15.52%	20.71%	14.16%
	8	17.95%	15.23%	20.31%	14.42%
Five-shock identification	1	15.26%	15.32%	16.12%	12.43%
	4	16.03%	15.24%	19.66%	13.18%
	8	16.89%	14.88%	19.32%	13.53%
No restrictions on interest rate and inflation	1	17.71%	17.38%	18.49%	15.18%
	4	18.73%	19.74%	21.28%	15.17%
	8	18.95%	19.16%	20.92%	15.65%
Pre-unconventional monetary policy	1	18.13%	16.88%	21.12%	13.75%
	4	18.17%	14.57%	24.43%	13.05%
	8	19.85%	14.02%	23.59%	12.86%
Inequality restrictions on FEV	1	19.87%	17.15%	20.21%	13.27%
	4	19.52%	16.72%	24.07%	14.38%
	8	20.38%	16.21%	23.51%	14.64%

Note: Table shows the FEV decomposition of EA output growth and inflation for one, four and eight quarters ahead.

The historical decomposition shown in Figure 11 also indicates similarity in the roles of loan and MBF supply shocks in the dynamics of output growth, particularly their crucial role during the financial crisis. Variance decomposition analysis in Table 6 also corroborates our baseline findings that both credit supply shocks are important, explaining more than 30% of the FEV of EA output growth and inflation across all horizons. Regarding output growth, in most cases, loan supply shocks have a larger explanatory power than MBF supply shocks by 2 to 5 percentage points at the two-year horizon. Without restrictions on interest rate and inflation, MBF supply shocks contribute slightly more at the one- and two-year horizons by 1 percentage point and 0.2 percentage point respectively. Conversely, we find that loan supply shocks dominate MBF supply shocks in explaining the FEV of EA inflation in all cases; specifically, at the two-year horizon, the differences range from 5 percentage points to 10 percentage points.

4.4 EA bank versus non-bank supply shocks

So far our analysis has focused on the distinction between loans and debt securities that are activity-based. It is well known that loans are mostly granted by banks while non-bank financial sectors hold the larger portion of debt securities (Cera et al., 2021). Our dataset also allows us to identify the source of funding based on entity: the share of non-bank financial sector compared with the banking sector. We therefore extend our analysis to investigate the importance of bank financing versus non-bank financing. Since the separation of banks and non-banks is available only within the EA, we perform this robustness check by focusing only on financing from EA banks and non-banks. EA banks supply about 72% of EA-based total loans and EA non-bank financial intermediaries supply 90% of EA-based total MBF. This exercise investigates bank versus non-bank credit supply shocks instead of loan versus MBF supply shocks.

As shown in online Appendix A.4, the impulse responses to a bank credit supply shock are similar to those in a loan supply shock, although the decline in output is slightly larger in the former than the latter (-0.5% versus -0.4% one year after the shock). A similar feature is also seen in the case of a non-bank credit supply shock (-0.4% for a non-bank shock versus -0.3% for an MBF shock one year after the shock). Table 7 shows that both bank and non-bank supply shocks are important, explaining more than 30% of the FEV of EA output growth and inflation across all considered horizons: first quarter, one year and two years. We also find that bank supply shocks have more explanatory power for output growth and inflation variations than non-bank supply shocks. The differences in their contributions are similar to those between loan and MBF supply shocks, as documented in the baseline estimates. These similarities further corroborate the robustness of our findings.

Table 7 – Sensitivity analysis: FEV decomposition of EA output growth and inflation for one, four and eight quarters ahead

Model	Horizon	FEV for EA output growth		FEV for EA inflation	
		Loan sup. shocks	MBF sup. shocks	Loan sup. shocks	MBF sup. shocks
Baseline	1	18.29%	17.37%	18.50%	14.11%
	4	18.30%	16.77%	22.63%	15.00%
	8	19.08%	16.27%	22.12%	15.22%
		Bank sup. shocks	Non-bank sup. shocks	Bank sup. shocks	Non-bank sup. shocks
Banks vs non-banks	1	18.73%	16.99%	19.31%	16.33%
	4	18.56%	16.67%	24.18%	16.07%
	8	19.93%	16.13%	23.67%	16.19%

Note: The table shows the FEV decomposition of EA output growth and inflation for one, four and eight quarters ahead.

4.5 2020 episode

In previous analyses, we excluded the 2020 sample to avoid the potential influence of the extraordinary COVID-19 event on evaluating the average impact of the two credit supply shocks over the sample. In this section we extend our analysis to investigate the role played by loan and MBF supply shocks in the context of COVID-19 crisis in the EA. Specifically, we expand the sample to include both the first and second quarters of 2020 and we deal with the substantially large shocks by incorporating a stochastic volatility framework into our Bayesian VAR model, similarly to Carriero et al. (2021) and Lenza and Primiceri (2020).

Methodology with stochastic volatility

We modify the relation between reduced-form residuals and structural shocks as follows:

$$\boldsymbol{u}_t = \boldsymbol{\Omega}_t^{1/2}\boldsymbol{e}_t,\ \boldsymbol{e}_t \sim N(\boldsymbol{0},\ \boldsymbol{I}), \tag{3}$$

where

$$\boldsymbol{\Omega}_t = A_0^{-1}\boldsymbol{H}_t A_0^{-1\prime}, \tag{4}$$

where H_t is the diagonal matrix of time-varying standard deviation following a random walk in a log specification and A_0 is as described in (1). Furthermore, for shocks identification, we use the same contemporaneous sign restrictions and inequality restrictions as in the baseline model, as summarised in Table 2.

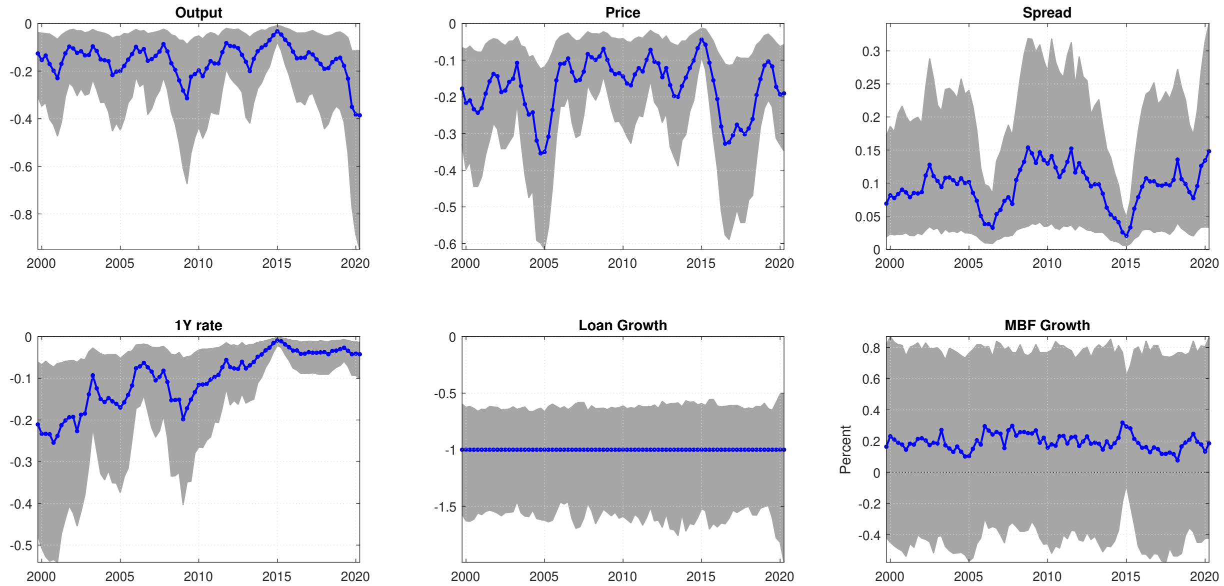
Results

Figures 12 and 13 show the impulse responses on impact of the EA variables to loan supply and MBF supply shocks.[7] The response of output to a loan supply shock is close to -0.2%, which is in line with the baseline estimate, therefore corroborating our findings. However, the same negative loan supply shock would lead to a larger fall in output during the crises, at about -0.3% in 2009 and -0.4% in 2020. The average response of output to an MBF supply shock is about -0.1%, which is similar to the baseline response. However, the impact of this shock is magnified during the crises, to more than -0.2% in 2009 and -0.3% in 2020. The response of price remains relatively stable with an MBF supply shock, but varies significantly with a loan supply shock. The larger response of output in the crises under both credit supply shocks is associated with larger increases in spreads during the crises. This is in line with Gertler and Karadi (2015) who show the amplifying role of credit spreads in the responses of economic activity to shocks (i.e., monetary policy surprises in their paper). Interestingly, we show that the response of interest rate has weakened since 2015, reflecting the period associated with the effective lower bounds in the EA.

While the impulse responses analyses are helpful in showing the impacts of these shocks, they do not reflect the role played by the shocks at every given point in time. For example, did credit supply shocks contribute to the 2020 recession? Nevertheless, it is interesting to quantify how much these structural shocks explain the historical decline observed in output in 2020. We address this question with a historical decomposition analysis. To enhance visualisation, we present historical decomposition of output growth in Figures 14 and 15, which end at the first quarter of 2020 and the second quarter of 2020, respectively. In line with the baseline model, the model with stochastic volatility further highlights the crucial roles played by both credit supply shocks in GDP growth, particularly during the recessions. In the GFC in 2009, loan supply shocks accounted for a slightly larger portion of the decrease in GDP compared with the MBF supply shock, which confirms the baseline results. Nevertheless, when allowing for the stochastic volatility, both credit supply shocks are found to cause a larger contraction in EA output growth (Figure 14, reflecting the larger impacts of these two shocks during the crises as shown in the impulse responses in Figures 12 and 13. Given the limited sample for a stochastic

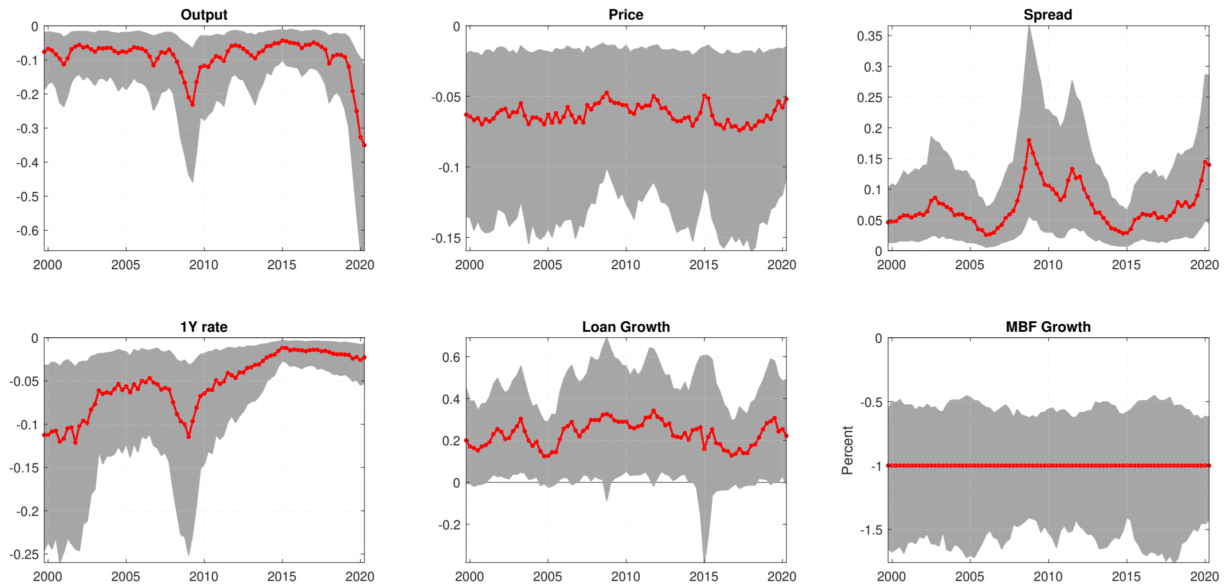
[7] See online appendix A.5 regarding impulse responses for four periods ahead.

Figure 12 – Impulse responses to a negative 1% loan supply shock: period 1



Notes: Impulse responses to a loan supply shock that reduces (median) loan growth by 1% on impact. The solid line is the median response and the shaded area represents the 16th and 84th bounds of responses.

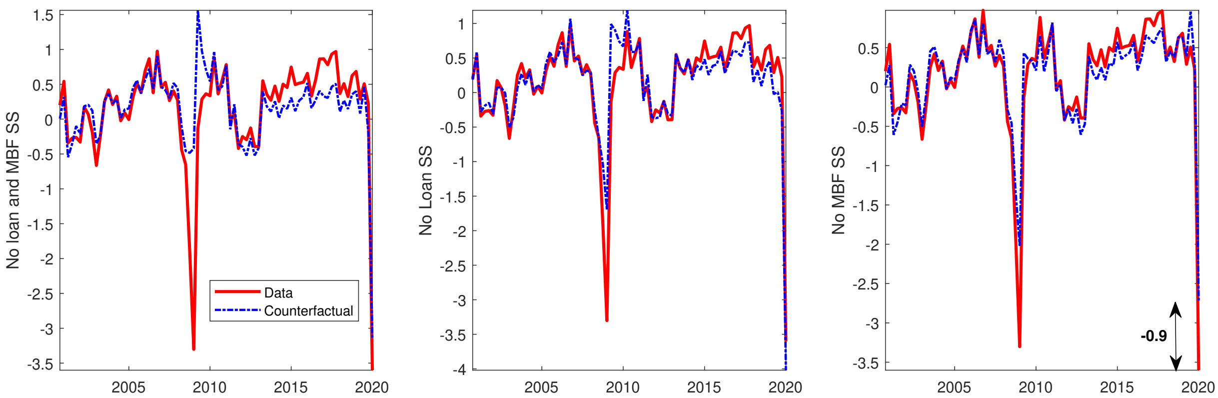
Figure 13 – Impulse responses to a negative 1% MBF supply shock: period 1



Notes: Impulse responses to a MBF supply shock that reduces (median) MBF growth by 1% on impact. The solid line is the median response and the shaded area represents the 16th and 84th bounds of responses.

volatility framework, these results should be interpreted with caution. However, the findings further reinforce the baseline results regarding the large impact of these credit supply shocks on business cycles.

Figure 14 – Historical decomposition of output growth: Q1 2020



Notes: Figure shows the historical decompositions of EA GDP growth (red line) from the fourth quarter of 2000 until to the first quarter of 2020. The impact of credit supply shocks to EA GDP growth is represented by the blue line. In panel a), the blue line represents EA output growth changes in the absence of both loan supply and MBF supply shocks. In panel b), the blue line simulates EA GDP growth excluding loan supply shocks only. In panel c), the blue line represents EA GDP growth excluding MBF credit supply shocks only.

By contrast, it is interesting to note that the impact on GDP of both credit supply shocks was less pronounced during the pandemic-induced recession in early 2020. The MBF supply shock appears to have had an adverse impact on GDP (explaining a quarter of the decrease in GDP), but this is not the case for the loan supply shock. These results likely reflect the greater impact of the March 2020 market turmoil on non-bank financial intermediaries than on banks. Specifically, the banking system did not cut funding to the real economy and continued to provide credit lines, thus helping to mitigate the contraction in GDP, whereas bonds issuance almost froze. Furthermore, in the second quarter of 2020 when the markets stabilised after significant interventions by monetary and fiscal authorities, MBF supply and loan supply shocks had a negligible impact on the decrease in GDP as bank and non-bank credit started to finance the real economy again (Figure 15). This large contraction of GDP in the second quarter of 2020 can instead be explained by other shocks, mainly supply shocks owning to lock-down measures and weak-demand due to increasing uncertainty and income losses.

