Cross-Border Bank Funding and Lending in a Monetary Union: Evidence from Slovenia*

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Abstract

We propose a novel way, based on the liability composition of banks and firms, to identify the shock to the supply of foreign funds to banks, and investigate its dynamic effects on bank lending to firms, output, and prices. We find that the increase in the supply of foreign funds to banks generates a strong and persistent increase in lending and output, while prices increase with a delay. Shocks to the supply of foreign funds to banks are also an important driver of business cycles, bank lending, and the co-movement between bank loans and output. When we distinguish between the behaviour of domestic and foreign-owned banks, we find that foreign-owned banks are slower in passing the increase in foreign funding to firms.

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1 Introduction

This paper proposes a new way to identify a shock to the supply of foreign funds to banks, using the structure of liabilities of banks and firms. It then proceeds to investigate how this shock affects bank lending to firms, output, and prices.

Cross-border financial flows have long been regarded as important drivers of economic fluctuations. Their importance has increased with the creation of the Euro and the resulting elimination of the exchange rate risk, which has increased the substitutability between domestic and foreign assets and fostered financial integration (Lane and Milesi-Ferretti, 2008). Financial integration in the monetary union is welcome, as it increases the possibilities for risk sharing and can work as a stabilizing force. However, it also makes the supply of external funding to an economy more elastic and more susceptible to sudden stops (see, for example, Lane (2010) and Aizenman (2020)). This can be particularly important for those small open economies where cross-border debt inflows come through the domestic banking system, which can generate credit booms even when domestic firms and households cannot access international markets directly (Lane (2013) and Lane and McQuade (2014)). A recent example are many countries in the euro area that exhibited strong growth in cross-border financial flows before the great recession, but also suffered from its decline, which to a large extent was driven by banks reducing their cross-border activities (Lane and Milesi-Ferretti, 2018).

Typically, all cross-border capital flows have been considered as exogenous for the recipient economy. However, Blanchard (2011) points out that this is not always the case: "We often think of inflows and outflows as coming primarily from decisions by foreign investors. The reality is that many of these inflows and outflows often come from decisions by domestic investors." This distinction is important, because private deleveraging can also take place without a sudden stop or an externally imposed constraint (Martin and Philippon, 2017). Moreover, the effects of changes in cross-border capital flows on the economy are likely to depend on what drives them, and may therefore require different policy responses (Moreno et al. (2016)).

The contribution of the paper is along three lines. First, we propose, in a time-series context, a way to identify a shock to the supply of foreign funding to banks within the country. Such a shock can be viewed as a push factor that originates outside the country it affected. It can also be viewed as a shock that is conceptually close to the sudden stop in Martin and Philippon (2017) and close to the notion of the 'ease of financing' in Cerutti, Claessens, and Ratnovski (2014), as it attempts to distinguish voluntary (endogenous) deleveraging (which would be classified as a pull factor) from deleveraging due to an externally imposed constraint (push factor). It is closely related to changes in the supply of liquidity by parent banks in the context of foreign-owned banks (as in Cetorelli and Goldberg (2012)), but our approach to the identification can be applied to domestic banks as well. The idea on which the identification relies is that an increase in the share of foreign

funding among bank liabilities, when accompanied by the increase in the share of bank loans to non-financial corporations ('firms') among other firm liabilities, is an indication that the availability of bank funds to firms has increased, *relative* to the availability of other sources of funding. Such changes in the composition of bank and firm liabilities allow us to use sign restrictions and narrative sign restrictions to distinguish shocks to the supply of foreign funding to banks from other shocks, such as domestic demand, or a domestic (loan) supply shock. This approach is similar to the idea of (Kashyap, Stein, and Wilcox (1993)), who refer to the indicators of the structure of liabilities as the 'Mix' indicators. To obtain these indicators, we use the structure of sectoral liabilities from the flow-of-funds statistics. This approach to identification can pick not only sudden stops, but also gradual stops and slowdowns in the flow of foreign funds. To the best of our knowledge, we are the first to use such an approach to identify shocks in the supply of foreign funding to banks and its transmission to lending and the real economy.

Second, we complement the existing literature by using the time series approach and by distinguishing between domestic and foreign-owned banks. Most empirical studies that distinguish between domestic and foreign-owned banks use cross-section or panel data, where the analysis of dynamics at cyclical frequencies is more difficult (or impossible).[1] While micro-level evidence is very valuable, it is often limited from the macroeconomic perspective, because the methods used rarely permit the analysis of dynamic macroeconomic effects. We complement this literature by using a dynamic method (a vector autoregression), but still keeping some granularity by using the sectoral flow-of-funds data. Distinguishing between all banks in the aggregate, domestic banks, and foreign-owned banks allows us to investigate whether the ownership of banks matters for the transmission of foreign funding supply shocks. An advantage of focusing on the dynamics is that we can analyse which structural shock is important for macroeconomic fluctuations and the co-movement between variables at cyclical frequencies.

Finally, our analysis requires fewer assumptions about the data than is typically the case, especially regarding the sectoral accounts and valuation effects. Most of the literature has to make assumptions regarding the valuation of stocks and flows and/or the sectoral split of funds (e.g. Avdjiev et al. (2018), Lane and Milesi-Ferretti (2007), or De Haas and van Lelyveld (2006)). In our sample, the vast majority of capital flows are in euros (Bank of Slovenia (2009) and Bank of Slovenia (2015a)) and the exchange rate has been fixed before the adoption of the Euro.[2] Moreover, capital flows have been unrestricted throughout the period. This means that we have a consistent dataset without having to make assumptions regarding the valuation or controlling for changes in capital flow restrictions, which is typically not the case in cross-country studies. If the retrenchment of cross-border interbank lending in the euro area is viewed as a sudden stop, then our data also contain a relatively

[1] An example is Ongena et al. (2015), who investigate the transmission of more general foreign shocks.

[2] The maximum deviation of the exchange rate from the parity at which the Euro was adopted has been less than 0.08% in any month (and zero on average).

rare example of a *sudden stop in a monetary union* (Martin and Philippon, 2017). This paper therefore also provides some empirical evidence on the effects of capital flows in a monetary union, i.e., in a setting at the extreme of the Mundell-Fleming's "trilemma" where a country has an irrevocably fixed exchange rate and is fully open to capital flows (Aizenman (2019)).

We find that the increase in the supply of foreign funds to banks generates a strong, procyclical and persistent increase in bank lending to firms, real GDP, and (after a delay) prices. This indicates that for a small open economy in a monetary union with a fixed nominal exchange rate and no monetary independence, capital inflows due to the supply of foreign funds to banks create a strong expansion of the business cycle. While we find that this is the case for foreign funding supply shocks to both domestic and foreign-owned banks, the latter transmit these shocks to firms slower and with a lower magnitude than domestic banks. This remains the case if one accounts for the differences in the structure of bank liabilities of domestic and foreign-owned banks, but if one accounts for the size of each sector the magnitude of responses is similar. We also find that shocks to the supply of foreign funds are an important driver of fluctuations in real GDP, bank loans, and the correlation between them.

Our paper is related to a broad literature on different factors that influence international capital flows. To distinguish different drivers of international capital flows, the literature typically classifies them as either push factors, which originate from the outside, or pull factors, which originate from within the country (Moreno et al., 2016). The precise operational definitions differ. For example, Fratzscher (2012) defines push factors as global common factors and pull factors as country-specific factors. With this definition, a factor can originate from the outside of a country, but it may still be country-specific. There may also be regional factors (Eller et al., 2016) that are difficult to fit in one of these categories (Koepke, 2015) and may not be completely exogenous to a country within the region. This is one of the reasons why several authors have argued that a more structural interpretation of these factors is required (Milesi-Ferretti and Tille (2011), or Cerutti, Claessens, and Ratnovski (2014)).

Although we perform the analysis using the data for Slovenia, we believe that the findings have broader implications for other small open economies in monetary unions, and in particular in the Central, Eastern, and South Eastern Europe (CESEE) with a similar structure of the economy and significant foreign bank presence. Fluctuations in financial flows in Slovenia since the entry into the ERM II and after accession to the euro area are not country-specific and have been a broader concern in the region. Most countries that have been preparing to join the Euro and after the Euro adoption experienced capital inflows, followed by significant outflows during the recent crisis (De Haas and van Lelyveld (2006), De Haas et al. (2015)). Distinction between domestic and foreign-owned banks is especially relevant, since policymakers in the CESEE countries have been concerned about foreign capital flows that enter the region through foreign banks, and have established the Vienna

Initiative to discus and monitor these flows.[3]

The paper begins with a brief description of the data, method and identification in Section 2. Sections 3 and 4 discuss the main results. Section 5 examines the robustness of the main results, and Section 6 concludes.

2 Data, method and identification

2.1 Data

In the analysis we use quarterly data on real GDP, price level proxied by the GDP deflator, sectoral flow of funds data on bank and firm liabilities, supplemented by the breakdown of bank loans and liabilities based on bank ownership (domestic or foreign), consistent with the flow-of-funds data. We use sectoral flow of funds data on a consolidated basis, i.e., the flows represent the amount of funds provided by one sector to another, net of any intra-sectoral positions, by instrument. The breakdown by bank ownership is available at the instrument level. The sample period is from 2004Q1 to 2013Q3. Importantly, there were no exchange rate movements throughout this period and the market share of foreign banks has been stable at around 30%.[4]

2.2 Estimation method

We use a structural vector autoregressive (VAR) model to condition the analysis on shocks. The estimated reduced-form VAR takes the following form:

$$Y_t = c + \beta t + A_0 D_t + \sum_{i=1}^{q} A_i Y_{t-i} + u_t, \tag{1}$$

where c is a constant, t is a linear trend, β is the coefficient on the linear trend, D_t is a vector of quarterly dummies, Y_t is a vector of endogenous variables, and u_t is a reduced-form error term. q is the number of lags and A_i are coefficient matrices.[5]

The benchmark VARs include real GDP, GDP deflator, bank loans to firms (by all banks, foreign banks, and domestic banks, respectively), and two variables that serve as bank loan supply and foreign funding supply indicators. All data are in log-levels, except loan supply

[3]The Vienna Initiative publishes a periodic publication that reports developments in the cross-border credit flows in the region (Vienna Initiative (2012), Vienna Initiative (2016)).

[4]Data before 2004 are not available at quarterly frequency. In 2013Q3 the transfer of a portion of bank loans to the Bank Asset Management Company, which was included in a different sector, caused a structural break in the series, so we end our sample at that point. The definition of foreign-owned banks follows Bank of Slovenia (2015a). There have been no sizeable new entries, mergers, or takeovers. The average market share of foreign banks in the sample is 30% measured by the size of the entire balance sheet, and 32% measured by the size of loans to firms, with fluctuations of less than 4 p.p. around the mean.

[5]Including a deterministic trend is not necessary, although it is common in empirical work (see den Haan (2000)). We have examined the robustness of our results to alternatives and the results are not materially affected.

indicators and foreign funding supply indicators, which are in levels. This yields consistent estimates even when variables are (co)integrated, as long as sufficient number of lags is used (Sims et al. (1990)). We opt for three lags in all specifications.