Figure 15 – Historical decomposition of output growth: 2020Q2

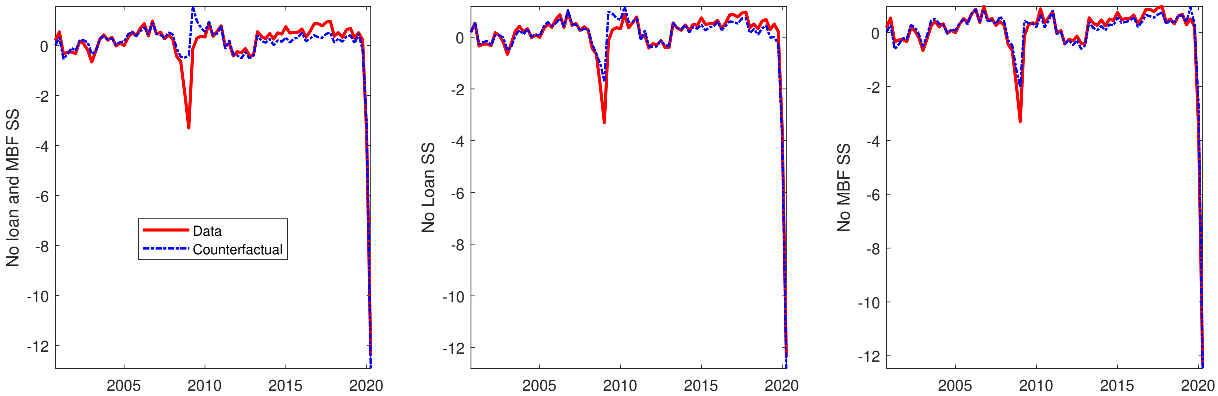


Figure shows the historical decompositions of EA GDP growth (red line) from the fourth quarter of 2000 until to the second quarter of 2020. The impact of credit supply shocks to EA GDP growth is represented by the blue line. In panel a), the blue line represents EA output growth changes in the absence of both loan supply and MBF supply shocks. In panel b), the blue line simulates EA GDP growth excluding loan supply shocks only. In panel c), the blue line represents EA GDP growth excluding MBF credit supply shocks only.

5 Concluding remarks

The key finding of this paper is that MBF supply shocks play an important role in explaining GDP growth in the euro area, while their explanatory power comparable to that of loans. Despite some differences, MBF supply shocks are found to be significant in explaining GDP growth in all five largest EA countries. In Germany and France, where corporate debt markets are relatively well developed, the explanatory power of MBF supply shocks is estimated to exceed that of loan supply shocks. GDP growth in these two countries is also found to be affected by MBF supply shocks in a more persistent and stronger way compared with the other three large EA economies (Italy, Spain and the Netherlands), with Italy and Spain in particular continuing to rely heavily on bank-based financial systems.

In addition, the historical decomposition highlights the particularly strong impact that credit supply shocks can have on GDP growth during recessions. But there are differences across the crises. In the aftermath of the GFC in 2009, both credit supply shocks had a major adverse impact on GDP, with loan supply shocks making a slightly larger contribution than MBF supply shocks. By contrast, during the 2020 pandemic-induced recession, we found that only the MBF supply shock had an adverse impact on GDP growth: around a quarter of the contraction in EA GDP can be attributed to the negative MBF supply shock.

Overall, our findings underline the importance of MBF for GDP growth in the euro area in general and its adverse effects during crisis periods in particular. Since MBF is mostly provided by non-bank financial intermediaries, the findings suggest that their resilience is also important for GDP growth and crucial to ensuring a steady flow of finance to NFCs in both down and up-markets. Enhancing the macroprudential framework for non-banks could thus be instrumental in enhancing the resilience of MBF, which in turn would support GDP growth.

The COVID-19 market turmoil is emblematic in this respect. In March 2020 non-banks shed assets on a large scale and MBF dried up, while NFCs continued to benefit from loans and credit lines provided by banks. A number of factors supported the flow of bank credit to NFCs during the turmoil, including government guarantees and moratoria on loans, and central bank provision of liquidity to banks. Nevertheless, the regulatory reforms of the banking system after the GFC, including macroprudential measures, also made banks more resilient to shocks. From this perspective, our results call for more regulatory attention to be paid to the non-bank part of the financial system going forward.

There are several important avenues for future research. In particular, the analysis could be extended to investigate whether the two credit supply shocks affect sectors in the economy differently. Moreover, the sector impact of these credit supply shocks could be split into direct and indirect effects, in which the latter would be associated with intersectoral production networks. In addition, given the inter-linkages between economies in the EA and the common monetary policy, it would be interesting to study the spillovers from credit supply shocks originating in one country to other EA countries.

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The impact of credit supply shocks in the euro area: market-based financing versus loans

Kristina Barauskaite, Anh Nguyen, Linda Rousová and Lorenzo Cappiello

Online appendices

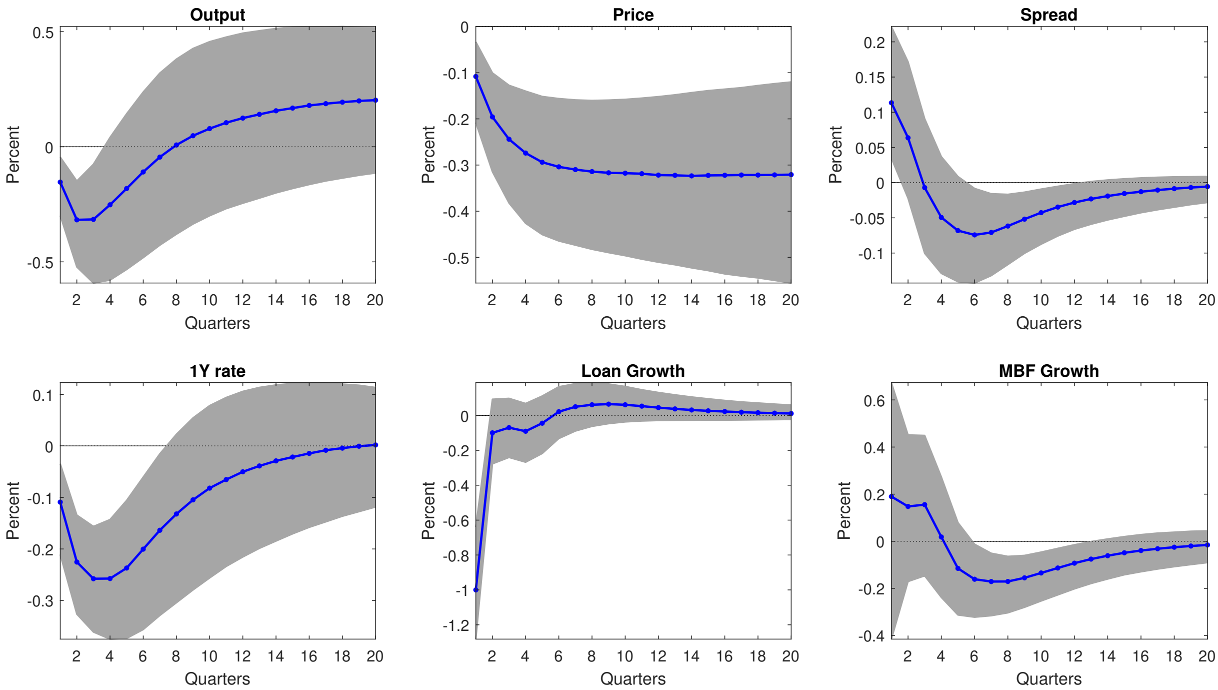
List of appendices

A Online appendix: results

A.1 Lag specifications and orthogonality condition

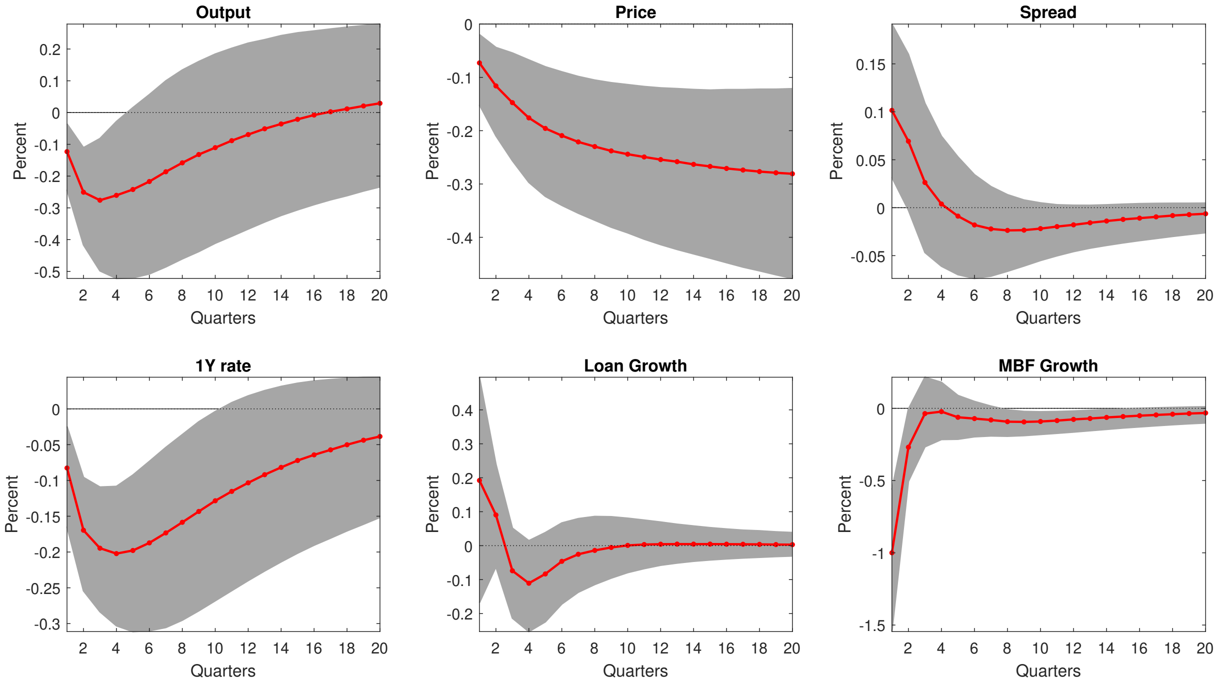
A.1.1 Different lag specification: three lags

Figure A1 – Impulse responses to a negative 1% loan supply shock: three lags



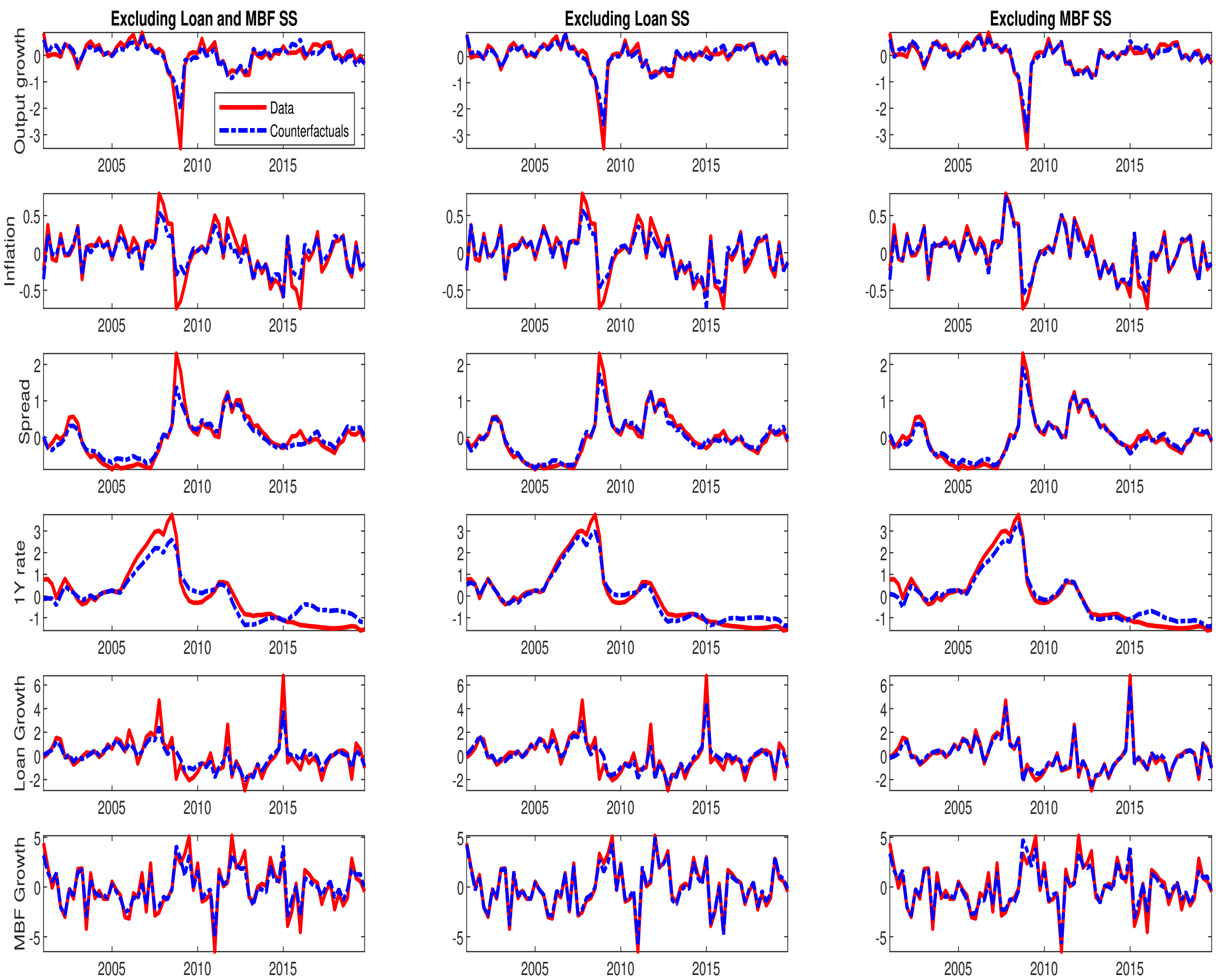
Note: Impulse responses to a loan supply shock that reduces (median) loan volume growth by 1% on impact. The solid line is the median response and the shaded area represents the 16th and 84th bounds of responses.

Figure A2 – Impulse responses to a negative 1% MBF supply shock: three lags



Note: Impulse responses to a MBF supply shock that reduces (median) MBF volume growth by 1% on impact. The solid line is the median response and the shaded area represents the 16th and 84th bounds of responses.

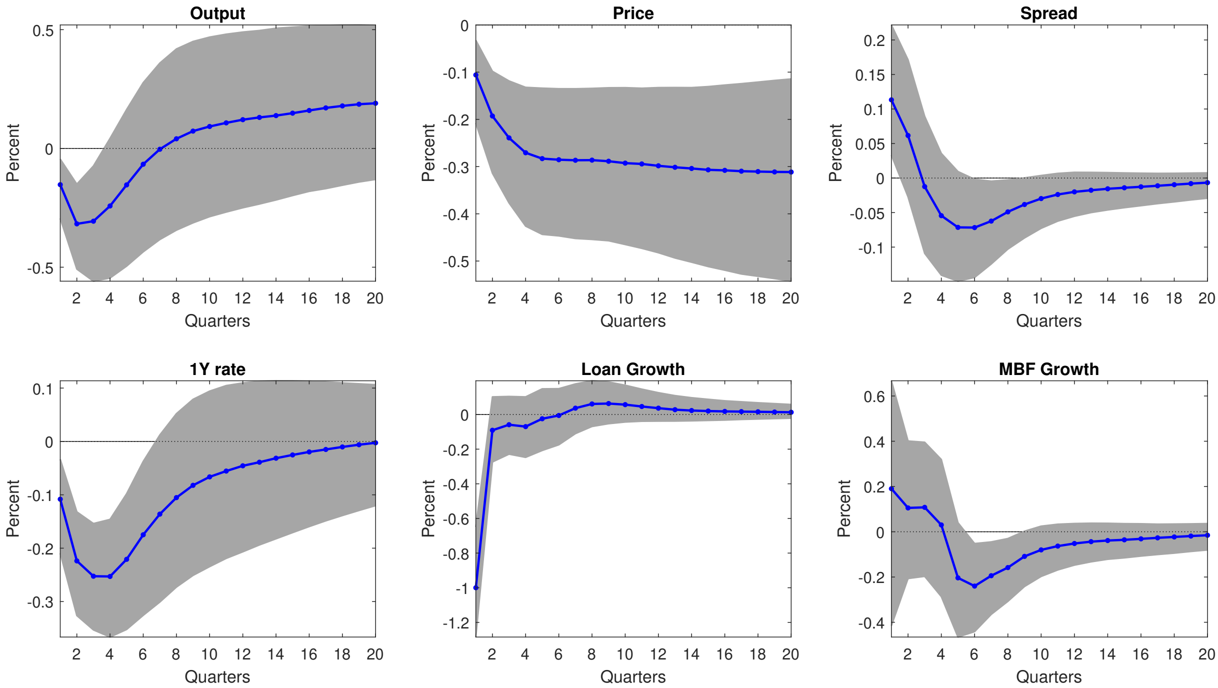
Figure A3 – Historical decomposition: three lags



Notes: Figure shows the data (red solid lines) and counterfactual changes (blue dashed lines) when(i) excluding both loan and MBF supply shocks ("Excluding loan and MBF SS" in first column); (ii) excluding loan supply shocks ("Excluding loan SS" in second column); and (iii) excluding MBF supply shocks ("Excluding MBF SS" in third column).

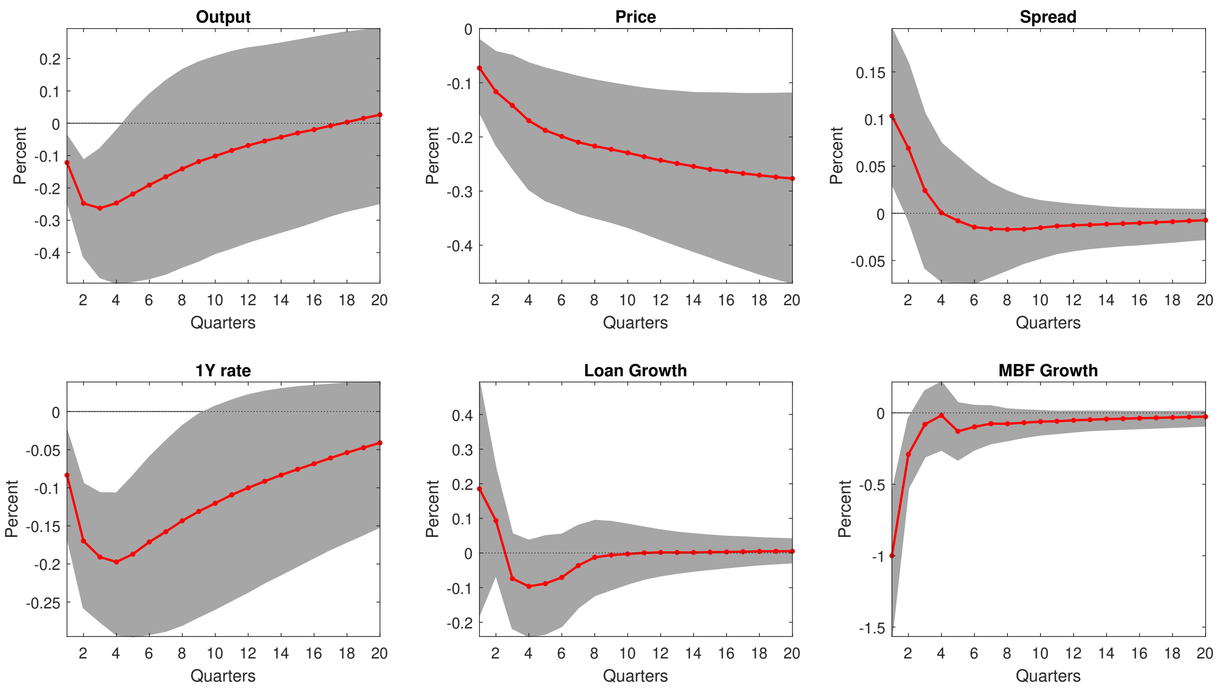
A.1.2 Different lag specification: four lags

Figure A4 – Impulse responses to a negative 1% loan supply shock: 4 lags



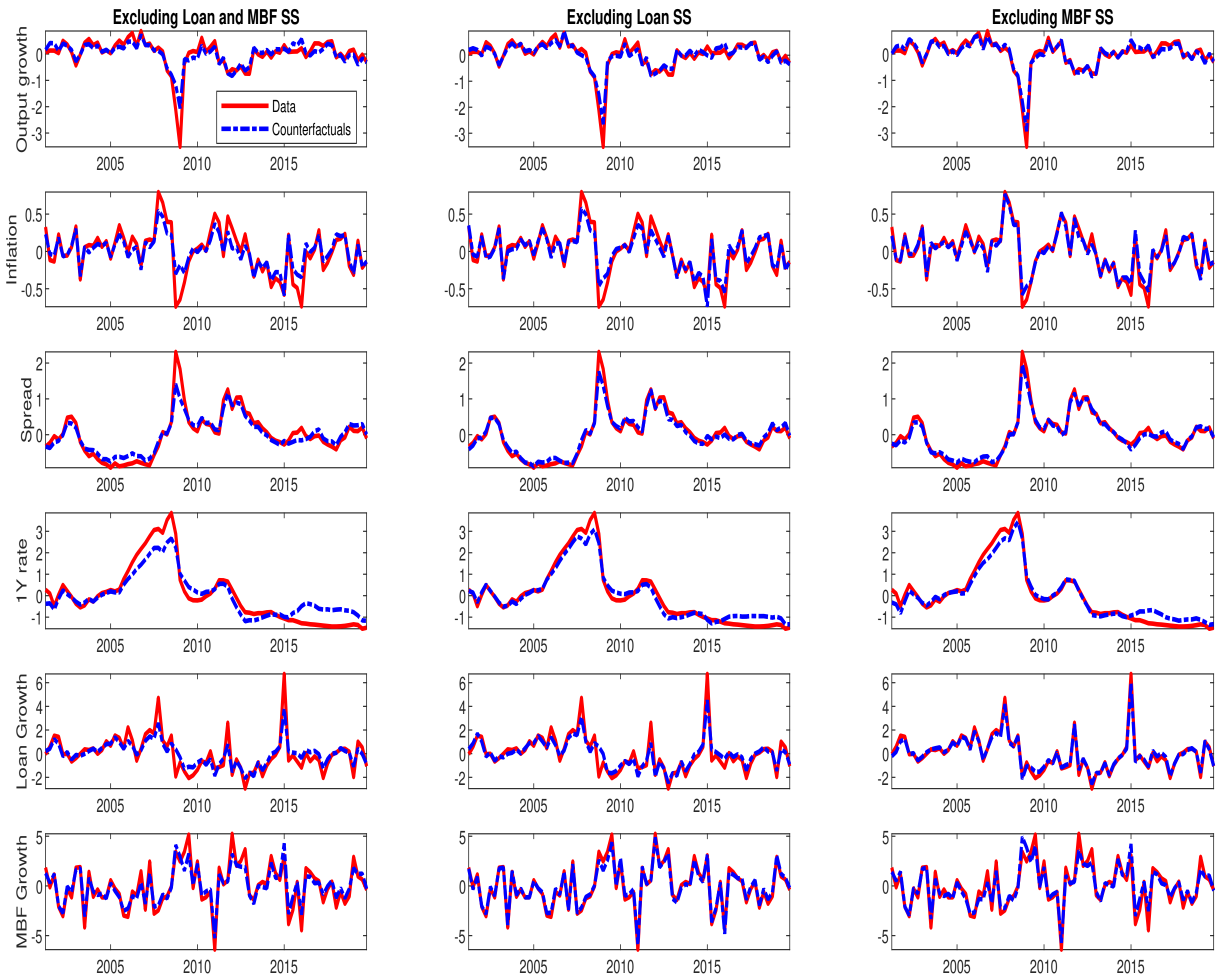
Note: Impulse responses to a loan supply shock that reduces (median) loan volume growth by 1% on impact. The solid line is the median response and the shaded area represents the 16th and 84th bounds of responses.

Figure A5 – Impulse responses to a negative 1% MBF supply shock: four lags



Note: Impulse responses to a MBF supply shock that reduces (median) MBF volume growth by 1% on impact. The solid line is the median response and the shaded area represents the 16th and 84th bounds of responses.

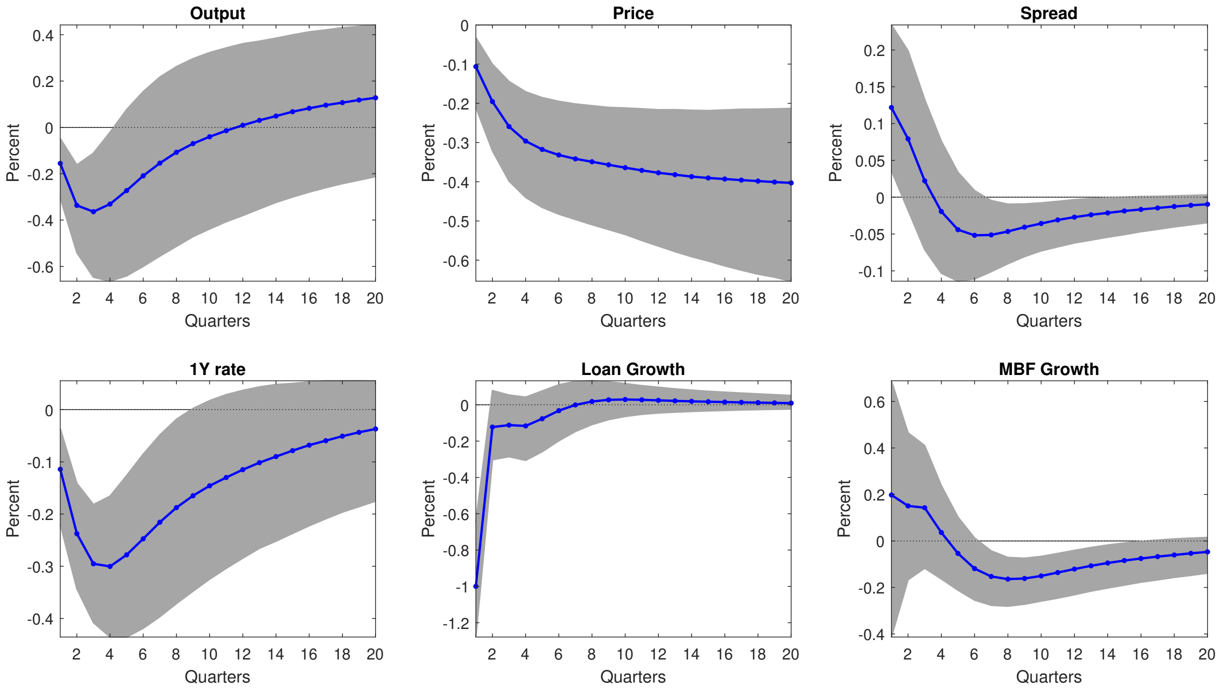
Figure A6 – Historical decomposition: four lags



Notes: Figure shows the data (red solid lines) and counterfactual changes (blue dashed lines) when(i) excluding both loan and MBF supply shocks ("Excluding loan and MBF SS" in first column); (ii) excluding loan supply shocks ("Excluding loan SS" in second column); and (iii) excluding MBF supply shocks ("Excluding MBF SS" in third column).

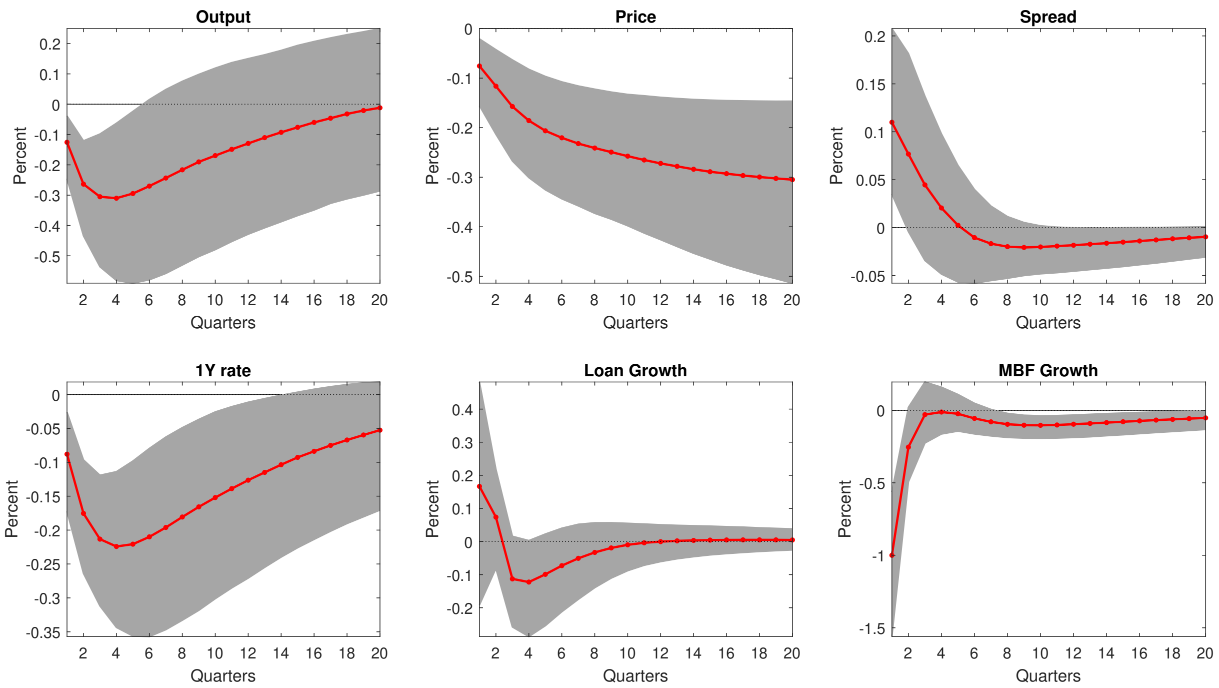
A.1.3 Imposing orthogonality

Figure A7 – Impulse responses to a negative 1% loan supply shock: imposing orthogonality