2.3 Foreign funding supply and bank loan supply indicators

The identification of changes in foreign funding supply to banks and the supply of bank loans to firms is based on the idea of Kashyap, Stein, and Wilcox (1993). They note that if the share of bank loans among firm liabilities with similar characteristics declines, then this must be due to the (relative) tightening of the supply of bank loans. Their measure of bank loan supply is a ratio of short-term bank loans to the sum of short-term bank loans and commercial paper issued by firms (non-financial corporations), which they call the 'Mix'. Their rationale is that if short-term bank loans and commercial paper are close substitutes, then changes in the demand for financing will not affect the Mix, because firms seek financing both from banks and on the markets. Only if there is a change in the supply of bank loans (relative to the supply of commercial paper), the Mix will be affected. We extend this idea to bank liabilities and construct Mix indicators to identify shocks in the supply of funding from abroad to banks.

We define the benchmark Mix variable *at the bank level*, $MixF$, as the ratio of liabilities to banks abroad to all debt liabilities of banks on a consolidated basis (excluding interbank liabilities). We do so for the banking system as a whole, for foreign-owned banks, and for domestic banks. We have experimented with different definitions of $MixF$ and obtained similar results.

To construct the benchmark Mix variable *at the firm level*, $MixH$, we divide bank loans to firms with the sum of bank loans to firms, trade credit, outstanding securities, foreign loans and loans from non-bank intermediaries. In this we follow the argument of Oliner and Rudebusch (1996) and consider all relevant financing alternatives of firms.[6] From the perspective of the sector, it matters how much funds have come into the sector, which is why we use all series on a consolidated basis (intra-sector positions are netted-out, because these are not flows into the sector). Quantitatively and economically the most important alternative to bank financing in Slovenia is trade credit, and the results are not materially affected if some or all other alternatives are omitted.

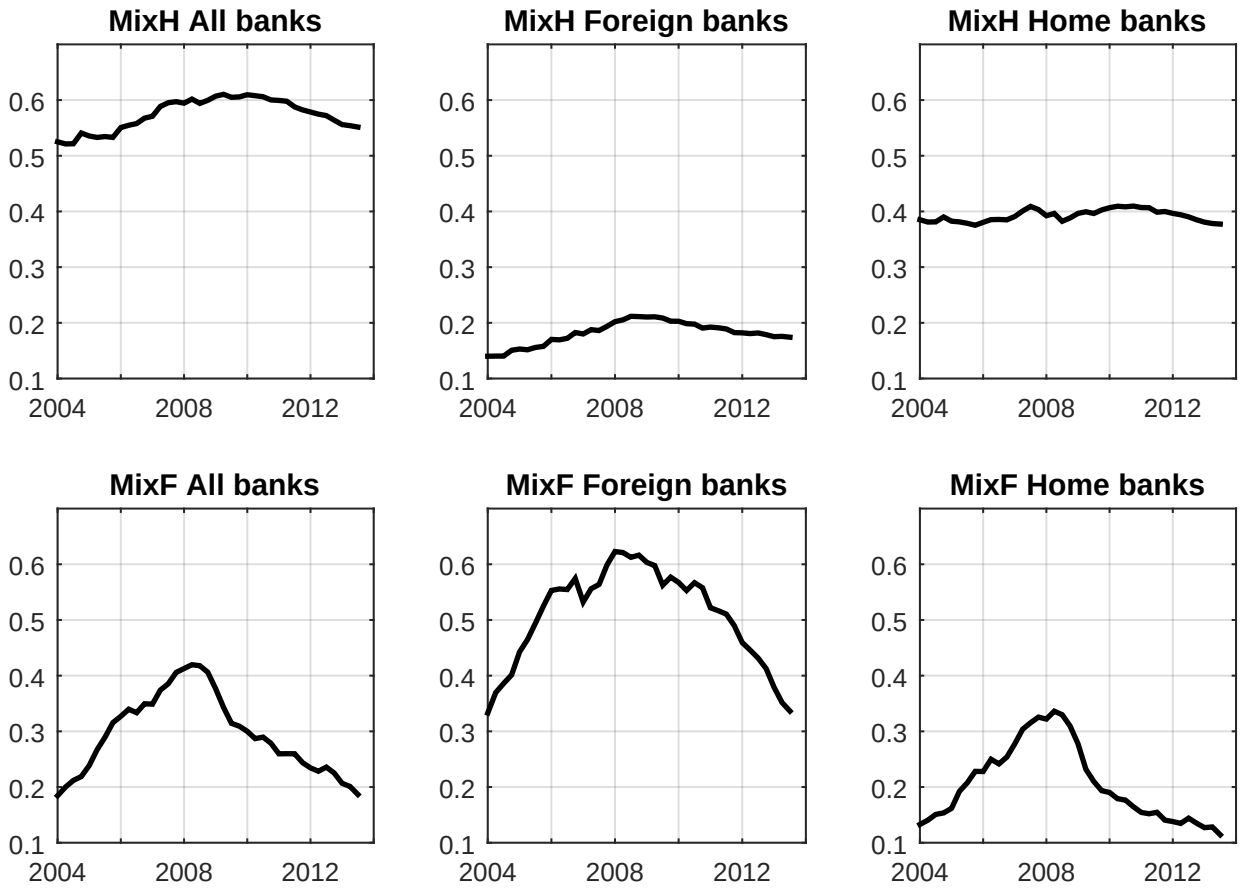
Figure 1 plots the Mix variables for all, domestic and foreign banks. The majority of external debt funding for firms comes from banks (top left panel in Figure 1, the sample mean is just below 60%), of which about two thirds comes from domestic banks and about a third from foreign banks, consistent with 32% market share of foreign banks in terms of lending over the sample.[7] The bottom three panels show the funding structure of banks.

[6] When we define $MixH$ for domestic and foreign-owned banks separately, we include in the denominator only loans from domestic and foreign banks, respectively, together with trade credit, securities, and loans from non-bank intermediaries.

[7] In terms of absolute values, bank lending to firms amounts to an average of EUR 17 billion over the

Foreign banks are substantially more dependent on foreign funding (51% over the sample average) compared to domestic banks (21% over the sample average). Moreover, both Mix indicators tend to be volatile, where $MixF$ is substantially more volatile than $MixH$. The standard deviation of the aggregate $MixH$ is 5.1% (12% for foreign banks and 2.7% for domestic banks) and the standard deviation of $MixF$ is 24.5% (18.4% for foreign banks and 32.9% for domestic banks). The standard deviation of trade credit over the sample is 20%.

Figure 1: Mix variables.



The advantage of using Mix indicators based on the outstanding stock of debt instead of relying on interest rates for identification is that Mix indicators capture the effect of credit rationing better than interest rates do. As argued by Stiglitz and Weiss (1981), interest rates are not a suitable screening device, and there may be borrowers that are willing to take a loan at a given interest rate, but are not able to obtain one due to rationing. This implies that fluctuations in the supply of funds may not be fully reflected in interest rates, either quoted or those based on actual transactions. Similarly, De Haas and van Lelyveld (2006) argue that perceived riskiness of borrowers may not be fully reflected in interest rates.[8] Our approach is therefore complementary and potentially more precise than approaches

sample, and consolidated trade credit (i.e., trade credit excluding inter-firm trade credit) to about EUR 5 billion. The remainder is a mixture of loans from insurances and pension funds, loans from abroad, and securities issued by firms (held by other sectors).

[8]See Ciccarelli, Maddaloni, and Peydró (2014) for evidence how banks tightened credit standards in Europe and Bank of Slovenia (2015a) for Slovenia.

based on spreads or interest rates often used for identification of loan supply shocks (e.g., Bijsterbosch and Falagiarda (2015) or Gambetti and Musso (2017)).

There are two reasons for focusing on bank lending to firms. The first is that, unlike households, firms can raise funding from other, non-bank sources, which makes it possible to construct $MixH$. The second is that banks in Slovenia have used their funds mainly to finance loans to firms. Direct lending of banks from abroad to domestic firms has been rare (see Gabrijelčič, Herman, and Lenarčič (2016) and Bank of Slovenia (2009)), while household borrowing has been very restrained.[9]

A concern regarding the Mix indicators of loan supply is that changes in the indicators may be driven by shifts of financing between different types of firms. Oliner and Rudebusch (1996) pointed out that changes in the Mix may be due to the shift of all forms of financing from small firms to large firms, because the latter rely less on bank loans and more on commercial paper. This argument is less of a concern in Slovenia, where all firms are small from the financing perspective (securities and commercial paper were either not used during the sample or their use was negligible - the average in our sample is a little more than EUR 0.5 bn.). Data on firm balance sheets by firm size are not available at quarterly frequencies, which prevents a formal investigation of potential distributional shifts. We used interpolated annual data to investigate whether large firms, who likely have more access to foreign financing, behave differently, but found no significant differences between large and small firms.[10]

2.4 Identification

To identify shocks to bank funding supply from abroad we rely on a set of Mix indicators and sign restrictions (Uhlig (2005) and Fry and Pagan (2011)). To further strengthen the identification we also apply narrative sign restrictions, as advocated by Antolín-Díaz and Rubio-Ramírez (2018).

Sign restrictions. The sign restrictions are summarized in Table 1. An expansionary foreign funding supply shock is defined as a situation when $MixF$, $MixH$, and loans increase on impact. If the supply of funds from abroad to banks increases *relative* to the supply of other sources of bank funds, then $MixF$ increases. To be consistent with the notion that banks pass the increase in the supply of foreign funds to firms, bank loan supply has to increase in absolute terms and *relative* to other sources of firm funding, which implies that both $MixH$ (the proportion of bank loans to firms in all firm debt liabilities) and loans must increase.

A concern with the above reasoning is that if the supply schedule for bank loans is more elastic than the supply schedule for other sources of firm funding, then an increase in

[9] Households in Slovenia are among the least indebted in Europe (Arrondel et al., 2014).
[10] Results are available upon request.

credit demand could also lead to an increase in $MixH$.[11] To see this, consider the following stylised definition of $MixH$:

$$MixH \equiv \frac{B}{B+T}, \tag{2}$$

where B is bank loans and T is trade credit. Importantly, an increase in credit demand by firms would increase both B and T, while an increase in the supply of B or in the supply of T would increase only one of them, but not the other. However, for a given increase in credit demand, if the supply of B is more elastic than the supply of T, $MixH$ would increase. To exclude this possibility, we impose a restriction that guarantees that the increase in $MixH$ does not come from a joint increase in B and T, but only from an increase in B.

Rewriting equation (2) in terms of deviations (where t is the percent deviation for trade credit, b is the percent deviation for bank loans, and m is the percentage point deviation for $MixH$) gives us

$$(m + MixH) \equiv \frac{(1+b)B}{(1+b)B + (1+t)T}. \tag{3}$$

Rearranging yields the following restriction on the magnitude of the change in $MixH$ that ensures that an increase in $MixH$ does not come from a joint increase in B and T (recall that the restriction on the response of bank loans guarantees that $b > 0$):

$$t = \frac{(1+b)(1-(m+MixH)}{(m+MixH)} \frac{MixH}{1-MixH} - 1 < 0. \tag{4}$$

In Table 1 we indicate this magnitude restriction by "$t < 0$" in the first row. During our identification procedure, we only accept those draws where this additional restriction is satisfied. In our benchmark case we evaluate $MixH$ at the sample mean, but we have checked that our results are not materially affected if we use the sample minimum or maximum for $MixH$.

The same concern as for $MixH$ can also arise for $MixF$. In our benchmark VAR we cannot apply the same restriction on $MixF$, because we would require an additional series for non-foreign funding sources of banks. We deal with this issue in two ways. The first is by adding a narrative restriction that strengthens the identification, as discussed below. The second is a robustness check with an additional variable in the VAR, discussed in Section 5.

To see how these restrictions operate, consider a sudden stop described by Martin and Philippon (2017). This would be picked up by our identification as a decrease in both $MixF$ and $MixH$, while firms' endogenous deleveraging would imply a decrease in $MixF$, but not a decrease in $MixH$ (if firms wanted to deleverage, they would deleverage with respect to all debt, not only with respect to bank debt). Note that we only identify a tightening of

[11] We are grateful to an anonymous referee for pointing this out.

one lending friction relative to others, not the overall level of lending frictions.[12]

Table 1: Sign restrictions for identified shocks

Expansionary shock	GDP defl.	GDP	Loans	MixH	MixF
Foreign funding supply			+	+, $t < 0$	+
Home bank loan supply			+	+	-
Aggregate supply	-	+	+	-	
Aggregate demand	+	+	+	-	

Although we are interested in the foreign funding supply shock to banks, we follow Fry and Pagan (2011) and identify other shocks to improve the identification of the foreign funding supply shock. The additional shocks are bank loan supply shock originating in the home country, aggregate demand and aggregate supply shock. The one remaining unidentified shock is meant to capture the effects of all other shocks and we check that it does not have the same sign pattern as the foreign funding supply shock.

A positive bank loan supply shock originating in the home country is identified as the increase in the proportion of bank loans among the alternative sources of firm finance, $MixH$, and the decrease in the proportion of foreign funding of banks, $MixF$. The rationale is that when banks have excess funding available within the country (e.g., due to an increase in deposits), they will not increase their foreign liabilities at an even higher rate than the increase in domestic funds, resulting in a decrease in $MixF$. In this case banks may even decide to repay some of their foreign liabilities. However, for our identification we only require a less restrictive assumption that banks do not increase their foreign liabilities by more than domestic liabilities increase. At the same time, they will try to increase lending (relative to other providers of funds to firms), resulting in an increase in $MixH$ and the level of loans.

To identify aggregate demand and aggregate supply shocks, we rely on assumptions consistent with a number of theoretical models (see Bijsterbosch and Falagiarda (2015) or Gambetti and Musso (2017) for an overview). An expansionary aggregate demand shock increases prices and real GDP, while an expansionary aggregate supply shock increases real GDP and decreases prices. We assume that both aggregate demand and aggregate supply shocks increase lending, but that they more than proportionally increase non-bank lending at home. The reason is that the main alternative to bank lending to firms is trade credit, which automatically increases with economic activity due to an increase in sales, while obtaining bank loans involves costs and delays related to loan applications.

When we use only sign restrictions, we impose them on impact responses. We follow Fry and Pagan (2011) and first generate a set of 500 models that all satisfy sign restrictions in Table 1 (*structural identification*). To select a single model from this set of models (*model identification*), we use the median target approach.[13] Confidence bands are generated using

[12] We are grateful to Sebnem Kalemli-Özcan for pointing this out.

[13] This approach picks the model whose impulse responses are closest to the median of the responses of

bootstrap around the median target response.

Narrative sign restrictions. To strengthen our identification of the foreign funding supply shock and to further investigate the robustness of our results, we use the narrative sign restrictions approach proposed by Antolín-Díaz and Rubio-Ramírez (2018), in addition to the sign restrictions. Specifically, we impose that in the historical decomposition, the contribution of the foreign funding supply shock to banks to $MixF$ and to loans has to be negative in the first three quarters of 2013. The reason for choosing this restriction is that the narrative of the events during this period is consistent with a negative foreign funding supply shock, but inconsistent with some alternative explanations.

First, the Bank of Slovenia (Slovenia's central bank) listed the intensification of a credit crunch due to bank deleveraging towards foreign creditors as a reason to justify an introduction of a macroprudential measure. Credit crunch is explicitly mentioned in its Notification to the European Systemic Risk Board, where the Bank also argues that deleveraging towards foreign creditors intensified in 2013 "... across the whole banking system ..." (Bank of Slovenia (2014b)). The intensification was such that in 2013 liabilities of banks to foreign creditors were reduced by 29.4% in one year only, which was the strongest reduction since the start of the crisis (Bank of Slovenia (2015b)). In the words of the then-governor of the central bank "... in the second quarter of 2013 ... the availability and the cost of funding for banks on wholesale markets came under further pressure" (Jazbec (2016)). Domestic banks kept loan-to-deposits (LTD) ratios constant from the onset of the crisis, but started to decrease them in 2013. Foreign banks were gradually reducing LTD since 2010, but almost doubled the rate of reduction in 2013 (Bank of Slovenia (2015b)). These statements and evidence are consistent with the negative foreign funding supply shock to domestic and foreign-owned banks during 2013.

Second, during 2013 the largest and most creditworthy firms almost doubled the issuance of commercial paper (Bank of Slovenia (2014a)). This indicates that there was creditworthy demand for debt, but that firms that could access markets found it easier to obtain funds on the market than from banks. There was also an increase of direct borrowing of firms abroad, which also indicates that credit demand was creditworthy (Šuler Štavt (2014)). Such behaviour is inconsistent with the hypothesis that the reduction of loans during this time was due to lower credit demand or credit demand that was not creditworthy, but is consistent with a negative foreign funding supply shock to banks.

Third, banks did not accumulate liquidity during 2013. According to the Bank of Slovenia (2015b), banks were rapidly reducing their liquidity ratios during this period, using their free cash flow to pay off foreign debt, while Jazbec (2016) states that this has further intensified in 2013. Such developments induced the Bank of Slovenia to adopt a macro-

all models that satisfy sign restrictions. The measure of proximity is the minimum squared distance between the model's impulse responses and the median impulse response from the set of models that satisfy sign restrictions. See Fry and Pagan (2011) for details.

prudential measure (Bank of Slovenia (2014b)) to contain the reduction in liquidity. Based on this evidence, our narrative sign restriction is consistent with the negative foreign funding supply shock to banks, but it is inconsistent with a potential alternative explanation that banks reacted to increased uncertainty. If that were the case, banks would accumulate liquid assets instead of reducing them.[14]

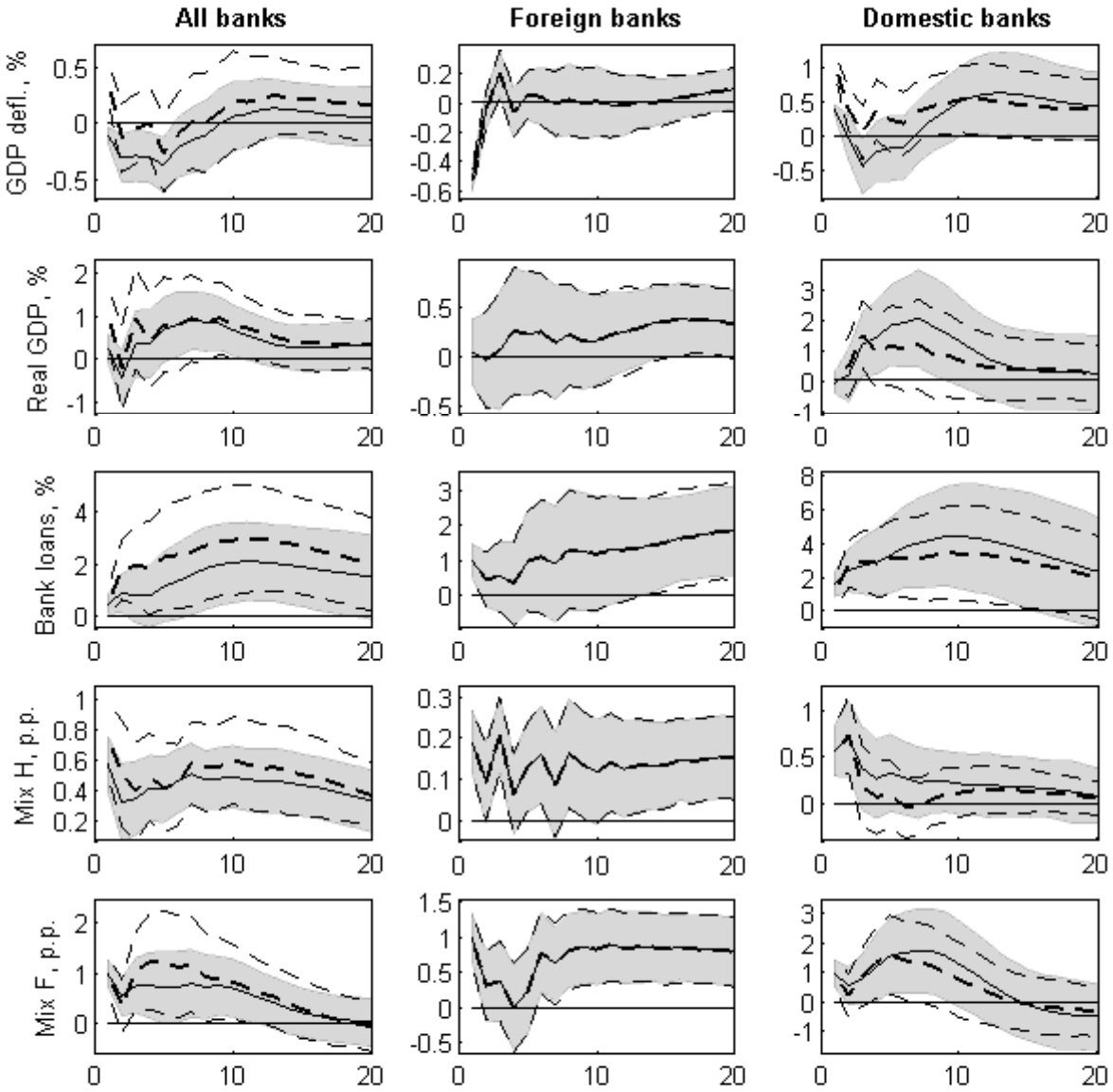
3 Responses to the foreign funding supply shock

The responses to an increase in foreign funding supply to banks, standardized to a one percentage point increase in the foreign funding supply indicator, $MixF$, are plotted in Figure 2. The left column shows the results for the banking system as a whole, the middle column for foreign-owned banks, and the right column for domestic banks. The results from sign restriction identification are reported with shaded areas and the results from the identification with sign and narrative sign restrictions are reported with dashed lines. All confidence bands are 90% (i.e., they correspond to the standard 5% significance level for a one-sided test).[15]

[14]Note that in standard consumption-savings models, even risk neutral agents will build precautionary savings if they face uncertainty and are subject to potentially binding constraints (see Carroll (2001), Carroll and Kimball (2001)). The same logic would apply to banks in the presence of minimum liquidity ratios (Bank of Slovenia (2014b)).

[15]Our identification relies on set identification. Baumeister and Hamilton (2019) point out that in set-identified models there is also uncertainty about the identifying assumptions themselves. There is no reason to claim that some of the responses in the identified set are more likely than the others. For example, it could be that some (or even many) impulse responses that satisfy sign restrictions reverse sign immediately after the sign restrictions stop binding, even if the median target impulse response retains the sign. Baumeister and Hamilton (2020) suggest that a way to be transparent about the uncertainty related to the identification assumptions is to report full identified sets, which we do in Appendix A.