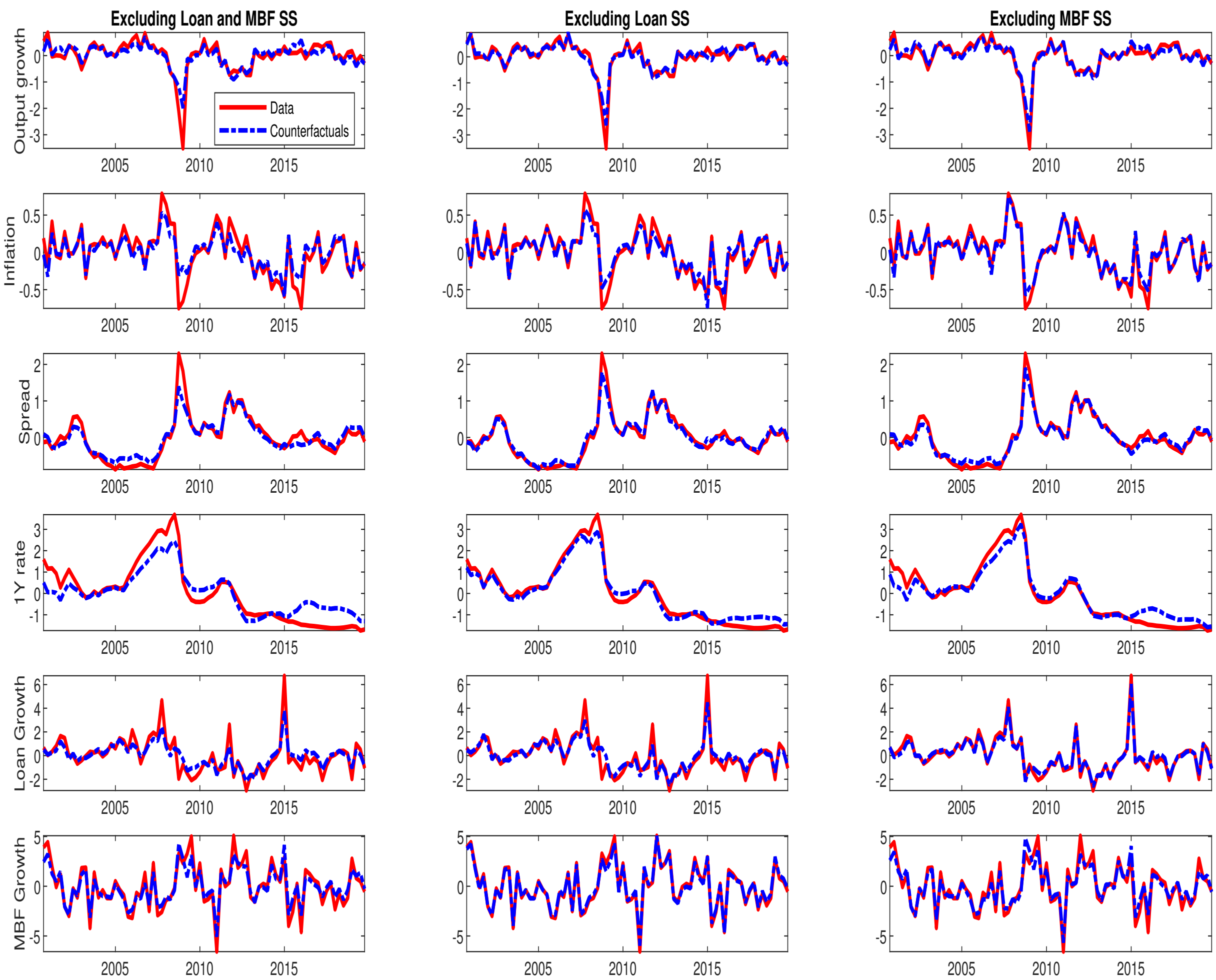
Note: Impulse responses to a loan supply shock that reduces (median) loan volume growth by 1% on impact. The solid line is the median response and the shaded area represents the 16th and 84th bounds of responses.

Figure A8 – Impulse responses to a negative 1% MBF supply shock: imposing orthogonality



Note: Impulse responses to a MBF supply shock that reduces (median) MBF volume growth by 1% on impact. The solid line is the median response and the shaded area represents the 16th and 84th bounds of responses.

Figure A9 – Historical decomposition: imposing orthogonality



Notes: Figure shows the data (red solid lines) and counterfactual changes (blue dashed lines) when(i) excluding both loan and MBF supply shocks ("Excluding loan and MBF SS" in first column); (ii) excluding loan supply shocks ("Excluding loan SS" in second column); and (iii) excluding MBF supply shocks ("Excluding MBF SS" in third column).

A.2 Country perspectives: FEV

Table A1 – FEV decomposition for Germany for one, four and eight quarters ahead

		Germany		
Variable	Horizon	Loan supply shock	MBF supply shock	Other shocks
Output growth	1	9.07%	14.12%	76.81%
	4	13.61%	15.73%	70.66%
	8	13.96%	15.74%	70.31%
Inflation	1	13.35%	13.46%	73.19%
	4	14.31%	14.14%	71.55%
	8	14.30%	14.14%	71.57%
Spread	1	16.35%	19.42%	64.22%
	4	12.80%	16.81%	70.39%
	8	13.85%	15.93%	70.23%
1Y interest rate	1	19.11%	14.42%	66.47%
	4	18.02%	15.79%	66.18%
	8	16.03%	15.42%	68.55%
Loan volume growth	1	36.87%	19.28%	43.85%
	4	36.41%	17.95%	45.64%
	8	35.48%	17.76%	46.77%
Debt securities volume growth	1	0.45%	14.27%	85.28%
	4	2.42%	14.02%	83.56%
	8	2.65%	14.03%	83.33%

Note: Table shows the FEV decomposition of variables for loan supply shock, MBF supply shock, and other shocks for Germany for one, four and eight quarters ahead.

Table A2 – FEV decomposition for France for one, four and eight quarters ahead

France				
Variable	Horizon	Loan supply shock	MBF supply shock	Other shocks
Output growth	1	14.01%	15.16%	70.83%
	4	13.26%	16.38%	70.36%
	8	14.02%	15.80%	70.18%
Inflation	1	17.96%	13.10%	68.94%
	4	17.89%	13.93%	68.18%
	8	17.55%	13.97%	68.48%
Spread	1	20.09%	20.50%	59.41%
	4	14.71%	17.79%	67.50%
	8	15.13%	16.48%	68.39%
1Y interest rate	1	23.32%	16.66%	60.02%
	4	21.69%	18.57%	59.73%
	8	17.07%	18.34%	64.59%
Loan volume growth	1	50.15%	8.27%	41.58%
	4	42.77%	10.99%	46.24%
	8	35.45%	12.02%	52.53%
Debt securities volume growth	1	1.64%	15.40%	82.96%
	4	3.47%	15.29%	81.24%
	8	4.37%	15.05%	80.58%

Note: Table shows the FEV decomposition of variables for loan supply shock, MBF supply shock, and other shocks for France for one, four and eight quarters ahead.

Table A3 – FEV decomposition for Italy for one, four and eight quarters ahead

		Italy		
Variable	Horizon	Loan supply shock	MBF supply shock	Other shocks
Output growth	1	23.78%	19.66%	56.57%
	4	21.91%	17.95%	60.14%
	8	21.53%	17.19%	61.27%
Inflation	1	19.64%	19.65%	60.71%
	4	25.76%	17.95%	56.29%
	8	27.26%	17.86%	54.88%
Spread	1	13.08%	12.24%	74.68%
	4	12.52%	9.12%	78.36%
	8	12.03%	9.17%	78.80%
1Y interest rate	1	12.81%	12.14%	75.05%
	4	29.97%	18.39%	51.64%
	8	35.54%	18.35%	46.11%
Loan volume growth	1	52.34%	8.95%	38.71%
	4	46.72%	10.43%	42.85%
	8	41.41%	11.31%	47.28%
Debt securities	1	0.47%	31.95%	67.58%
	4	2.80%	29.18%	68.02%
	8	3.49%	28.64%	67.87%

Note: Table shows the FEV decomposition of variables for loan supply shock, MBF supply shock, and other shocks for Italy for one, four and eight quarters ahead.

Table A4 – FEV decomposition for Spain for one, four and eight quarters ahead

Spain				
Variable	Horizon	Loan supply shock	MBF supply shock	Other shocks
Output growth	1	20.95%	16.64%	62.41%
	4	24.41%	13.51%	62.08%
	8	22.08%	13.41%	64.50%
Inflation	1	16.93%	16.40%	66.67%
	4	21.51%	15.57%	62.93%
	8	23.83%	15.01%	61.16%
Spread	1	11.40%	13.40%	75.20%
	4	13.12%	10.31%	76.56%
	8	12.66%	10.35%	76.98%
1Y interest rate	1	12.41%	13.05%	74.54%
	4	21.68%	15.59%	62.73%
	8	31.37%	15.64%	52.98%
Loan volume growth	1	47.01%	13.04%	39.95%
	4	48.73%	10.27%	40.99%
	8	47.04%	9.52%	43.44%
Debt securities volume growth	1	0.43%	18.18%	81.38%
	4	2.39%	17.95%	79.66%
	8	2.95%	17.73%	79.32%

Note: Table shows the FEV decomposition of variables for loan supply shock, MBF supply shock, and other shocks for Spain for one, four and eight quarters ahead.

Table A5 – FEV decomposition for Netherlands for one, four and eight quarters ahead

Netherlands

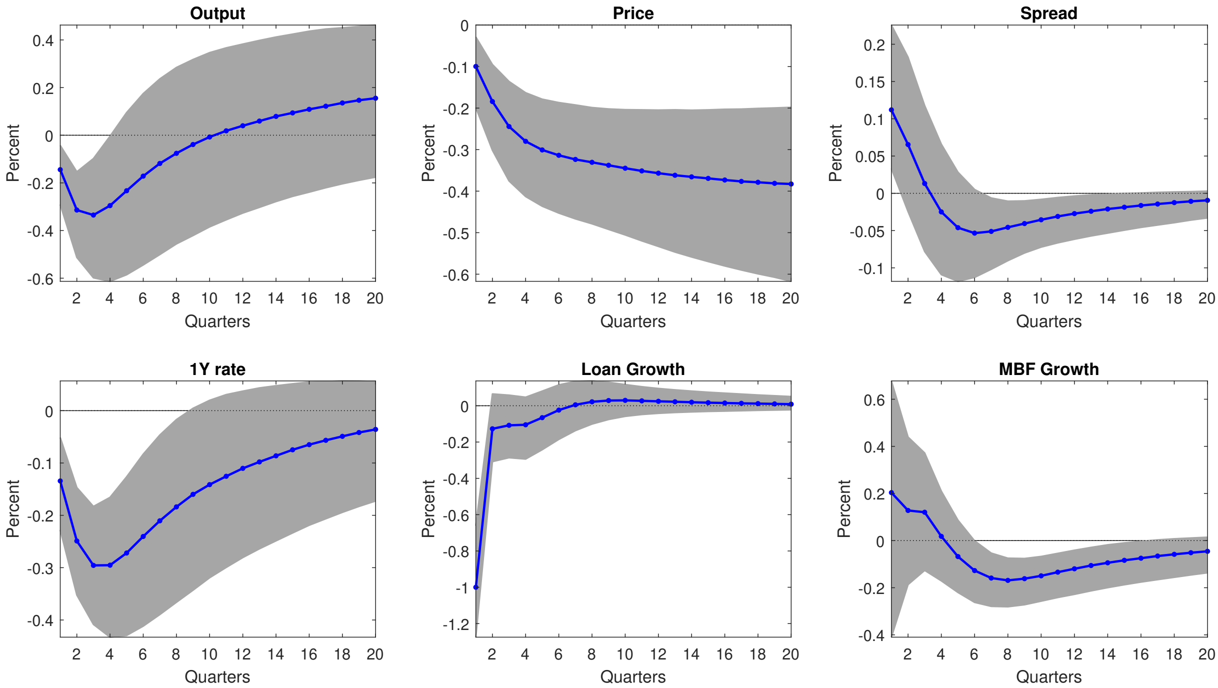
Variable	Horizon	Loan supply shock	MBF supply shock	Other shocks
Output growth	1	16.31%	16.66%	67.03%
	4	18.95%	17.49%	63.56%
	8	18.86%	17.08%	64.05%
Inflation	1	13.68%	15.26%	71.07%
	4	16.65%	16.12%	67.23%
	8	17.78%	16.48%	65.74%
Spread	1	16.87%	20.84%	62.30%
	4	12.82%	16.51%	70.67%
	8	14.15%	15.23%	70.62%
1Y interest rate	1	25.80%	21.18%	53.01%
	4	26.72%	20.93%	52.35%
	8	23.49%	20.04%	56.47%
Loan volume growth	1	38.28%	14.75%	46.97%
	4	36.27%	14.82%	48.91%
	8	35.53%	14.91%	49.56%
Debt securities volume growth	1	0.61%	22.22%	77.18%
	4	2.79%	20.90%	76.31%
	8	3.19%	20.74%	76.07%

Note: Table shows the FEV decomposition of variables for loan supply shock, MBF supply shock, and other shocks for Netherlands for one, four and eight quarters ahead.