Figure 2: Effects of an expansionary foreign funding supply shock, sign and narrative sign restrictions.



Notes: All responses are percentage deviations from initial values, except for the mix variables, which are in percentage point deviations. The full line with the shaded areas represents the responses when only sign restrictions are used. The shaded areas are 90 percent confidence bands, generated using bootstrap with 1000 draws. The thick dashed line represents the responses when both sign and narrative sign restrictions are used. The corresponding thin dashed lines are 90 percent confidence bands. All impulse responses are standardised to a 1 standard deviation shock to $MixF$.

For the banking system as a whole (the left column in Figure 2), an expansionary shock to foreign funding supply causes a strong and persistent increase in both mix indicators. Bank loans increase persistently and significantly already on impact, and real GDP increases significantly after about a year and remains elevated for about three years. The response of prices is ambiguous on impact, but after about one year after the shock they start returning to the initial level and tend to increase afterwards, although not significantly. These responses hold regardless of the identification method, but the results from

the identification with both sign and narrative sign restrictions tend to show a stronger credit expansion and lower initial decline in the price level. This difference is mainly due to the stronger propagation of the shock in $MixF$ when narrative sign restrictions are used. The response of $MixH$, which indicates that banks pass the increase in the supply of foreign funds to firms by increasing loan supply by more than other providers of firm funding, follows a similar path in both identification schemes.

The responses in VARs including only foreign or only domestic banks (middle and right columns in Figure 2) tend to follow a similar pattern as the responses of the banking system as a whole. However, the short-run responses of domestic and foreign-owned banks are somewhat different. Foreign-owned banks tend to respond with a delay in passing on the increase in their foreign funding to firms, and the responses of loans and GDP are less pronounced than is the case for domestic banks, even though the response of their loans is statistically significant on impact and then again after about three years. GDP does increase, but this does not become significant until about three years after the shock. This pattern holds across both identification schemes (narrative restrictions turn out to be satisfied already with sign restrictions). The response of foreign bank loans also tends to be lower in terms of magnitude than the response of domestic bank loans. In contrast, domestic banks tend to respond faster and more strongly to the shock, but the effects tend to be less persistent. A different identification scheme does not materially affect the results for domestic banks, except the response of prices, which do not decrease when narrative restrictions are used. Overall, the results suggest that the attenuation of the responses for the banking system as a whole compared to domestic banks is mainly due to the contribution of less pronounced initial responses of foreign banks.

The magnitudes of responses in Figure 2 can be somewhat misleading. Because the structure of bank balance sheets of domestic and foreign banks differs with respect to foreign funding, it is not clear that the comparison based on the standardization of the shock with respect to $MixF$ is appropriate. Domestic banks use only 20.5% of foreign funding, foreign-owned banks use 50.8%, and the banking system as a whole uses 29.5% (all are sample averages), so that a 1 p.p. increase in $MixF$ means that foreign-owned banks are subject to a substantially larger shock in terms of the balance sheet structure than domestic banks or the banking system. If we take the liability structure of the banking system as the benchmark, then the responses of domestic banks should be scaled up by a factor of 1.44, and the responses of foreign banks scaled down by a factor of 0.58. With such scaling, the peak real GDP response to a foreign funding supply shock is 0.93% for the banking system, 0.42% for foreign banks, and 2.1% for domestic banks. The peak responses for loans are 3.58%, 1.03%, and 4.90% for the banking system, foreign banks, and domestic banks, respectively (all numbers are reported for the identification scheme with sign and narrative restrictions).

We can also compare the magnitudes of real GDP and lending responses after taking into account the market share of foreign-owned banks, which has been stable at around

30% over the sample, both when measured in terms of the balance sheet size and in terms of lending. Again taking the banking system as a whole as the benchmark, this implies that the responses of real GDP and loans should be scaled up by a factor of 3.3 for foreign-owned banks and by a factor of 1.7 for domestic banks. The peak GDP response to a shock in foreign funding supply, adjusted for the market share is 2.40% for foreign-owned banks and 2.53% for domestic banks. The market-share adjusted peak response of loans is 5.87% and 5.78% for foreign-owned and domestic banks, respectively.

Therefore, after taking into account the market share, the finding that foreign-owned banks respond less vigorously to shocks in foreign bank funding supply is not upheld. These results are consistent with the finding that the transmission of shocks to the supply of foreign funds to the domestic economy is slower, but not necessarily more attenuated when it is transmitted through foreign-owned banks, if one accounts for their market share and the structure of their balance sheet. A possible interpretation is that foreign-owned banks follow more prudent lending practices (as reported in Brezigar-Masten, Masten, and Volk (2015)), which is why they distribute funds obtained from abroad more gradually to the economy. It may, however, also be the case that foreign banks were subject to less severe or less persistent foreign funding supply shocks over the sample. The macroeconomic consequence of either explanation is that this led to less procyclical behaviour of lending, real GDP, and inflation.

4 Shocks to the supply of foreign funds and business cycles

To determine the relative importance of shocks to foreign funding supply for the business cycle, we use the co-movement statistic of den Haan (2000), which is an intuitive form of decomposition of VAR forecast errors. This statistic allows us to decompose the contributions of all structural shocks to standard deviations or correlations to any variable in the VAR.[16] It allows us to investigate whether the shock to foreign funding supply is important relative to other shocks in driving the co-movement of the variables of interest. We focus on the standard deviations of real GDP and loans, and on the correlation between them.

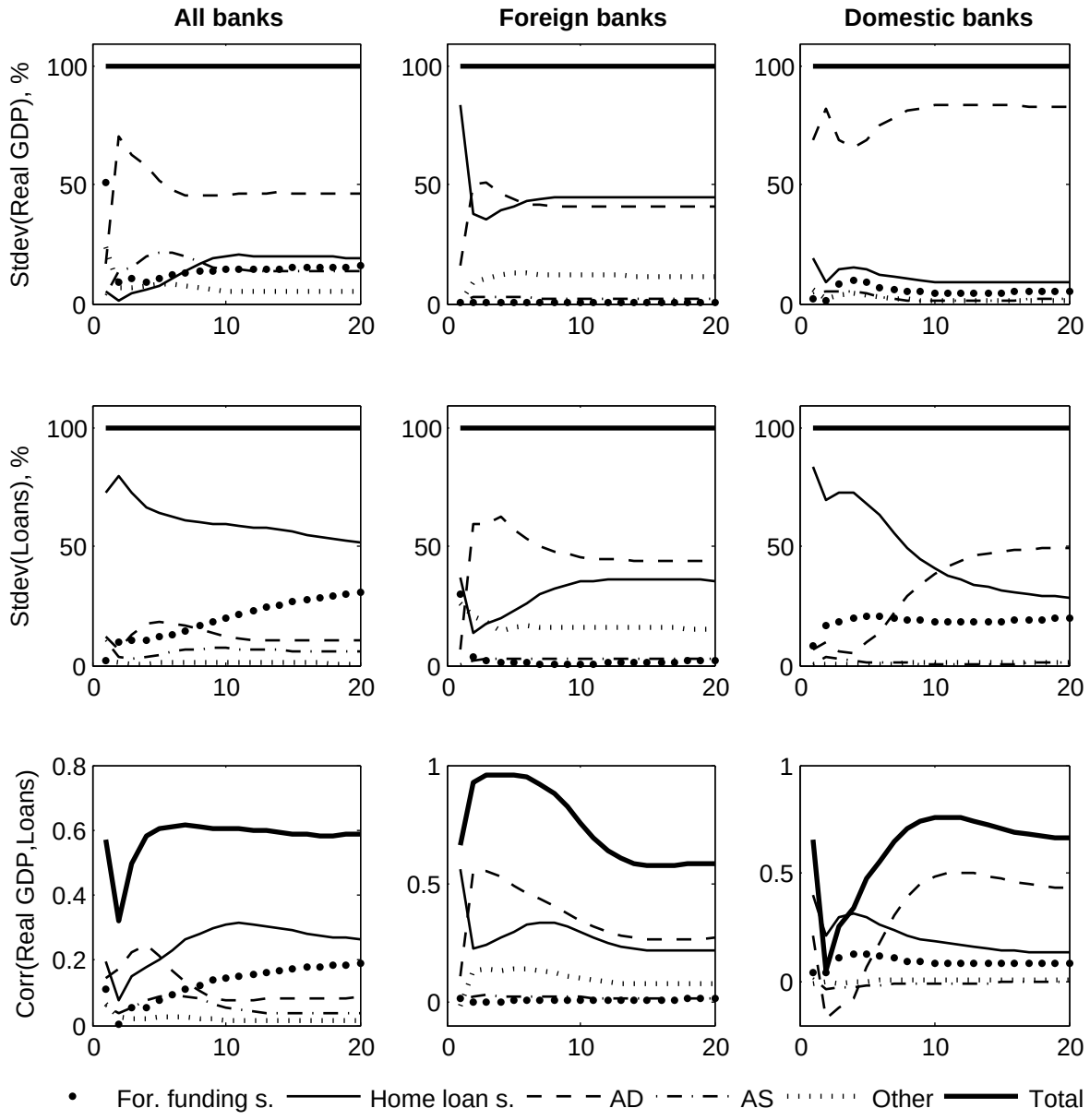
The results are reported in Figure 3, where the columns correspond to the columns in Figure 2. The left column shows the results for the banking sector as a whole. In our sample, aggregate demand shocks (dashed line) are the most important driver of fluctuations in real GDP, and home loan supply shocks tend to drive most of the movement in bank loans, and their correlation with GDP.[17] They are followed by the shock to foreign funding supply to banks (dotted line), which tends to be the second or third most important shock in the medium run, contributing about 20% to the variation and the co-movement of the

[16] The co-movement between two variables, conditional on a shock, is the standardized product of impulse responses to this shock up to the chosen time horizon. Note that the total correlation or standard deviation *do not* depend on how the shocks are identified.

[17] Note that the finding that an aggregate demand shock is important even at longer horizons is not unusual if there are hysteresis effects (see Furlanetto et al. (2019).)

variables. At frequencies below one year, fluctuations of loans and the co-movement of loans and real GDP tend to be driven also by shocks to aggregate demand, but their effects in these cases diminish at longer horizons.

Figure 3: Co-movement and variance decomposition.



Notes: The top and middle rows show the contributions of structural shocks to the standard deviation of real GDP and loans, in percent. The x-axis indicates the time horizon in quarters. The bottom row shows the contribution of shocks to the correlation between real GDP and loans. Left, middle, and right columns corresponds to VARs with all loans, loans of foreign-owned banks, and loans of domestic banks, respectively. The shocks are based on the identification with sign and narrative restrictions.

The results for foreign-owned banks (the second column of Figure 3) are similar to the results for the aggregate in that shocks to aggregate demand and home loan supply cause most of the fluctuation of variables. The difference is that shocks to foreign funding supply have little importance, except in driving the fluctuations in bank loans in the short run,

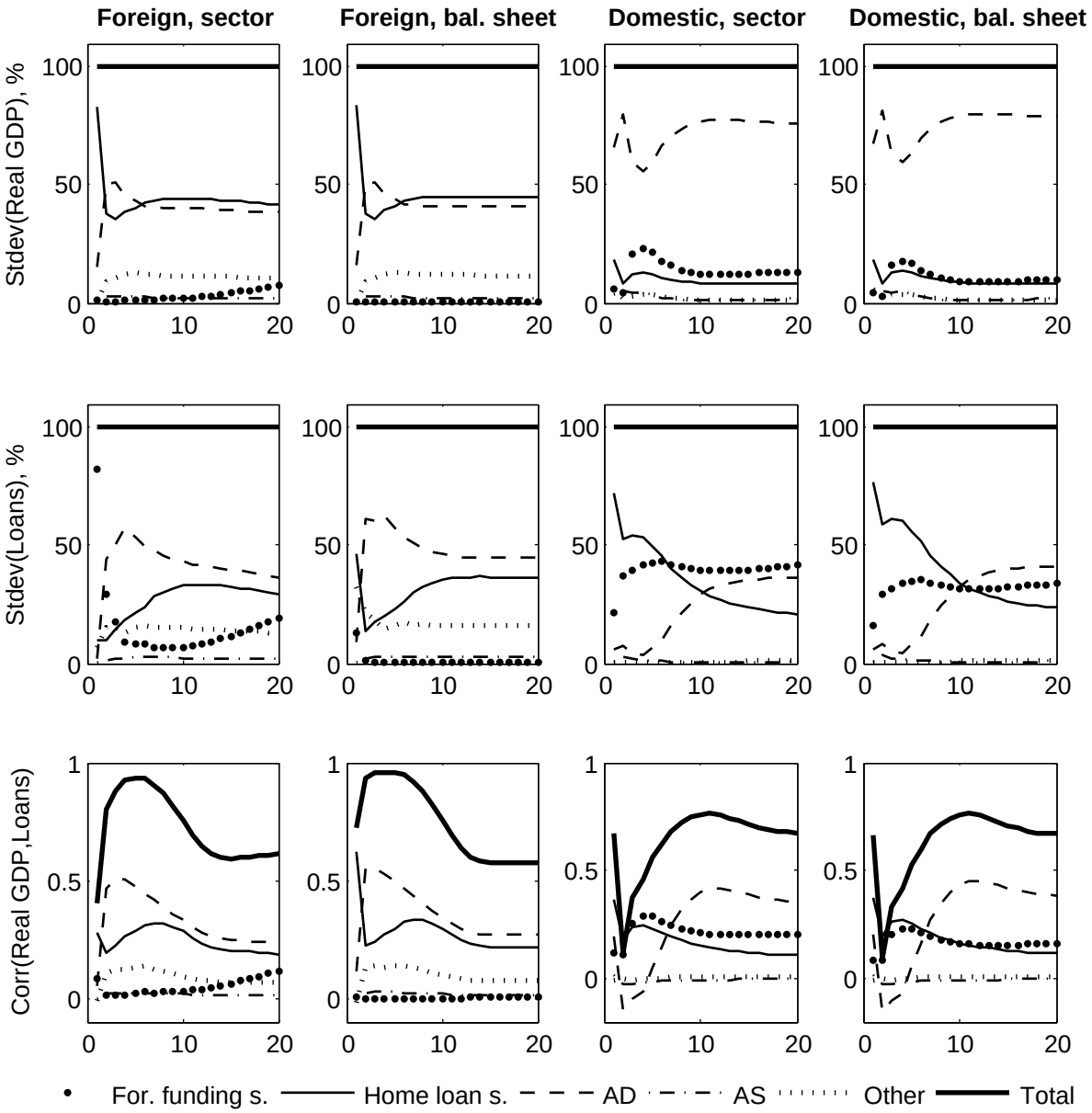
where this shock explains about 30% of fluctuations of foreign bank loans. For domestic banks (the third column of Figure 3), shocks to aggregate demand are by far the most important drivers of fluctuations in real GDP at all time horizons and the correlation of real GDP and loans at longer time horizons. Shocks to foreign funding supply are the third most important shock in terms of their contribution to fluctuations and the correlation between real GDP and bank loans.[18]

These results indicate that the findings reported in Section 3 are only part of the explanation of how foreign funding supply shocks transmit through banks to the economy. It is still the case that, conditional on the foreign funding supply shock, foreign-owned banks act less expansionary than domestic banks and that they do so with a delay. The results from this section show that shocks to foreign funding supply have been less important for foreign-owned banks than for domestic banks, relative to other shocks, except for short-term fluctuations of foreign bank loans. Therefore, conditional on shocks to foreign funding supply, domestic banks have contributed more to the fluctuations in real GDP, loans, and the correlation between them, compared to foreign banks.

We have argued above that to compare the responses of foreign and domestic banks to the responses of the banking sector as a whole, one should account for the structure of balance sheets and the market share of each sector's banks. Figure 4 plots the same variance decomposition as Figure 3, just that this time we re-scale the responses of foreign banks to a foreign funding shock by a factor of 3.3 to account for the sector size and by a factor of 0.58 to account for the structure of the balance sheet. Similarly, we rescale the responses of domestic banks to a foreign funding shock by a factor of 1.7 for the sector size and by a factor of 1.44 to account for the structure of the balance sheet. The results for foreign banks are reported in the left two columns in Figure 4 and the results for domestic banks in the two columns on the right. This counterfactual experiment tells us that if domestic banks were of the same size as the entire banking sector or if the structure of their balance sheet was the same, then foreign funding shock would be the second most important driver of fluctuations in GDP (top right two panels) and the most important or the second most important shock driving the fluctuations in loans (middle two panels on the right). The same experiment for foreign banks does not alter the results much, except that the foreign funding shock becomes the most important driver of fluctuations in lending in the short run. There is also some gain in importance of this shock in explaining output fluctuations and co-movement between output and loans over the longer horizon, consistently with the finding that foreign banks pass the shock through with a delay.

[18] Totals reported in the bottom panels of Figure 3 (thick full lines) are consistent with correlations obtained using more standard methods (which do not permit conditioning on shocks). Using a Christiano-Fitzgerald band-pass filter corresponding to frequencies between six and 32 quarters, we obtain the correlation between domestic bank loans and real GDP of 0.54, and the correlation between loans by foreign-owned banks and real GDP of 0.33.

Figure 4: Counterfactual variance decomposition.



Notes: The top and middle rows show the contributions of structural shocks to the standard deviation of real GDP and loans, in percent. The x-axis indicates the time horizon in quarters. The bottom row shows the contribution of shocks to the correlation between real GDP and loans. Left, middle, and right columns corresponds to VARs with all loans, loans of foreign-owned banks, and loans of domestic banks, respectively. The shocks are based on the identification with sign and narrative restrictions.

5 Robustness analysis

While using narrative sign restrictions helps to strengthen the identification with sign restrictions, there are also other ways to strengthen the identification and investigate if the results are upheld when using a different approach. This section examines the robustness of results to several alternatives.[19]

[19]See also Appendix B for further robustness checks.

5.1 Additional sign restrictions

In our benchmark case, we used narrative sign restrictions to ensure that the foreign funding supply shock we identify coincides with the narrative evidence. Here we apply the same sign restrictions as in Section 2.4, but we add an additional restriction on $MixF$ that excludes the possibility that an increase in $MixF$ is caused by an increase in demand for funding from banks. To apply the same reasoning as we did above for $MixH$, we need to include foreign liabilities of banks as an additional variable in the VAR. We impose the restriction that these liabilities increase after a positive foreign funding supply shock, and the restriction that an increase in $MixF$ does not coincide with the increase in other bank liabilities (as it would be the case if banks' demand for funding increased).

To be precise, if $MixF$ is defined as

$$MixF \equiv \frac{F}{F+D}, \tag{5}$$

where F stands for banks' foreign liabilities and D for other bank liabilities, our restriction is:

$$d = \frac{(1+b)(1-(m+MixF)}{(m+MixF)} \frac{MixF}{1-MixF} - 1 < 0. \tag{6}$$

These additional restrictions are reported in the first row of Table 2.

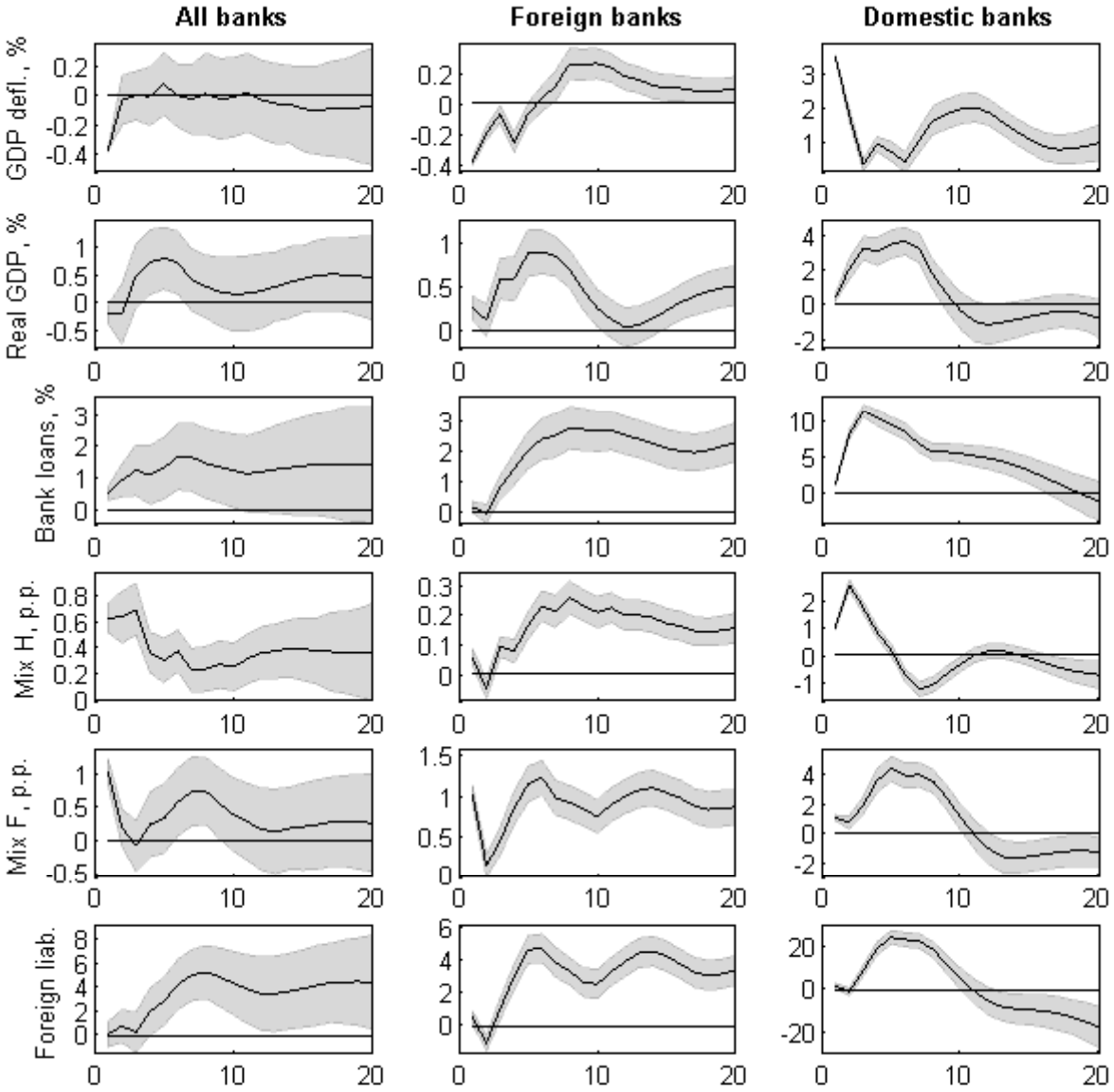
Table 2: Sign restrictions in the augmented VAR