A.3 Sensitivity analyses

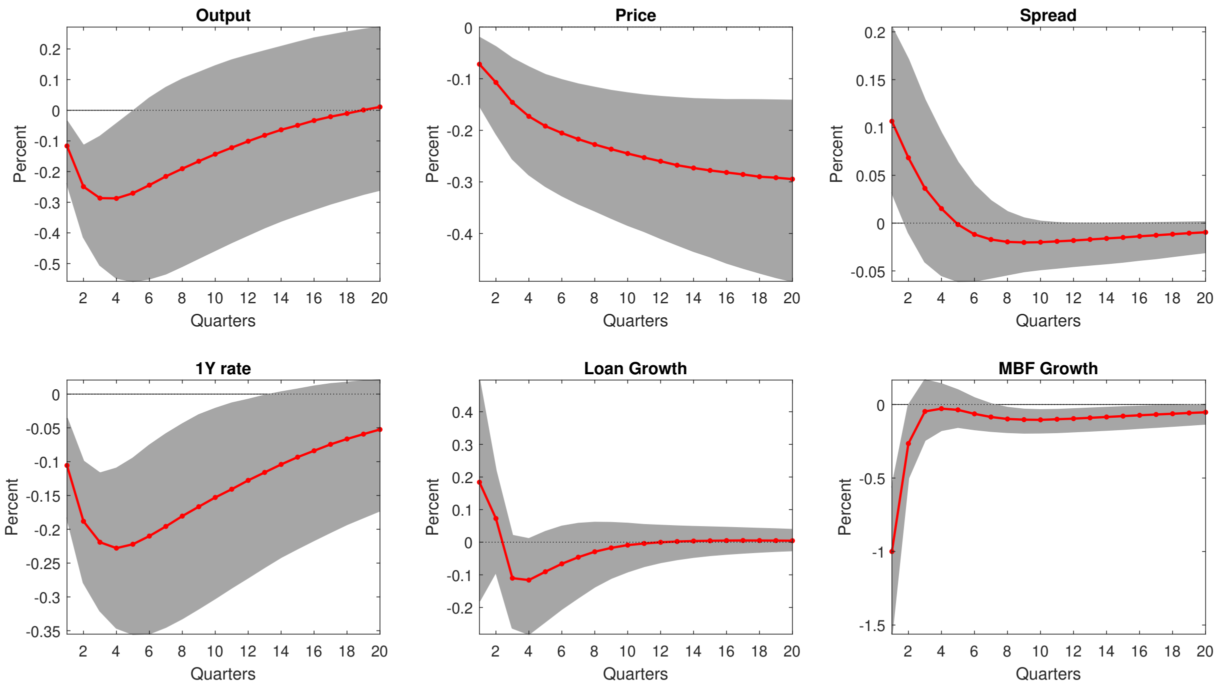
A.3.1 Control for monetary policy shock

Figure A10 – Impulse responses to a negative 1% loan supply shock: control for monetary policy shock



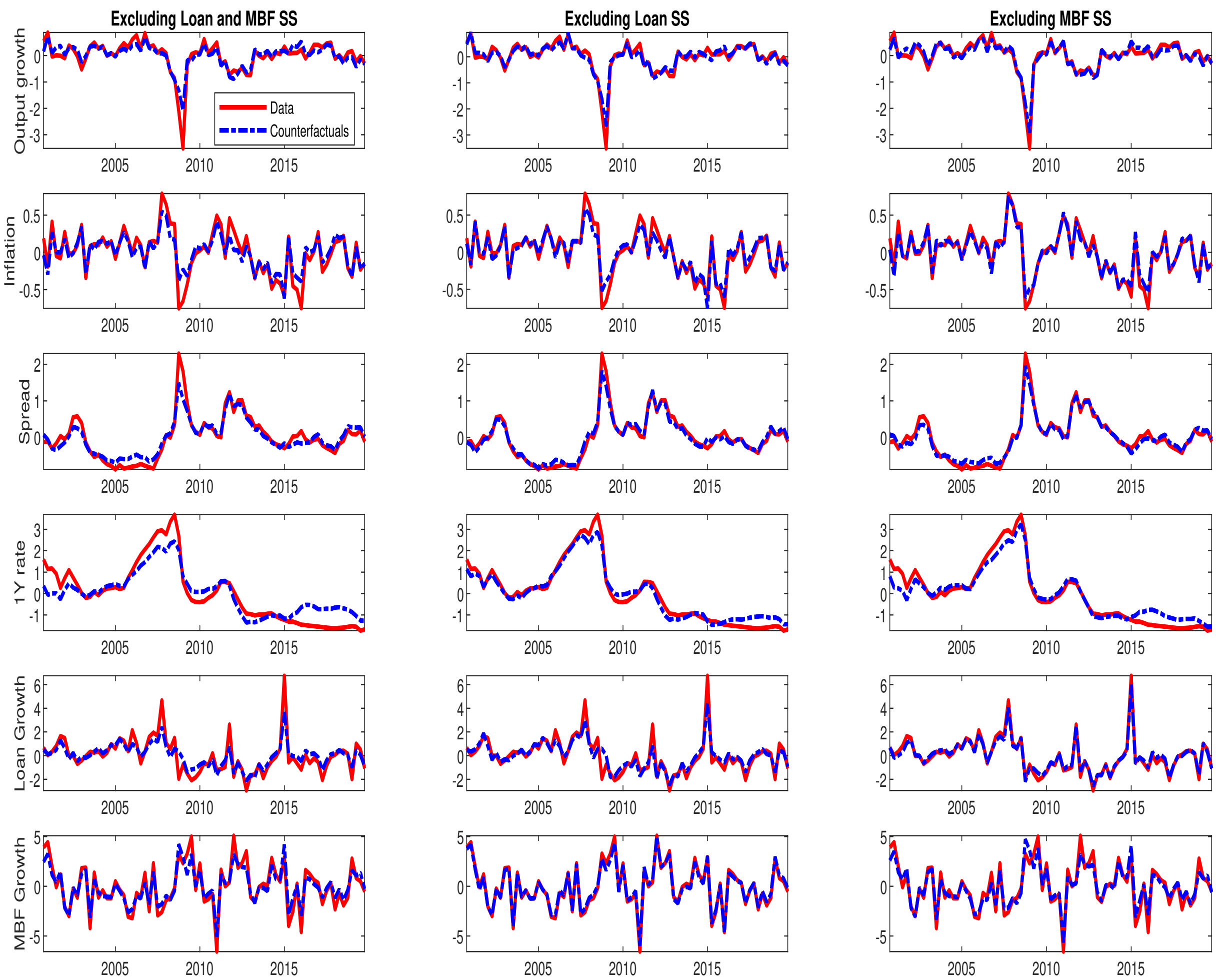
Note: Impulse responses to a loan supply shock that reduces (median) loan volume growth by 1% on impact. The solid line is the median response and the shaded area represents the 16th and 84th bounds of responses.

Figure A11 – Impulse responses to a negative 1% MBF supply shock: control for monetary policy shock



Note: Impulse responses to a MBF supply shock that reduces (median) MBF volume growth by 1% on impact. The solid line is the median response and the shaded area represents the 16th and 84th bounds of responses.

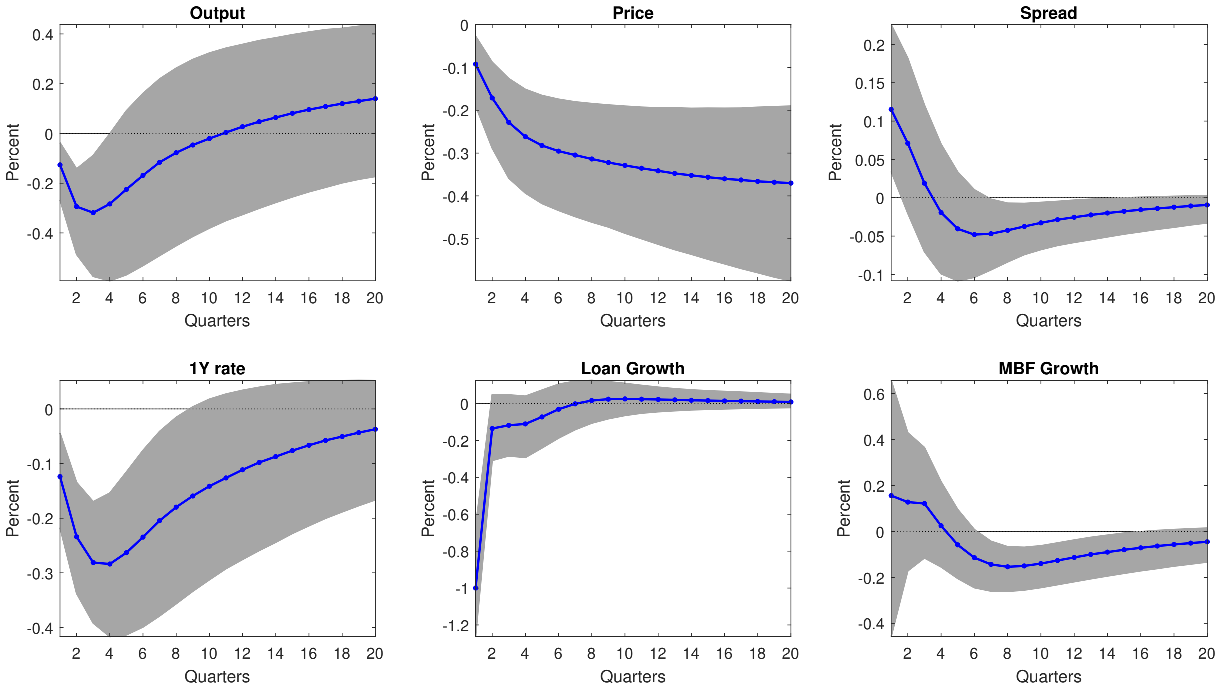
Figure A12 – Historical decomposition: control for monetary policy shock



NNotes: Figure shows the data (red solid lines) and counterfactual changes (blue dashed lines) when(i) excluding both loan and MBF supply shocks ("Excluding loan and MBF SS" in first column); (ii) excluding loan supply shocks ("Excluding loan SS" in second column); and (iii) excluding MBF supply shocks ("Excluding MBF SS" in third column).

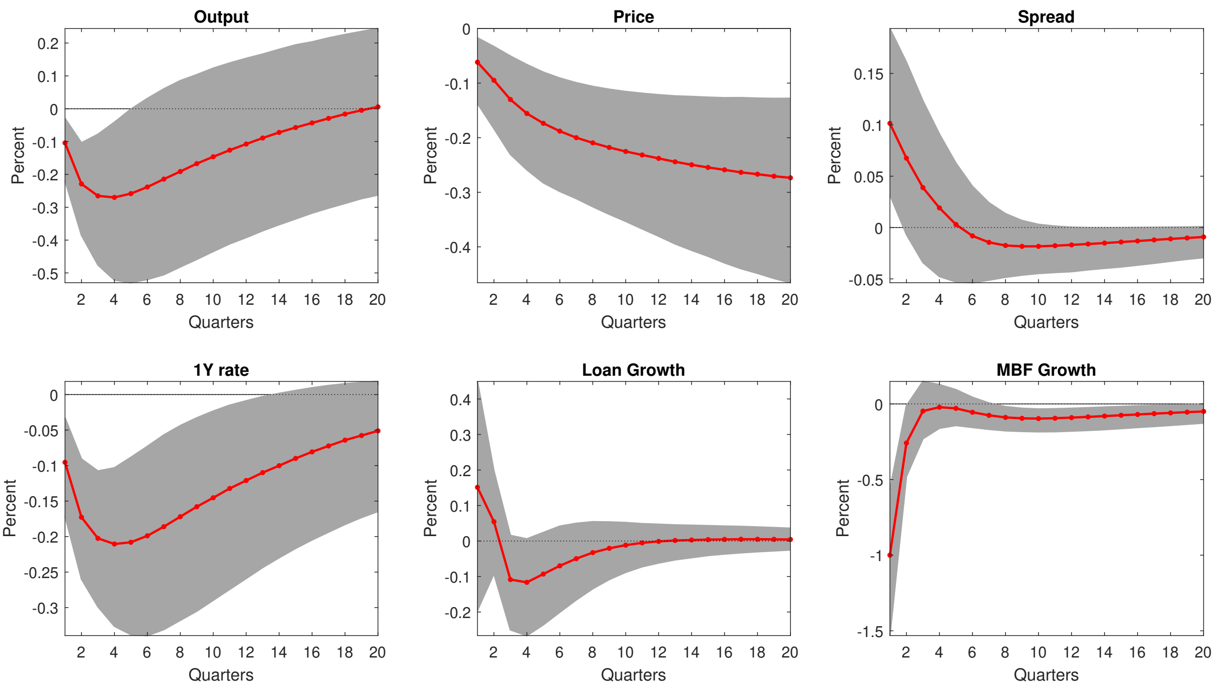
A.3.2 Five-shock identification

Figure A13 – Impulse responses to a negative 1% loan supply shock: five-shock identification



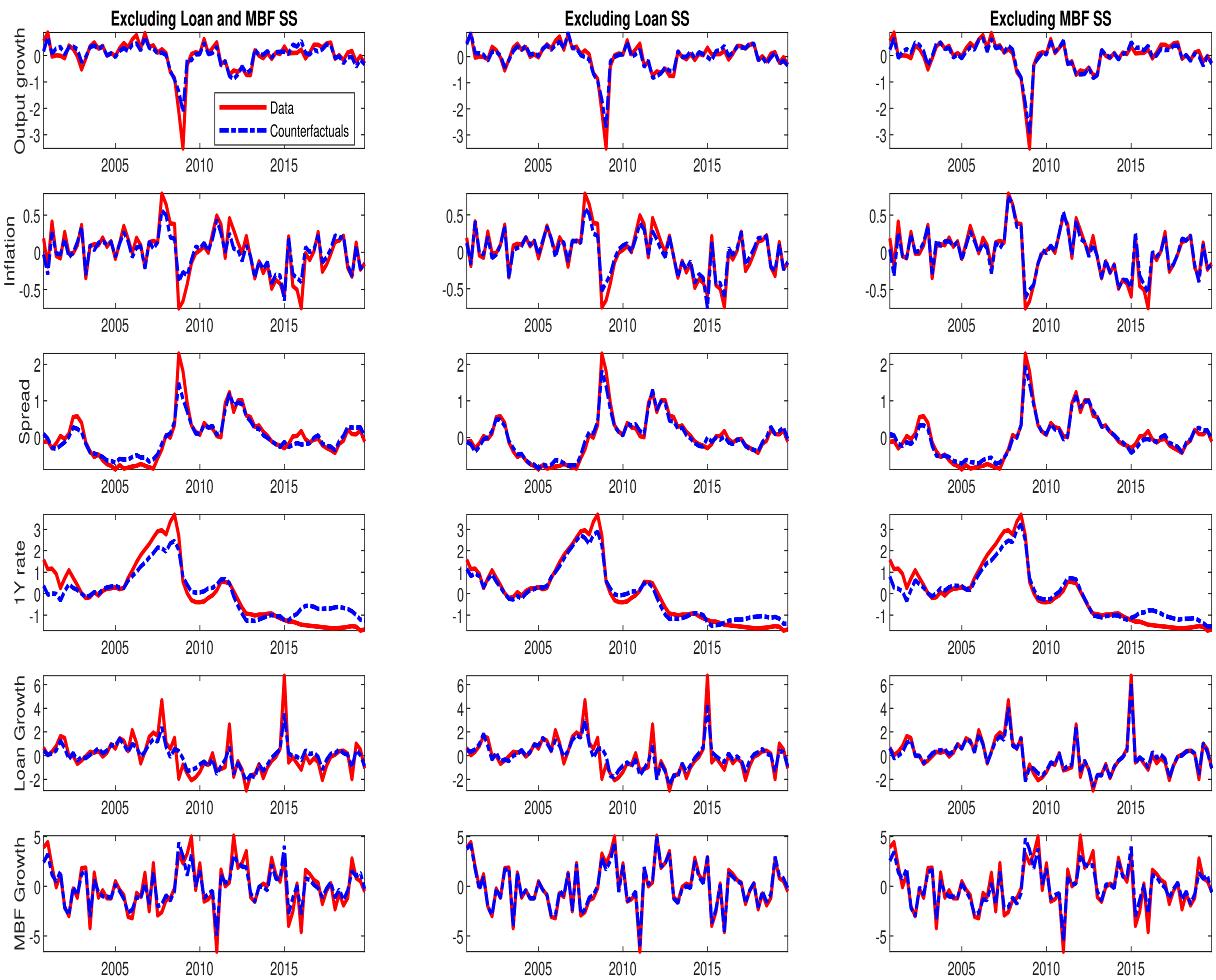
Note: Impulse responses to a loan supply shock that reduces (median) loan volume growth by 1% on impact. The solid line is the median response and the shaded area represents the 16th and 84th bounds of responses.

Figure A14 – Impulse responses to a negative 1% MBF supply shock: five-shock identification



Note: Impulse responses to a MBF supply shock that reduces (median) MBF volume growth by 1% on impact. The solid line is the median response and the shaded area represents the 16th and 84th bounds of responses.

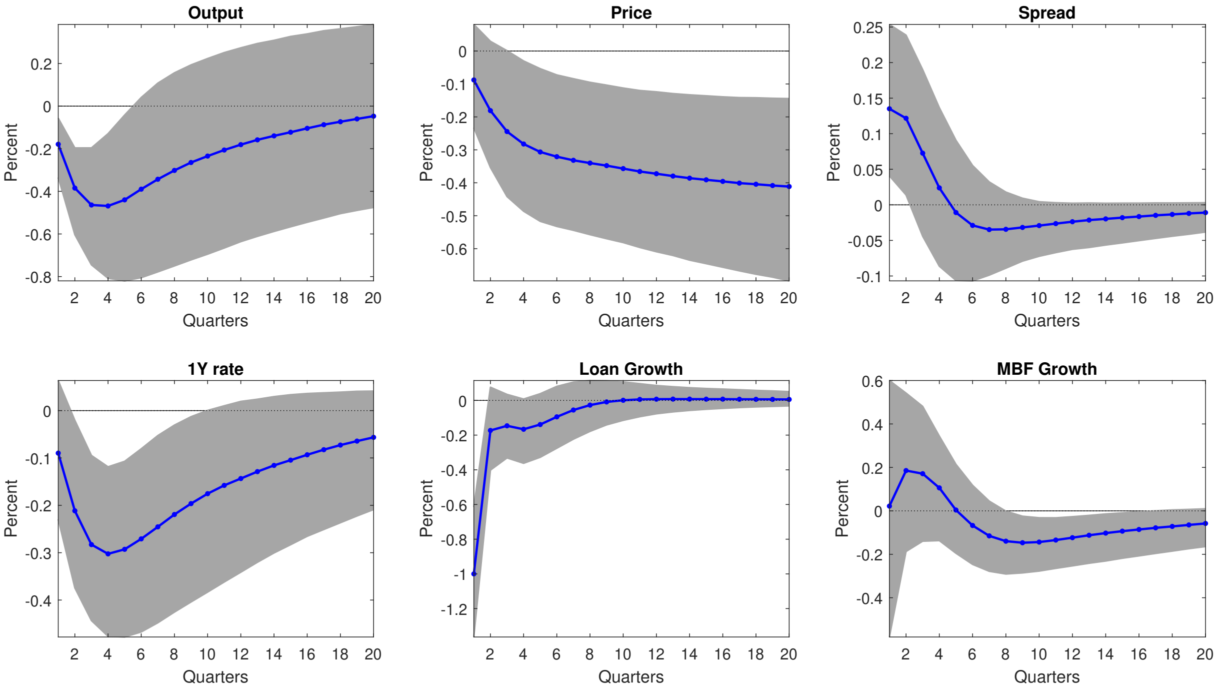
Figure A15 – Historical decomposition: five-shock identification



Notes: Figure shows the data (red solid lines) and counterfactual changes (blue dashed lines) when(i) excluding both loan and MBF supply shocks ("Excluding loan and MBF SS" in first column); (ii) excluding loan supply shocks ("Excluding loan SS" in second column); and (iii) excluding MBF supply shocks ("Excluding MBF SS" in third column).

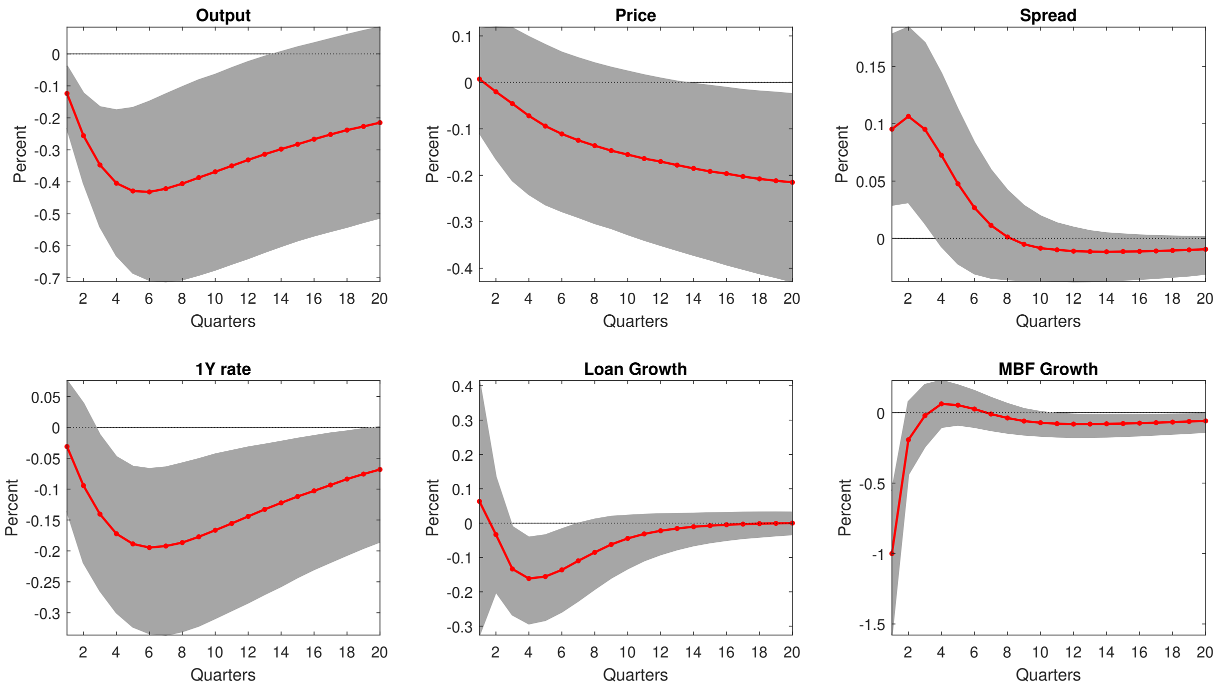
A.3.3 No restrictions on interest rate and inflation

Figure A16 – Impulse responses to a negative 1% loan supply shock: no restrictions on interest rate and inflation



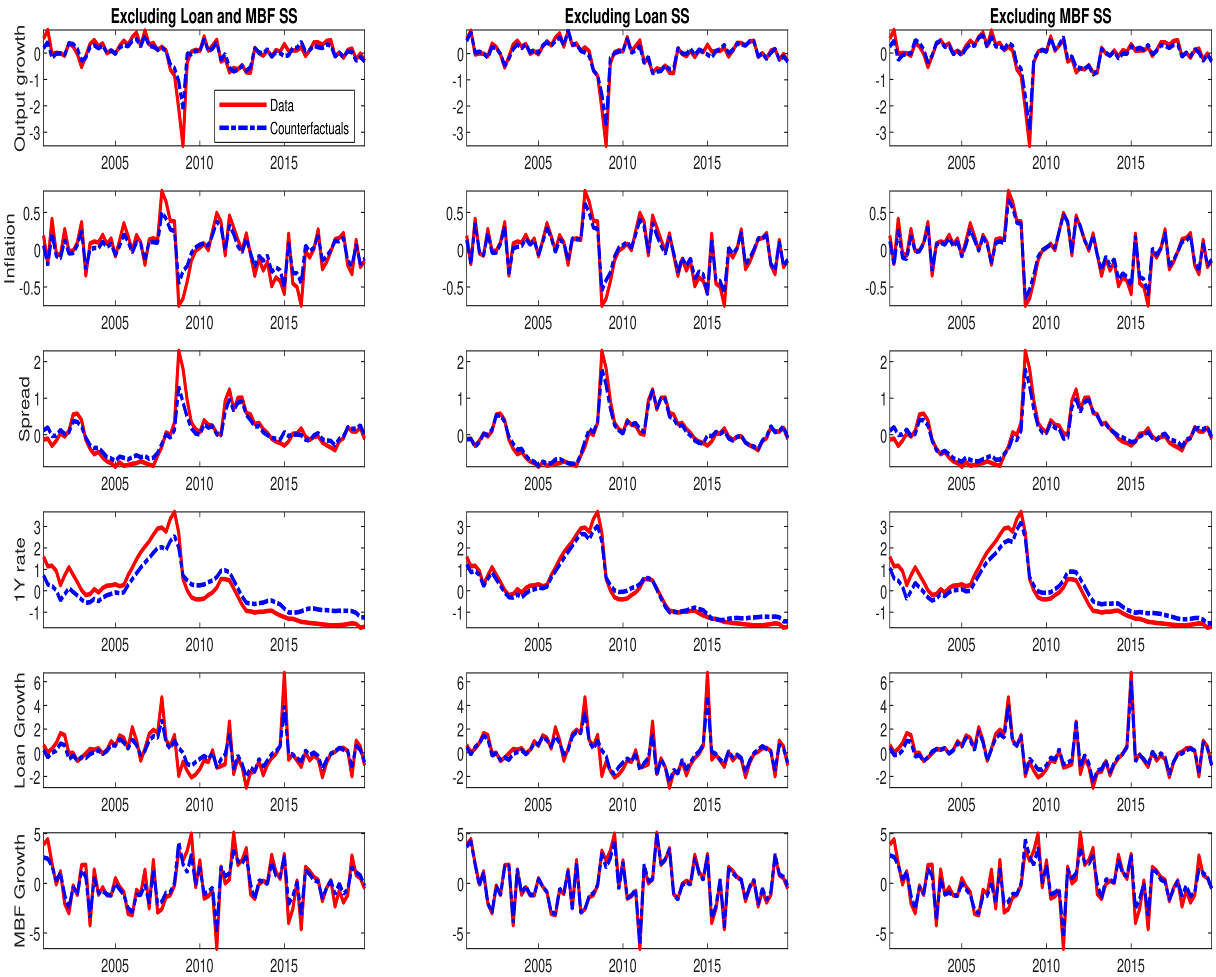
Note: Impulse responses to a loan supply shock that reduces (median) loan volume growth by 1% on impact. The solid line is the median response and the shaded area represents the 16th and 84th bounds of responses.

Figure A17 – Impulse responses to a negative 1% MBF supply shock: no restrictions on interest rate and inflation



Note: Impulse responses to a MBF supply shock that reduces (median) MBF volume growth by 1% on impact. The solid line is the median response and the shaded area represents the 16th and 84th bounds of responses.

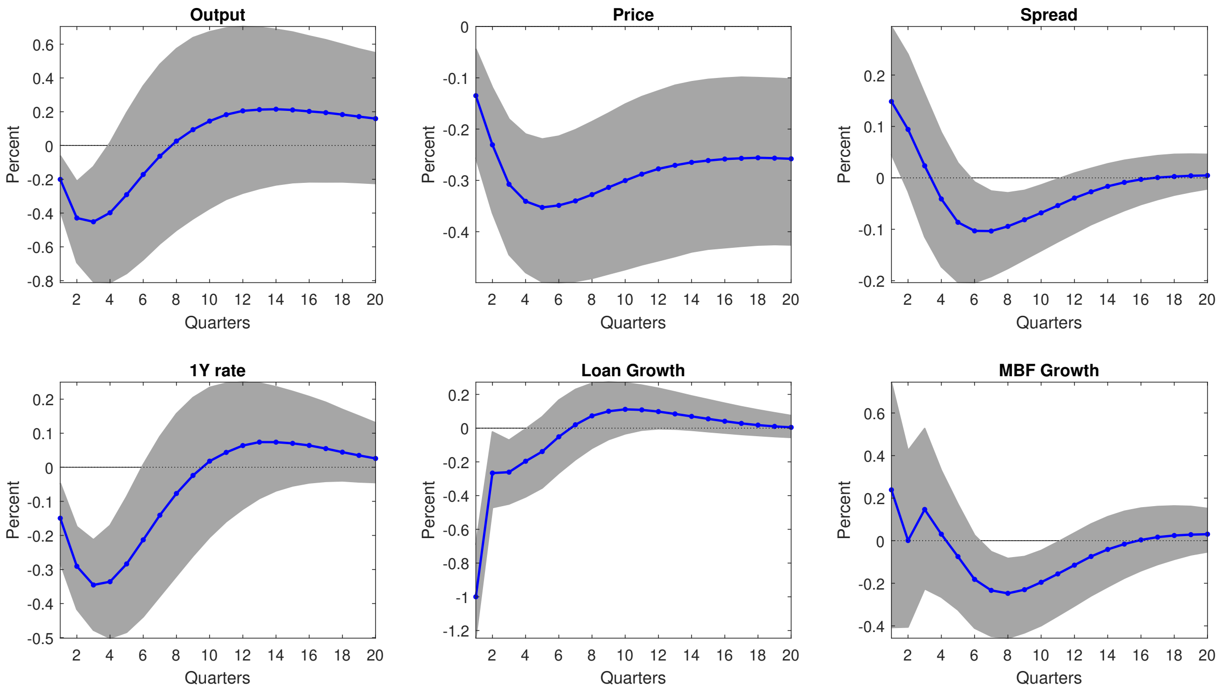
Figure A18 – Historical decomposition: no restrictions on interest rate and inflation



Notes: Figure shows the data (red solid lines) and counterfactual changes (blue dashed lines) when(i) excluding both loan and MBF supply shocks ("Excluding loan and MBF SS" in first column); (ii) excluding loan supply shocks ("Excluding loan SS" in second column); and (iii) excluding MBF supply shocks ("Excluding MBF SS" in third column).