Expansionary shock	GDP defl.	GDP	Loans	MixH	MixF	For. loans
Foreign funding supply			+	+, $t < 0$	+, $d < 0$	+
Home bank loan supply			+	+	-	
Aggregate supply	-	+	+	-		
Aggregate demand	+	+	+	-		

The results for all banks reported in Figure 5 are broadly in line with the benchmark results in Figure 2; prices fall initially and then return to the initial level, output increases after a few quarters' delay, and bank loans increase immediately and persistently. Foreign liabilities increase and remain elevated for an extended period. The results for foreign banks and domestic banks in terms of their lending and the impact on GDP are quantitatively much more pronounced than in the benchmark VAR, and for domestic banks the impact on prices is stronger. The direction of responses is preserved. Again, the response of lending of domestic banks is more front-loaded than the response of lending of foreign banks, which, unlike in the benchmark case, is now statistically significant after one quarter. As in the benchmark VAR, the increase in loans of foreign banks is more persistent than the increase in loans of domestic banks. There is a persistent increase in foreign liabilities for both foreign and domestic banks that goes much beyond the sign restriction imposed

on impact.[20] This increase is more persistent for foreign banks. Overall, the responses are consistent with the narrative that a foreign funding supply shock leads to a persistent economic expansion, accompanied by a persistent credit boom financed by bank borrowing abroad.

Figure 5: Effects of an expansionary foreign funding supply shock, augmented VAR.



Notes: All responses are percentage deviations from initial values, except for the mix variables, which are in percentage points. The shaded areas are 90 percent confidence bands, generated using bootstrap with 1000 draws. All impulse responses are standardised to a 1 standard deviation shock to $MixF$.

5.2 Identifying an additional shock

A potential concern is that an increase in bank borrowing abroad and firm borrowing from banks might be driven by a domestic shock that increases demand for funds by firms. We

[20]It should be noted that as we move towards more disaggregated level (foreign liabilities by bank type), these series tend to become smaller compared to the aggregate series and also much more volatile.

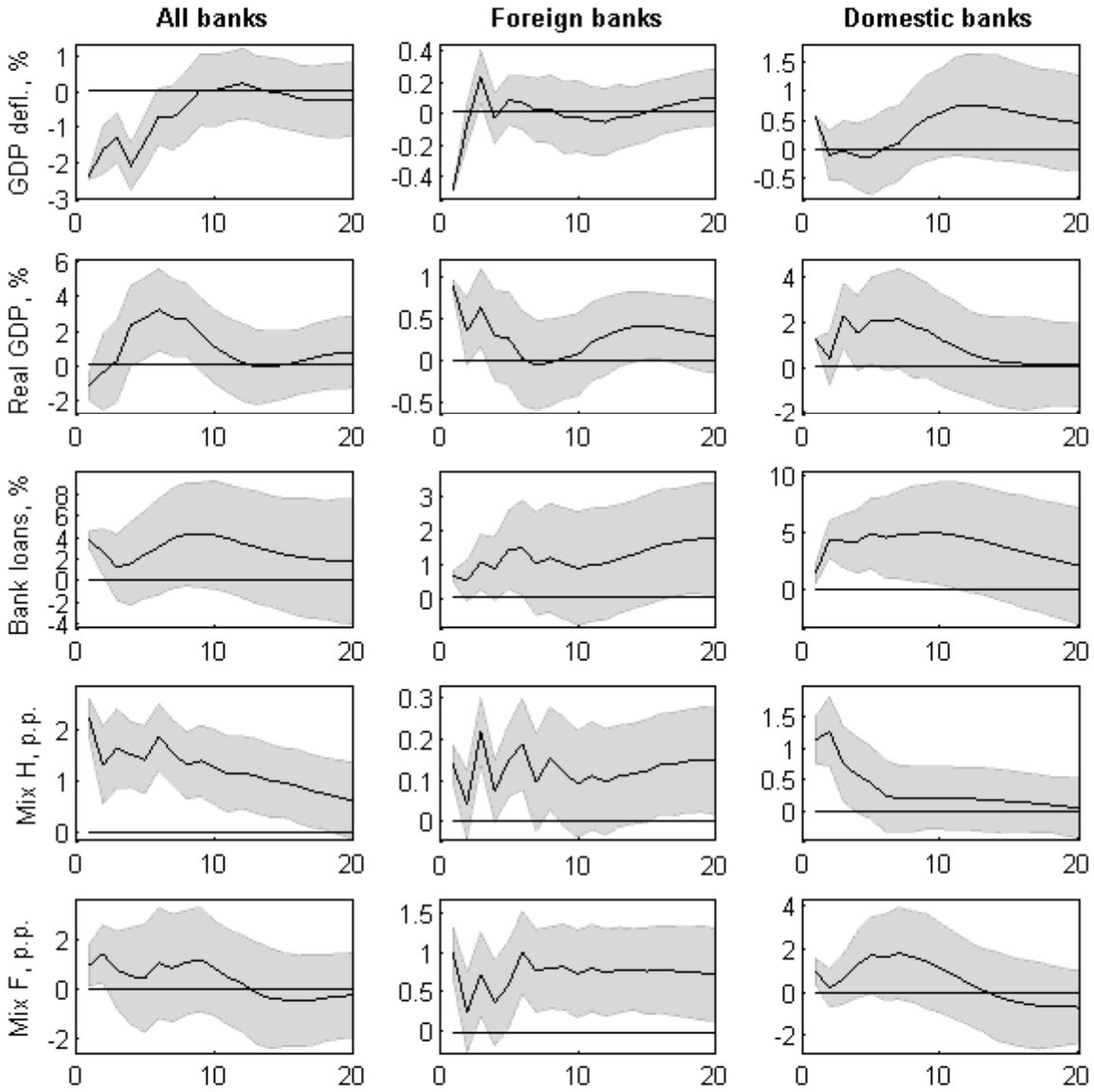
address this issue by a robustness check, where we identify a funding demand shock by firms as the fifth shock with a mix of zero and sign restrictions. We assume that an increase in funding demand by firms increases output, inflation, and bank borrowing abroad, but does not alter firm financing mix and therefore has a zero restriction on $MixH$. The rationale follows the logic of Kashyap et al. (1993) that an increase in funding demand by firms should not affect the composition of firm liabilities, but it may induce banks to borrow abroad. This additional restriction is imposed on impact and is reported in the last row of Table 3. We keep the sign restrictions for the other four shocks the same as in Table 1.

Table 3: Sign restrictions for five identified shocks

Expansionary shock	GDP defl.	GDP	Loans	MixH	MixF
Foreign funding supply			+	+, $t < 0$	+
Home bank loan supply			+	+	-
Aggregate supply	-	+	+	-	
Aggregate demand	+	+	+	-	
Funding demand by firms	+	+	+	0	

Figure 6 shows the responses to the foreign funding supply shock with the alternative identification of shocks. The results for all banks are with the benchmark results reported above. The response of lending by foreign-owned banks to a shock to foreign funding supply is slower than the response of domestic banks and it increases at longer horizons, but is now statistically significant at the shorter time horizon. The same holds for the GDP response. The response of lending by domestic banks is strong, immediate, persistent and statistically significant. The response of GDP for domestic banks is positive and propagates over about two years. Prices tend to decrease on impact, except in the VAR with domestic banks, where they increase on impact and then again about two years after the shock. Overall, the results are broadly in line with the findings reported for the benchmark case in Figure 2.

Figure 6: Effects of an expansionary bank funding shock, identification with a mix of sign and zero restrictions.



Notes: Impulse responses to a 1 standard deviation shock to the *MixF*. The responses are percentage deviations from initial values, while *MixH* and *MixF* are in percentage points. Shaded areas are 90 percent confidence bands, generated using bootstrap with 1000 draws.

5.3 Using different Mix definitions and recursive identification

We examine the robustness of our results using several definitions of Mix variables, and also using the recursive identification based on the Cholesky decomposition. This identification is often used and relies on timing assumptions. It requires that some variables react slower than others, and we assume that the Mix variables react quickly, while loans, output and prices react slowly.[21]

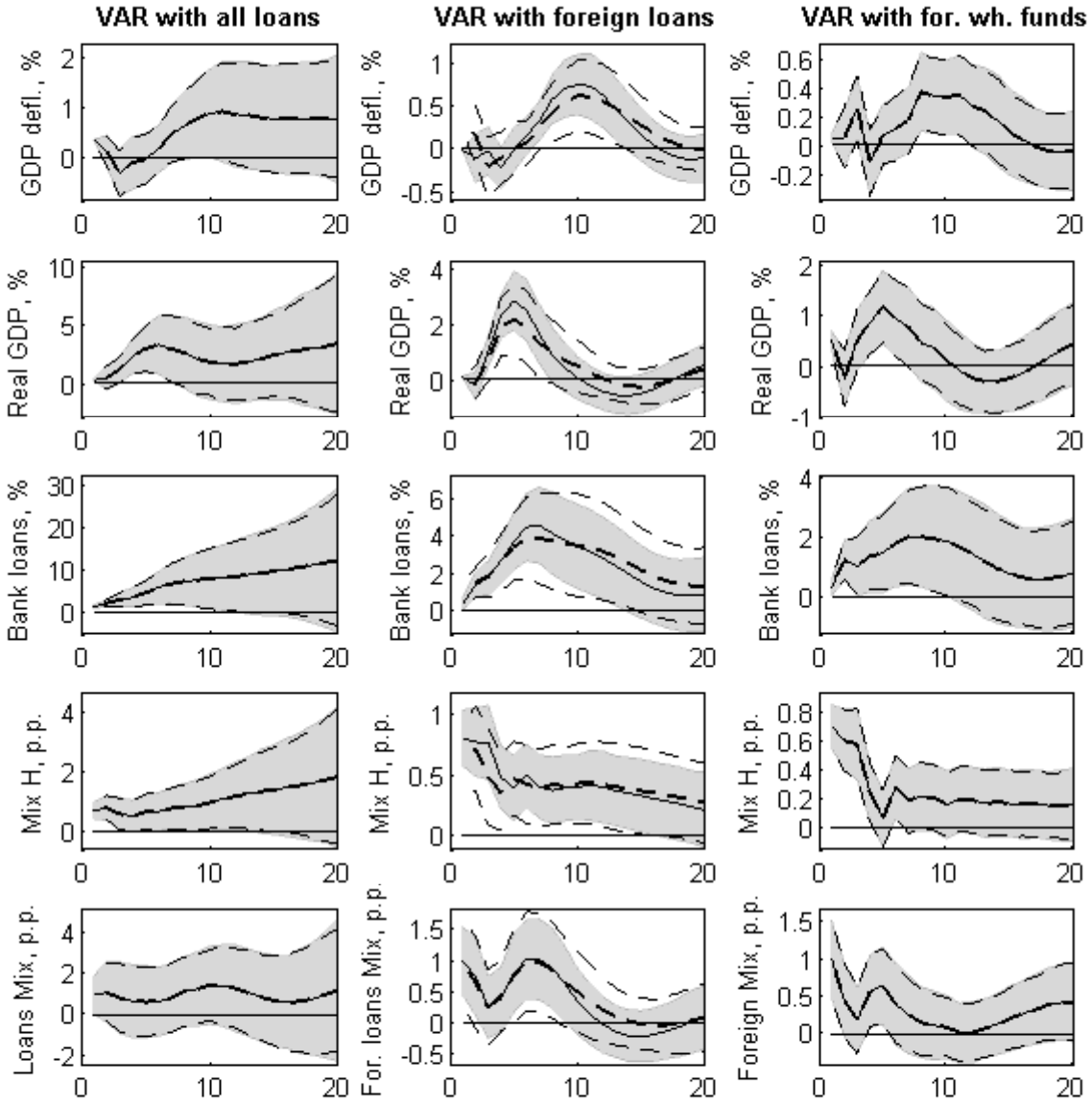
We first examine the addition of domestic wholesale funds of banks (loans provided by insurance companies, mutual funds, etc.) to foreign funds. We label this "Loans Mix,"

[21] The results are robust to how the Mix variables and loans are ordered.

which differs from the *MixF* in that domestic wholesale funds are now also in the numerator (and not only in the denominator) of the indicator. The results are shown in the left column of Figure 7 for the case with the identification with sign and narrative restrictions, and in the left column of Figure 8 for the case with recursive identification.

For the case of recursive identification in Figure 8 we also obtain results broadly consistent with those reported above. Note that also in this case, where Mix variables at the firm level and bank loans to firms are restricted to be zero on impact, we obtain that both these variables increase after the initial period, which is consistent with an expansionary shock to foreign funding to banks.

Figure 7: Robustness: Expansionary bank funding shock, identification with sign restrictions.

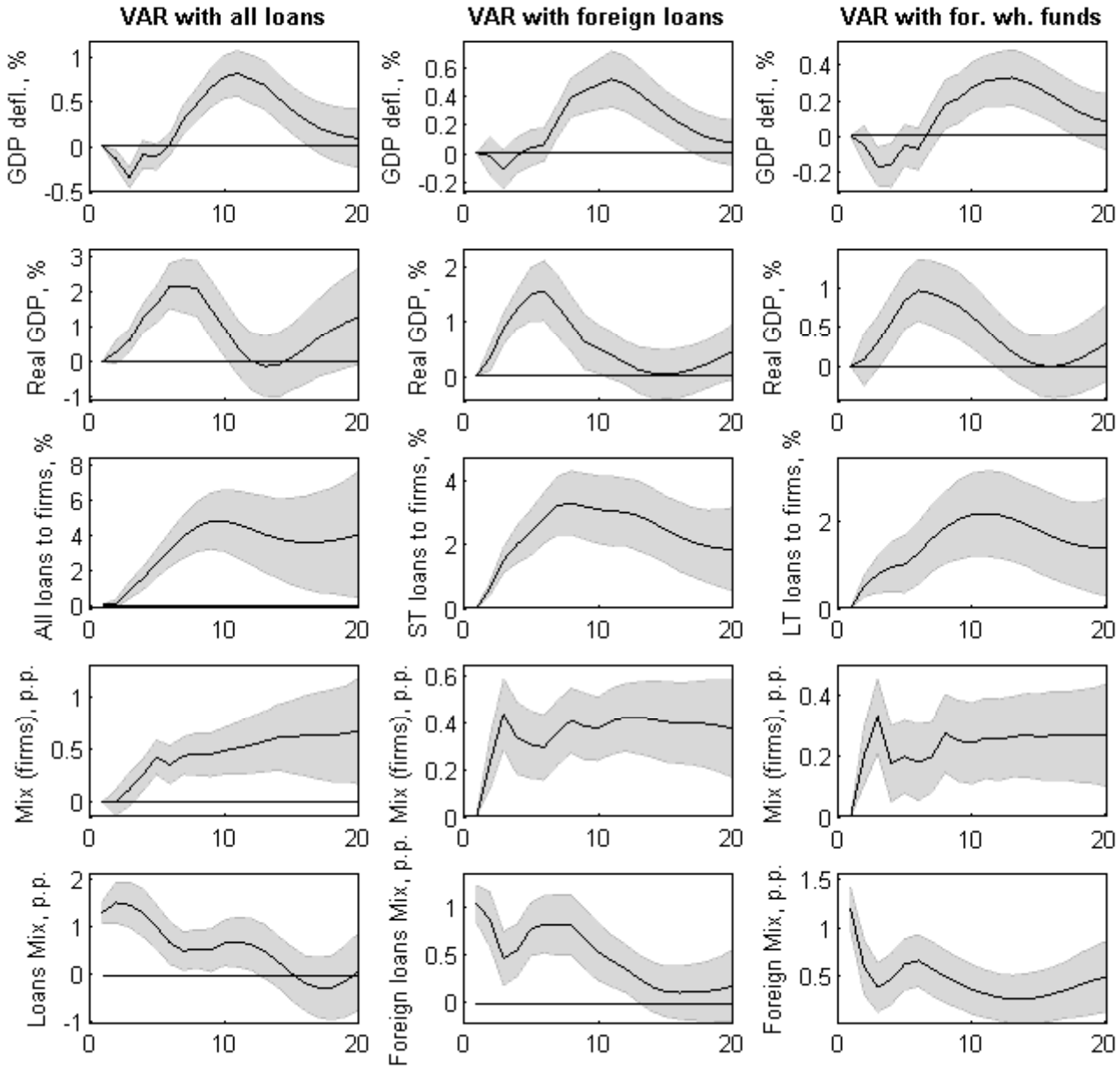


Notes: Impulse responses to a shock to the indicator of foreign funding supply. The responses are percentage deviations from initial values, except for the mixes, which are in percentage points. Shaded areas are 90 percent confidence bands, generated using bootstrap with 1000 draws.

Next, we investigate whether a particular type of foreign funds drives the results. To inspect this, we divide all foreign funds on loans and on other foreign wholesale funds (deposits and bonds from abroad), and compute the shares of each in all bank debt liabilities. We call these indicators "Foreign loans Mix" (which includes only foreign loans) and "Foreign Mix" (which includes all foreign funds, regardless of their type), respectively. The results for "Foreign loans Mix" are shown in the middle column of figure 7 for the identification with sign and narrative restrictions and in the middle column of Figure 8 for the recursive identification. Similarly, the results for "Foreign Mix" are shown in the rightmost column of both figures.

For all alternative Mix definitions and for all identification approaches the results are broadly in line with those reported above. There are differences in statistical significance and magnitude, especially regarding the responses of output and loans, which tend to be more pronounced and statistically significant when only foreign loans are considered in $MixF$. This is telling, given that foreign loans are the largest component of $MixF$ and it indicates that other, more sporadically used sources of funding may be less relevant for the analysis.

Figure 8: Robustness: Expansionary bank funding shock, recursive identification.



Notes: Impulse responses to a shock to the indicator of foreign funding supply. The responses are percentage deviations from initial values, except for the mixes, which are in percentage points. Shaded areas are 90 percent confidence bands, generated using bootstrap with 1000 draws.

6 Conclusions

In this paper we propose a way to identify a shock to the foreign funding supply to banks in the domestic economy using data from the flow of funds statistics and a combination of sign restrictions and narrative sign restrictions. We distinguish between all banks in the aggregate, foreign-owned banks, and domestic banks.

Our findings suggest that the effect of changes in the supply of foreign funds to banks on the domestic economy in a monetary union is procyclical, strong and persistent. An increase in the supply of foreign funding to banks results in a protracted expansion of

domestic lending, real activity and, after a delay, prices.

We also find some differences that depend on bank ownership. Foreign-owned banks tend to be slower in passing the increase in foreign funding to firms than domestic banks, and this remains the case when we account for the differences in the structure of liabilities and the sizes of balance sheets of domestic and foreign-owned banks. However, the magnitude of the response of foreign banks is not materially different from the magnitude of the response of domestic banks once one adjusts for the size of the sector. This implies that foreign-owned banks are only slower to transmit shocks from foreign funding supply, but do not differ from domestic banks in terms of the magnitude. An explanation consistent with these findings is that foreign-owned banks follow stricter lending practices, which slows the process of lending new funds received from abroad.

Shocks to foreign funding supply are an important driver of macroeconomic fluctuations in real GDP, loans, and their co-movement. These findings imply that it is important to monitor changes in bank funding conditions for domestic and foreign-owned banks. In principle, to avoid a credit expansion driven by the easing of credit conditions abroad, which we find causes a domestic output expansion and an increase in prices, macroprudential policies could be used either to dampen bank borrowing abroad or to slow the extension of these funds to firms. Our findings also suggest that measures that reduce the importance of foreign funding shocks to banks would be beneficial in terms of reducing the co-movement between bank loans and GDP, and their volatility.

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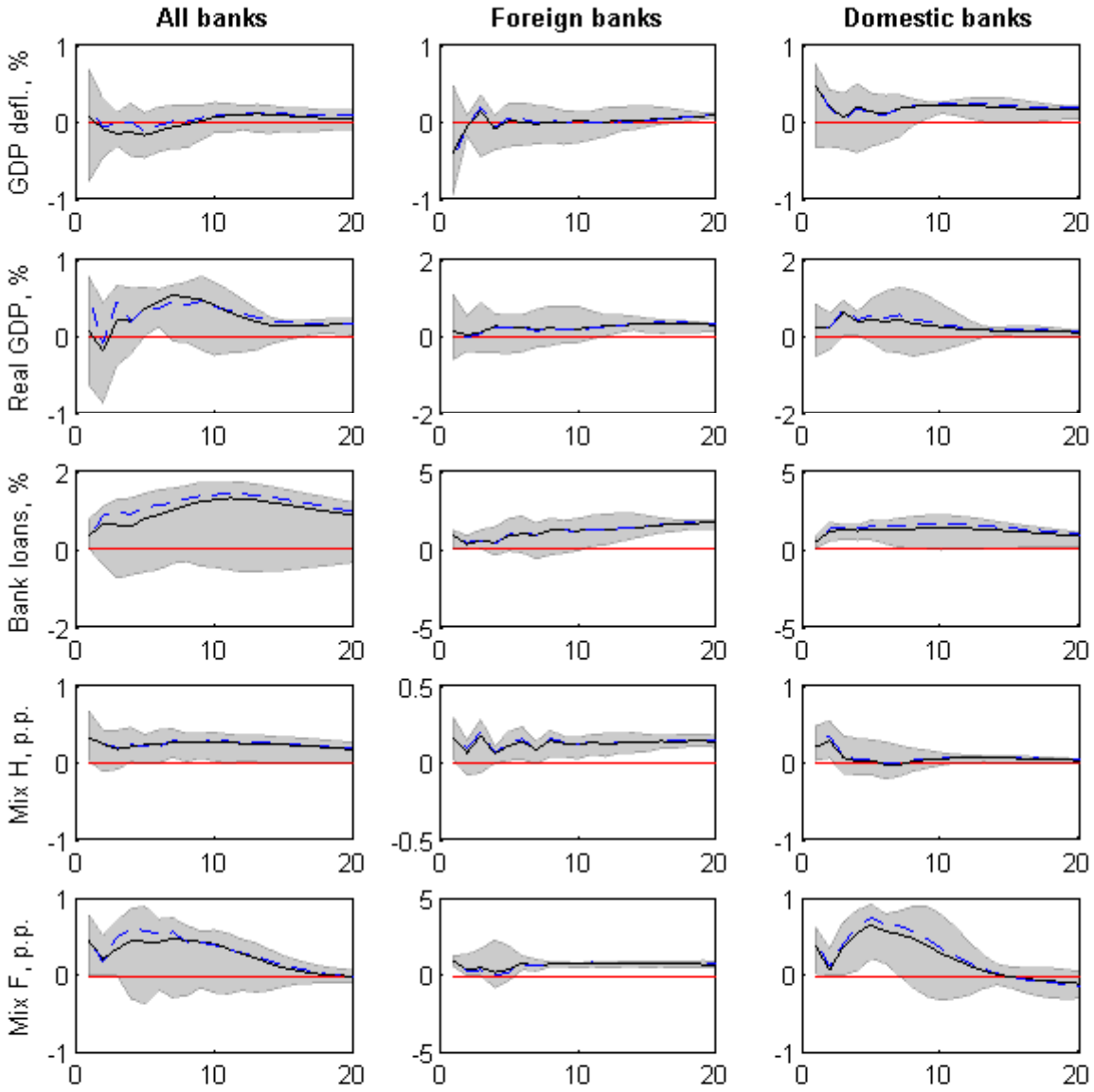
A The full identified set