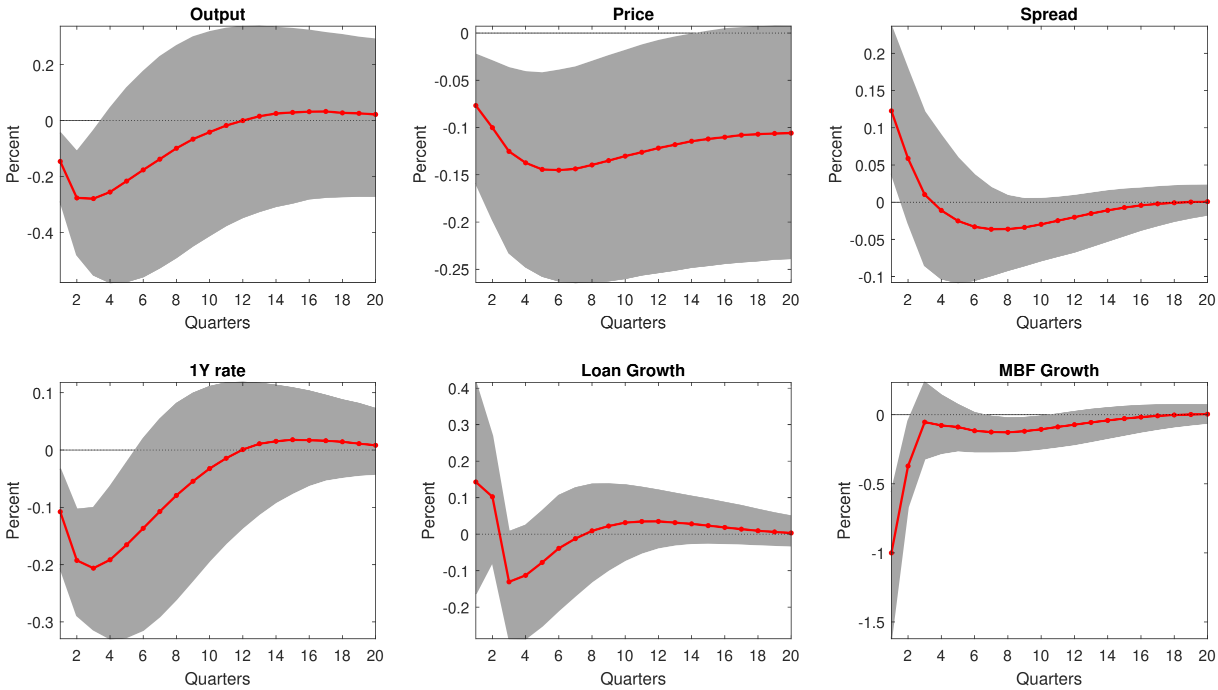
A.3.4 Pre-unconventional monetary policy (MP)

Figure A19 – Impulse responses to a negative 1% loan supply shock: pre-unconventional MP



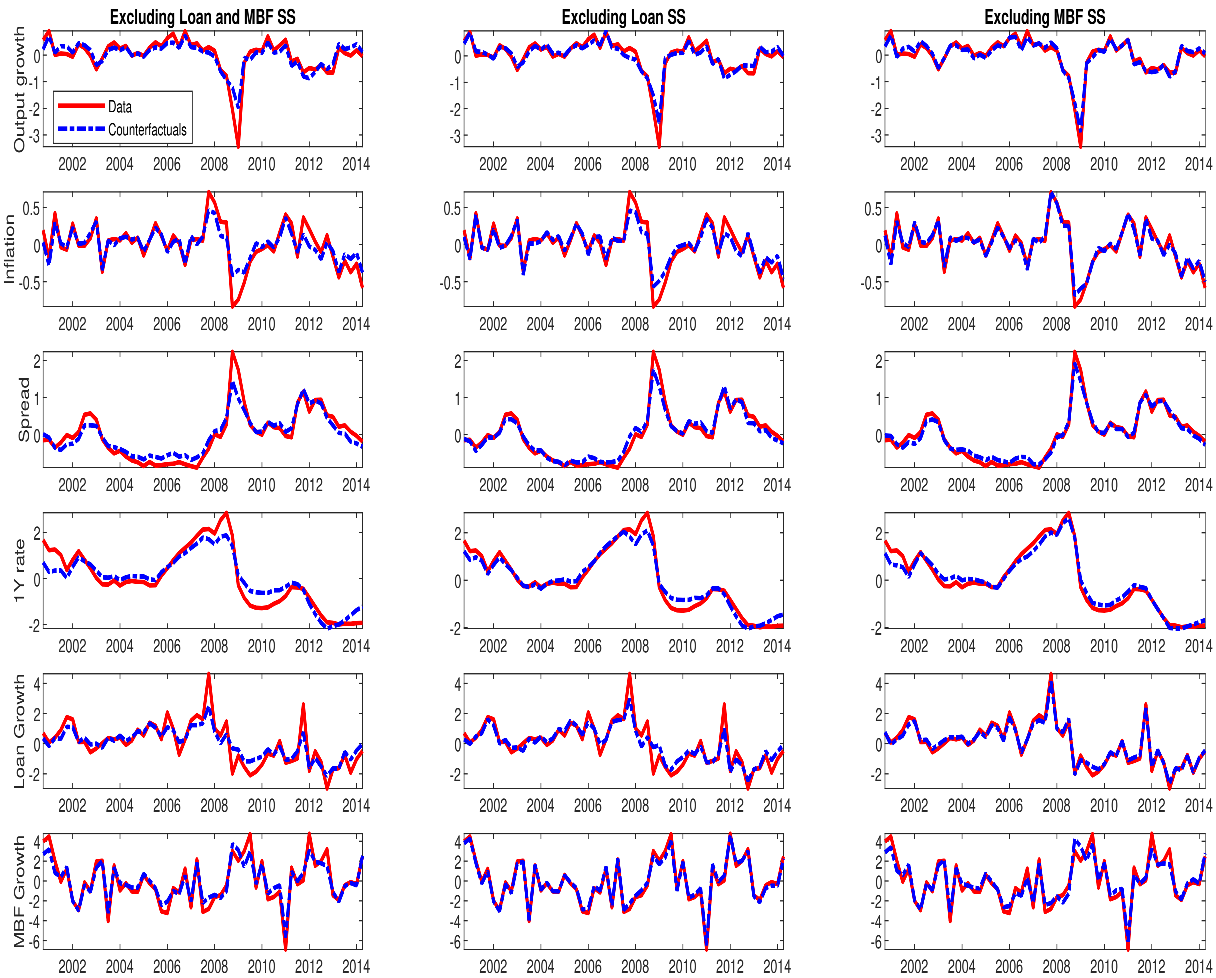
Note: Impulse responses to a loan supply shock that reduces (median) loan volume growth by 1% on impact. The solid line is the median response and the shaded area represents the 16th and 84th bounds of responses.

Figure A20 – Impulse responses to a negative 1% MBF supply shock: pre-unconventional MP



Note: Impulse responses to a MBF supply shock that reduces (median) MBF volume growth by 1% on impact. The solid line is the median response and the shaded area represents the 16th and 84th bounds of responses.

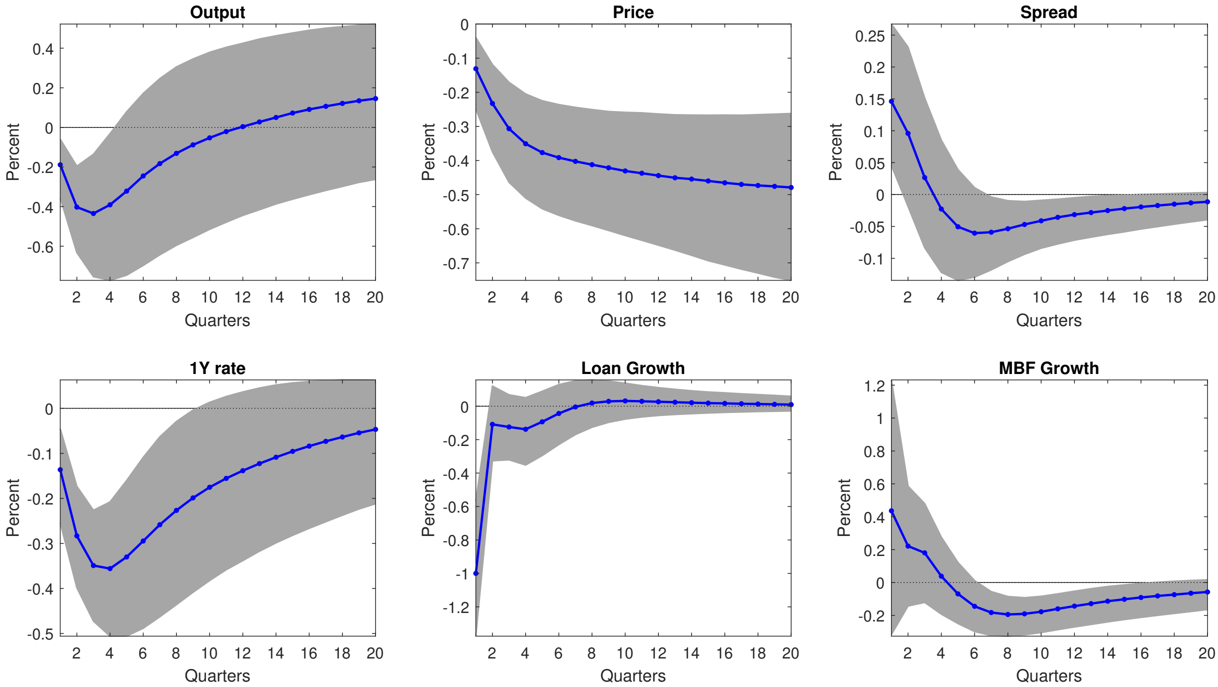
Figure A21 – Historical decomposition: pre-unconventional MP



Notes: Figure shows the data (red solid lines) and counterfactual changes (blue dashed lines) when(i) excluding both loan and MBF supply shocks ("Excluding loan and MBF SS" in first column); (ii) excluding loan supply shocks ("Excluding loan SS" in second column); and (iii) excluding MBF supply shocks ("Excluding MBF SS" in third column).

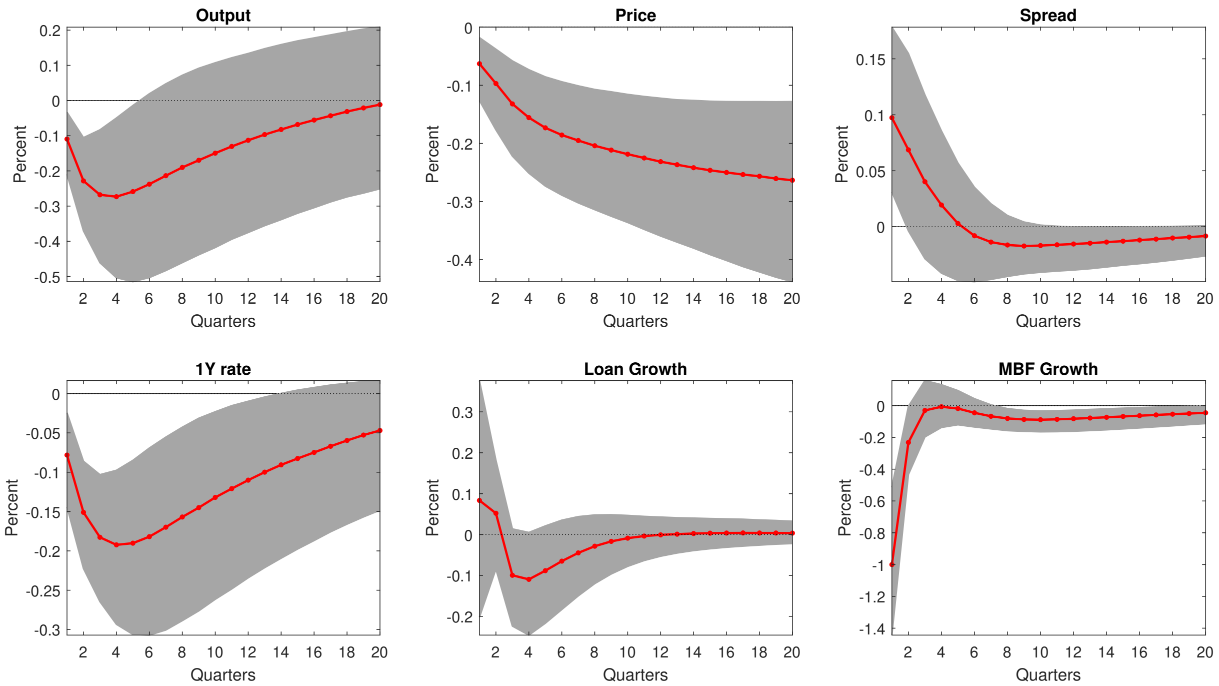
A.3.5 Inequality restrictions on FEV

Figure A22 – Impulse responses to a negative 1% loan supply shock: inequality restrictions on FEV



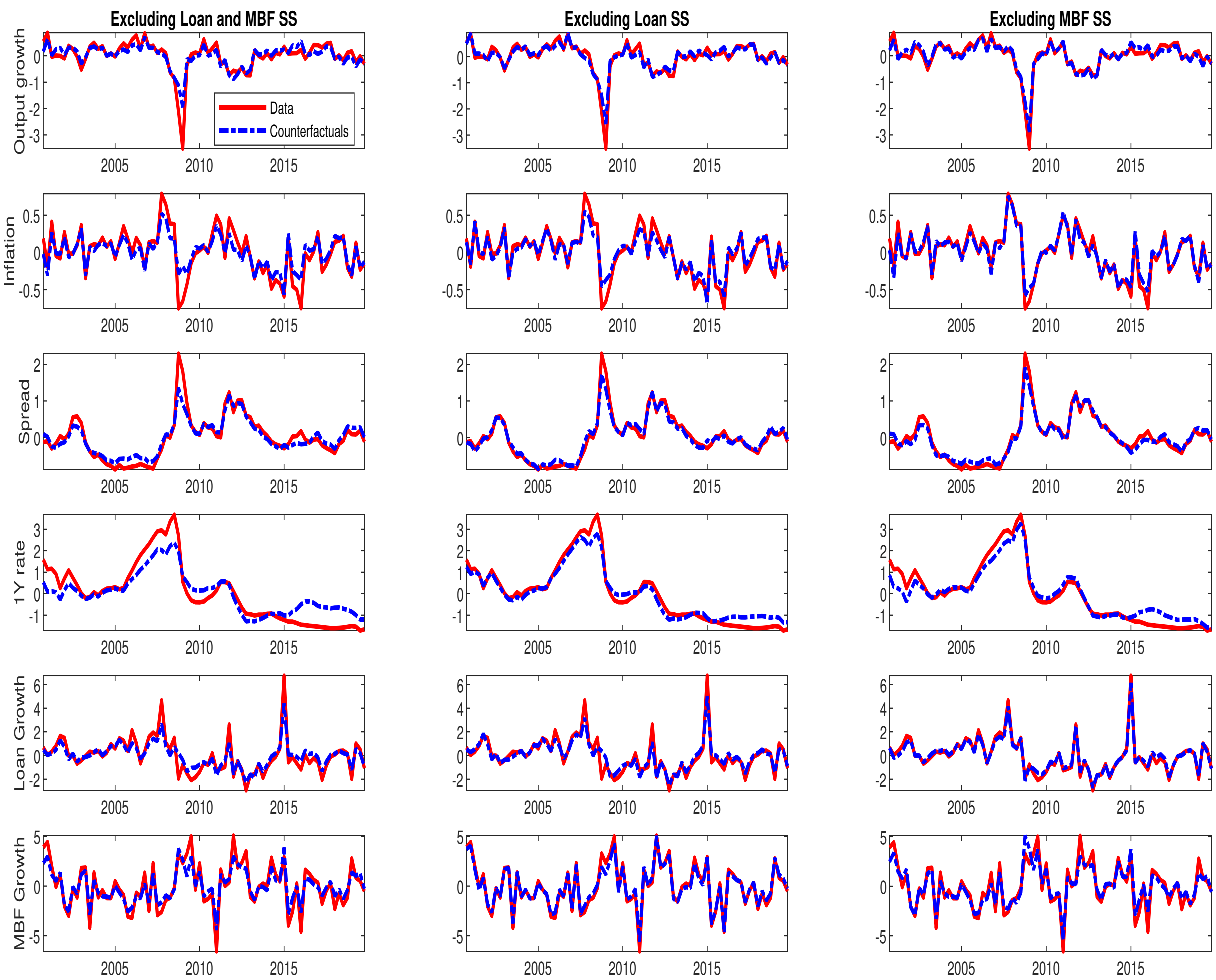
Note: Impulse responses to a loan supply shock that reduces (median) loan volume growth by 1% on impact. The solid line is the median response and the shaded area represents the 16th and 84th bounds of responses.

Figure A23 – Impulse responses to a negative 1% MBF supply shock: inequality restrictions on FEV



Note: Impulse responses to a MBF supply shock that reduces (median) MBF volume growth by 1% on impact. The solid line is the median response and the shaded area represents the 16th and 84th bounds of responses.

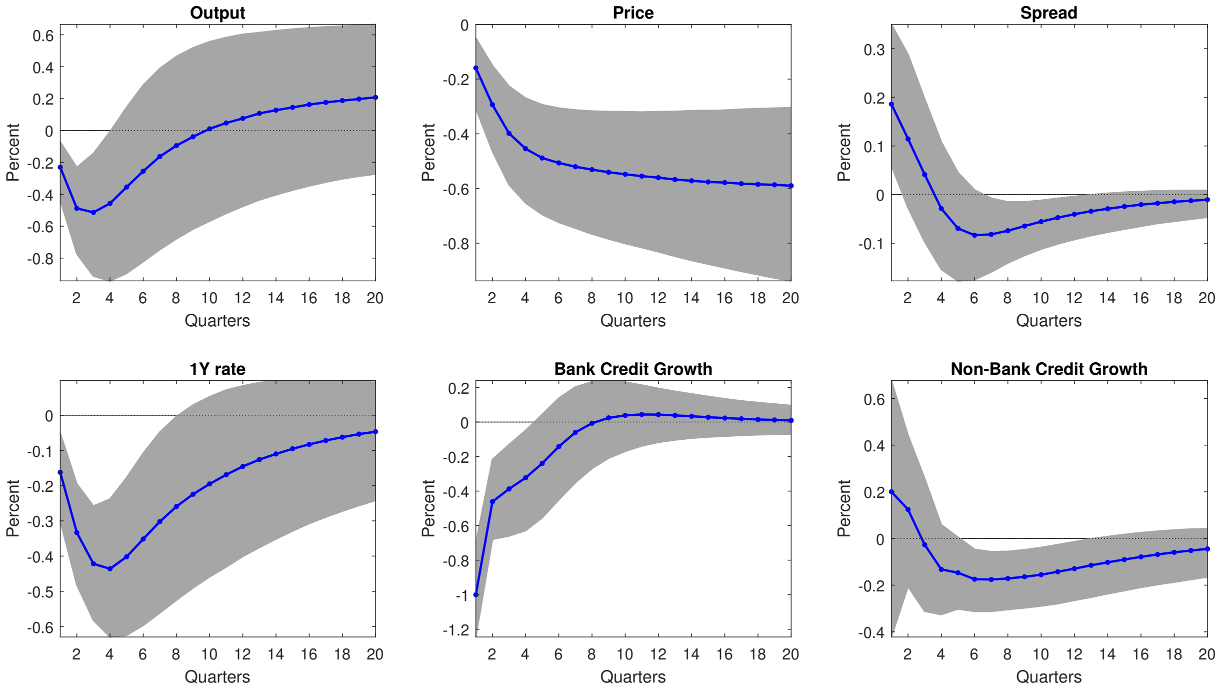
Figure A24 – Historical decomposition: inequality restrictions on FEV



Notes: Figure shows the data (red solid lines) and counterfactual changes (blue dashed lines) when(i) excluding both loan and MBF supply shocks ("Excluding loan and MBF SS" in first column); (ii) excluding loan supply shocks ("Excluding loan SS" in second column); and (iii) excluding MBF supply shocks ("Excluding MBF SS" in third column).

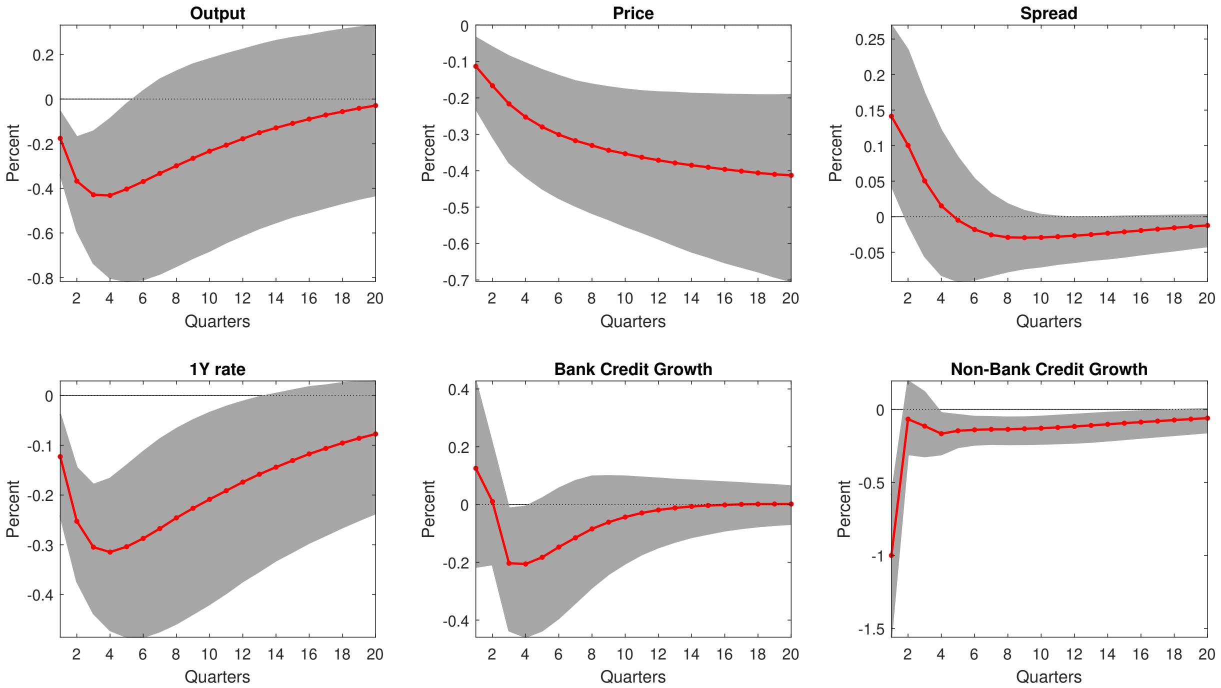
A.4 Bank versus non-bank

Figure A25 – Impulse responses to a negative 1% bank credit supply shock: bank versus non-bank



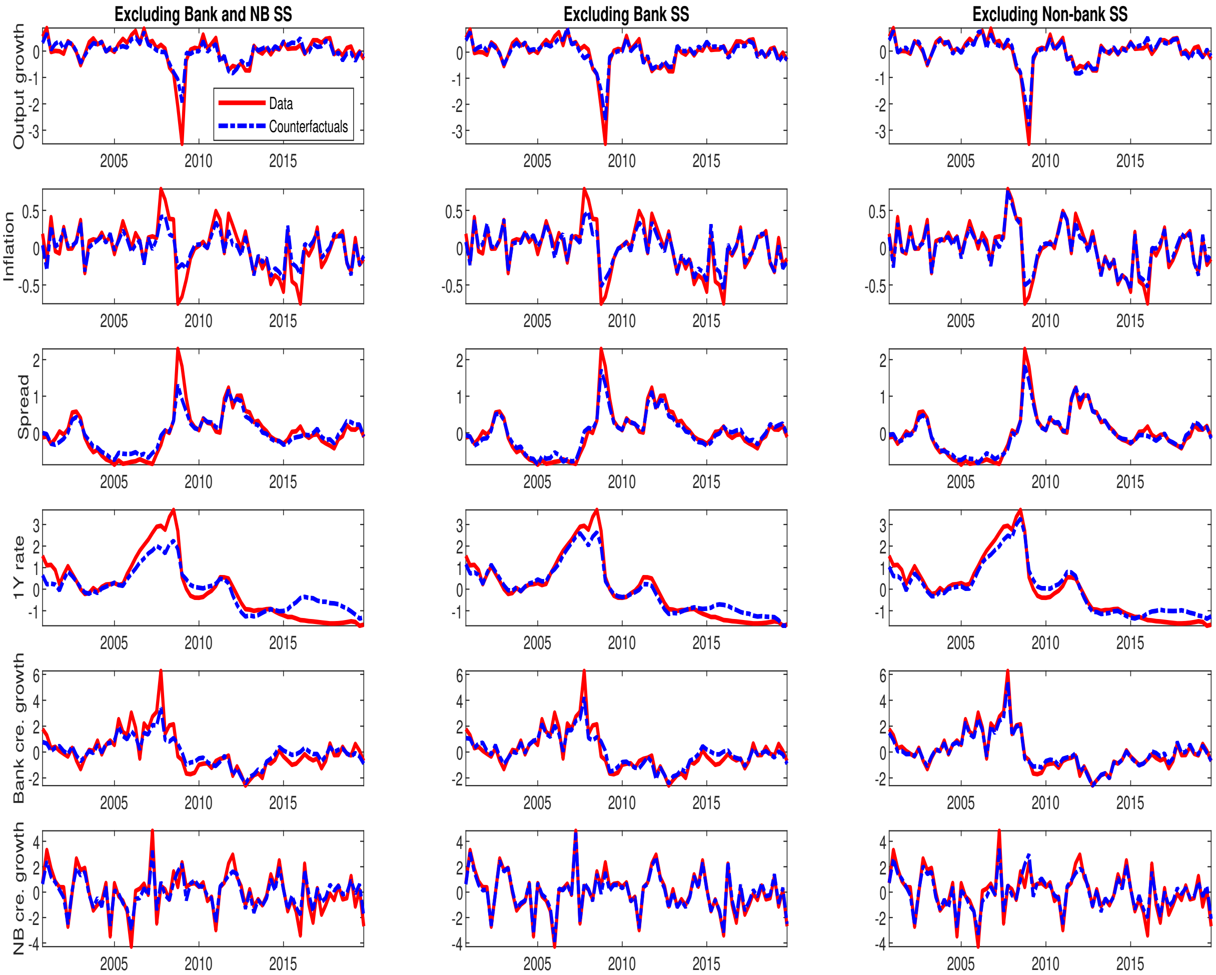
Note: Impulse responses to a bank credit supply shock that reduces (median) bank credit growth by 1% on impact. The solid line is the median response and the shaded area represents the 16th and 84th bounds of responses.

Figure A26 – Impulse responses to a negative 1% non-bank credit supply shock: bank versus non-bank



Note: Impulse responses to a non-bank credit supply shock that reduces (median) non-bank credit growth by 1% on impact. The solid line is the median response and the shaded area represents the 16th and 84th bounds of responses.

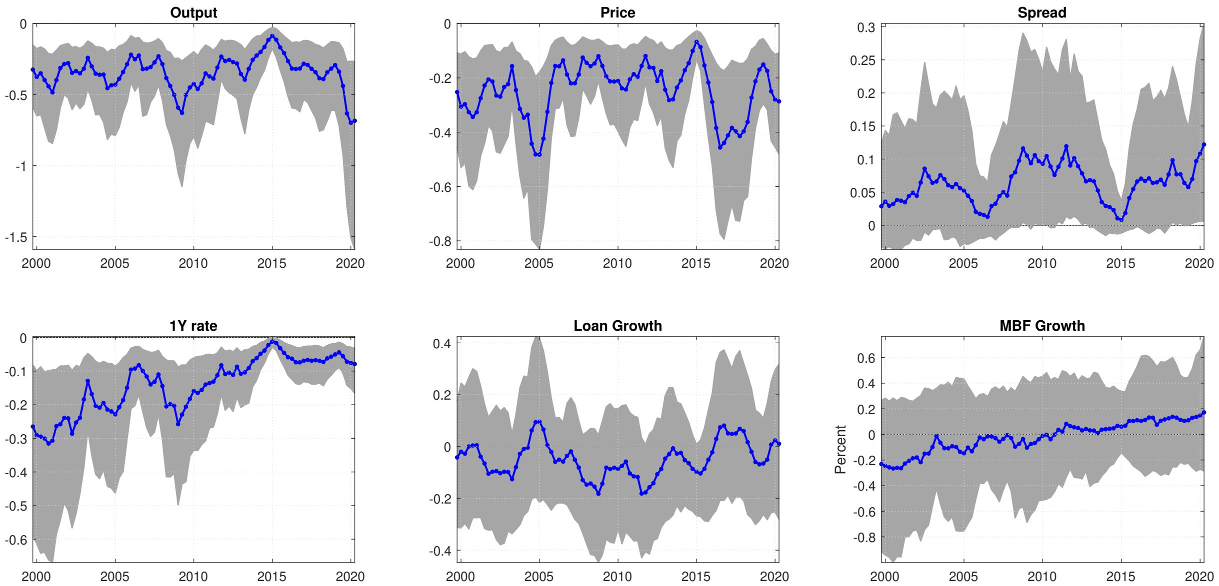
Figure A27 – Historical decomposition: bank versus non-bank supply shocks



Notes: Figure shows the data (red solid lines) and counterfactual changes (blue dashed lines) when(i) excluding both loan and MBF supply shocks ("Excluding loan and MBF SS" in first column); (ii) excluding loan supply shocks ("Excluding loan SS" in second column); and (iii) excluding MBF supply shocks ("Excluding MBF SS" in third column).

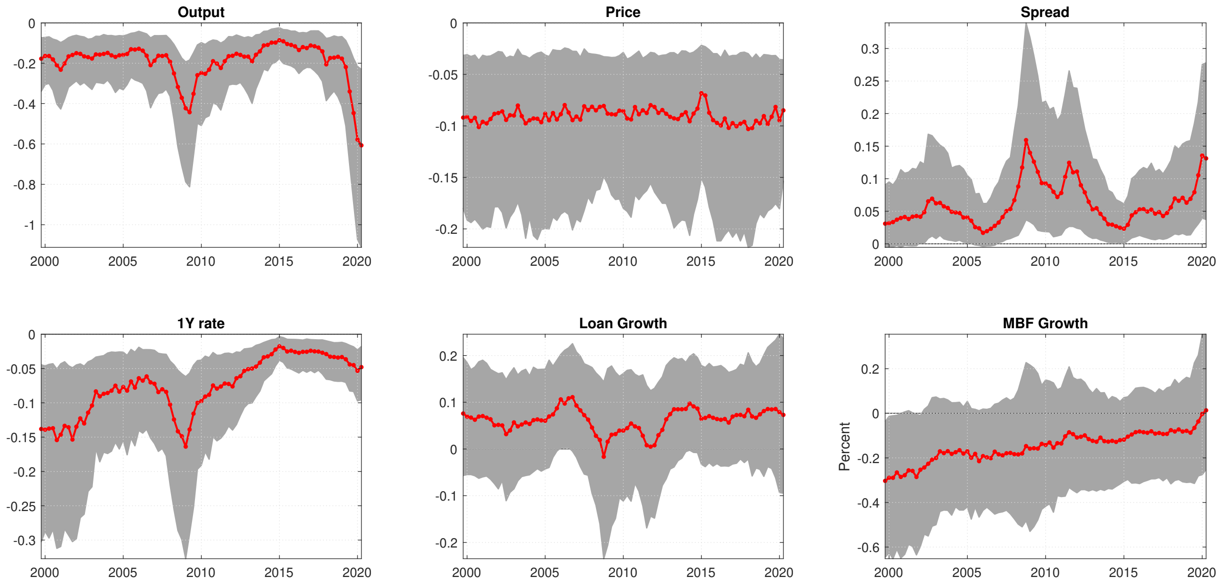
A.5 Stochastic Volatility: impulse response four periods ahead

Figure A28 – Impulse responses to a negative 1% loan supply shock: period 4



Note: Impulse responses to a loan supply shock that reduces (median) loan volume growth by 1% on impact. The solid line is the median response and the shaded area represents the 16th and 84th bounds of responses.

Figure A29 – Impulse responses to a negative 1% MBF supply shock: period 4



Note: Impulse responses to a MBF supply shock that reduces (median) MBF volume growth by 1% on impact. The solid line is the median response and the shaded area represents the 16th and 84th bounds of responses.

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