In a recent paper Baumeister and Hamilton (2020) argue that reporting confidence bands around a median target impulse response can be misleading when a set identification is used, such as sign restrictions. They make the point that the Haar distribution is indeed uninformative about the angle of rotation associated with the rotation matrix, but the rotation matrix itself is a nonlinear function of the angle of rotation, and the impulse response is also a nonlinear function of the angle of rotation. Because a nonlinear transformation of a uniform distribution is no longer flat, some draws may appear more likely, even though they are not (Baumeister and Hamilton (2019)). Using the median target impulse response therefore implies that one is using more information than just the information contained in the data.

As one possible remedy Baumeister and Hamilton (2020) suggest researchers to report the full identified set, that is all draws that satisfied the set identification used. We report these sets for the identification with both sign and narrative sign restrictions in Figure 9. Note that all our admissible sets lead to an increase in both mix indicators and in bank loans typically also at periods beyond which sign restrictions were imposed. Also, output increases for all banks and for foreign banks in all successful draws after about one year, and after two and a half years for foreign banks. As explained in Baumeister and Hamilton (2020), this means that, if we had perfect knowledge of the coefficients in the estimated VARs, our results suggest that all mix indicators, all bank loans, and real GDP for domestic and foreign banks increase after a positive bank funding shock from abroad. While the response of loans in the VAR for all banks is not positive for every successful draw, this is the case for the vast majority of draws. I particular, it is not the case that successful draws for the relevant variables are almost evenly distributed around the zero line, as in the example analysed by Baumeister and Hamilton (2020) in their Figure 3. Only the results for inflation are less clear-cut, as inflation can either increase or decrease during the first ten periods (but tends to increase afterwards in all identified sets).

Figure 9: Effects of an expansionary bank funding shock, all admissible models.



Notes: The shaded areas include all admissible draws from the identification scheme with sign and narrative sign restrictions. The responses are percentage deviations from initial values, except for the mix variables, which are in percentage points. The full line is the median of all models and the dashed line is the median target impulse response.

B Additional evidence and robustness checks

This appendix documents some of the facts that are relevant for the more general background. In particular, we document:

1. The exchange rate changes during the ERM II period were negligible
2. The market share of domestic and foreign banks has not changed materially during the period under investigation

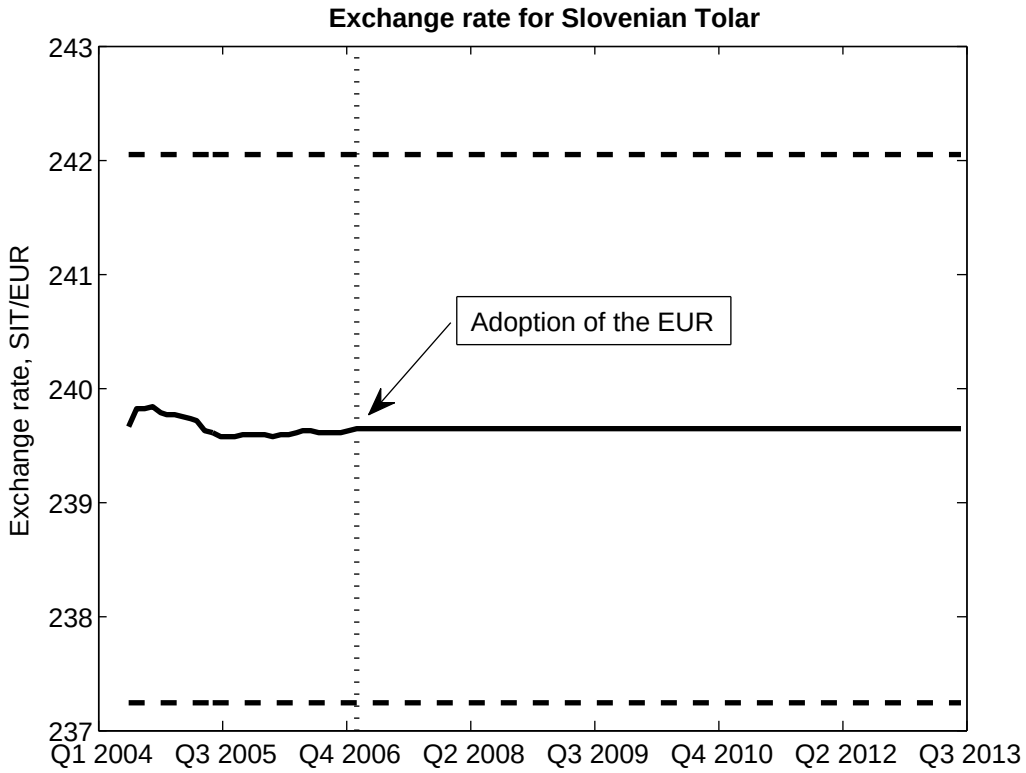
3. Results are robust across firm size

4. Excluding the ERM II period does not alter our results

5. Results remain robust to Bayesian estimation

Exchange rate during the ERM II Figure 10 plots the exchange rate deviations from the parity in ERM II (which was the same as the conversion rate at which the Euro was adopted) throughout our sample. The dashed lines are deviations of +/-1% from the parity. The maximum deviation in any month during this period did not exceed 0.08%. Note that with such a tight fix there was no exchange rate risk involved. Moreover, because of the free flow of capital, domestic monetary policy had to follow the monetary policy of the ECB.

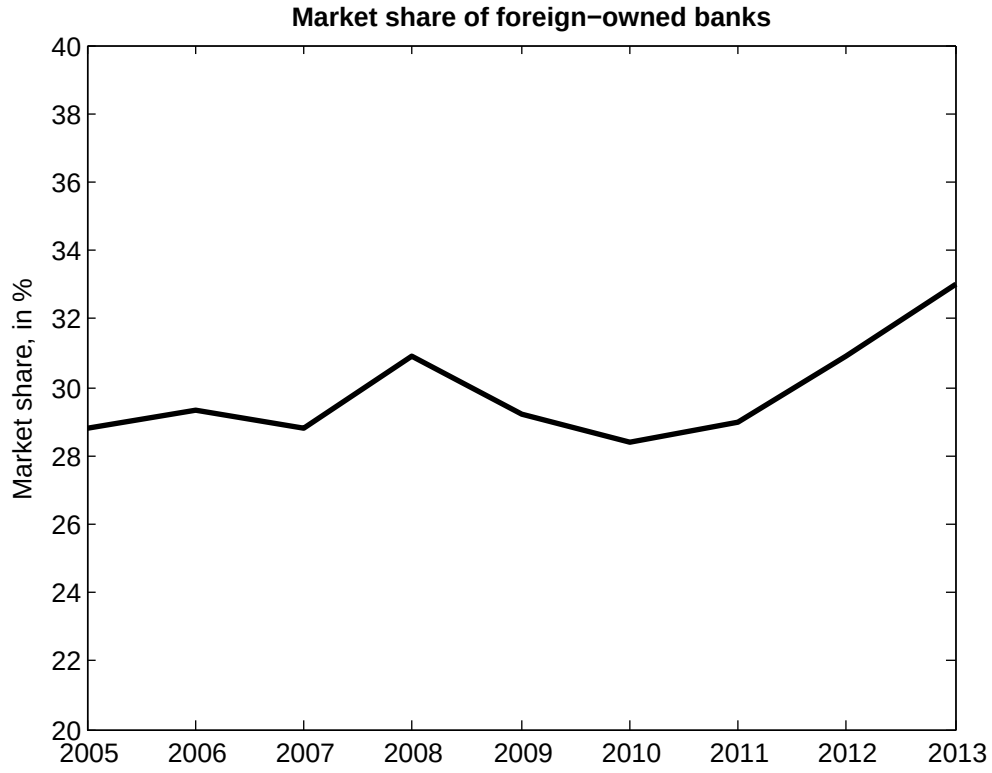
Figure 10: Deviation from the exchange rate parity in the sample



Notes: The full line is the exchange rate between the Slovenian Tolar and the Euro (number of Slovenian Tolars per one Euro). The dashed lines indicate 1% deviations from parity.

Market share of foreign banks during the sample period Foreign-owned banks have a significant share of the market throughout the sample period, but their market share has been fairly stable at around 30%. The market share of foreign-owned banks in Slovenia over the sample is plotted in Figure 11.

Figure 11: Market share of foreign-owned banks in Slovenia



Notes: Market share in %. Data on market share are obtained from Financial Stability Reviews (Bank of Slovenia (2009) and Bank of Slovenia (2015a)).

There is no evidence that foreign-owned banks are materially different from domestic banks as regards the scope of operations. They are universal banks (as are domestic banks), and do not specialise in a particular type of lending, products, or other market niches (Bank of Slovenia (2009), Bank of Slovenia (2015a)). There are differences in the liability structure of balance sheets of domestic and foreign-owned banks, but not in the structure of assets (the market share of foreign-owned banks in terms of loans to firms over the sample is 32%, similar to that measured by all assets reported in Figure 11). However, it is true that foreign-owned banks rely much more on funding sources from abroad, as discussed in the main text.

An objection to our analysis might be that domestic banks were mainly government-owned in this period. This is only partially true, as even the biggest bank in Slovenia (NLB) has been partially owned by private investors (including KBC and EBRD, and some private domestic investors). Moreover, even some foreign banks active in the country have been owned by either foreign state or by foreign provincial government (e.g., Hypo Alpe Adria bank).

Robustness to firm size In the paper we argue that all firms are similar in the sense that they do not have access to debt securities markets. It may, however, still be the case that firms differ in their access to banks. For instance, large firms may have easier access to

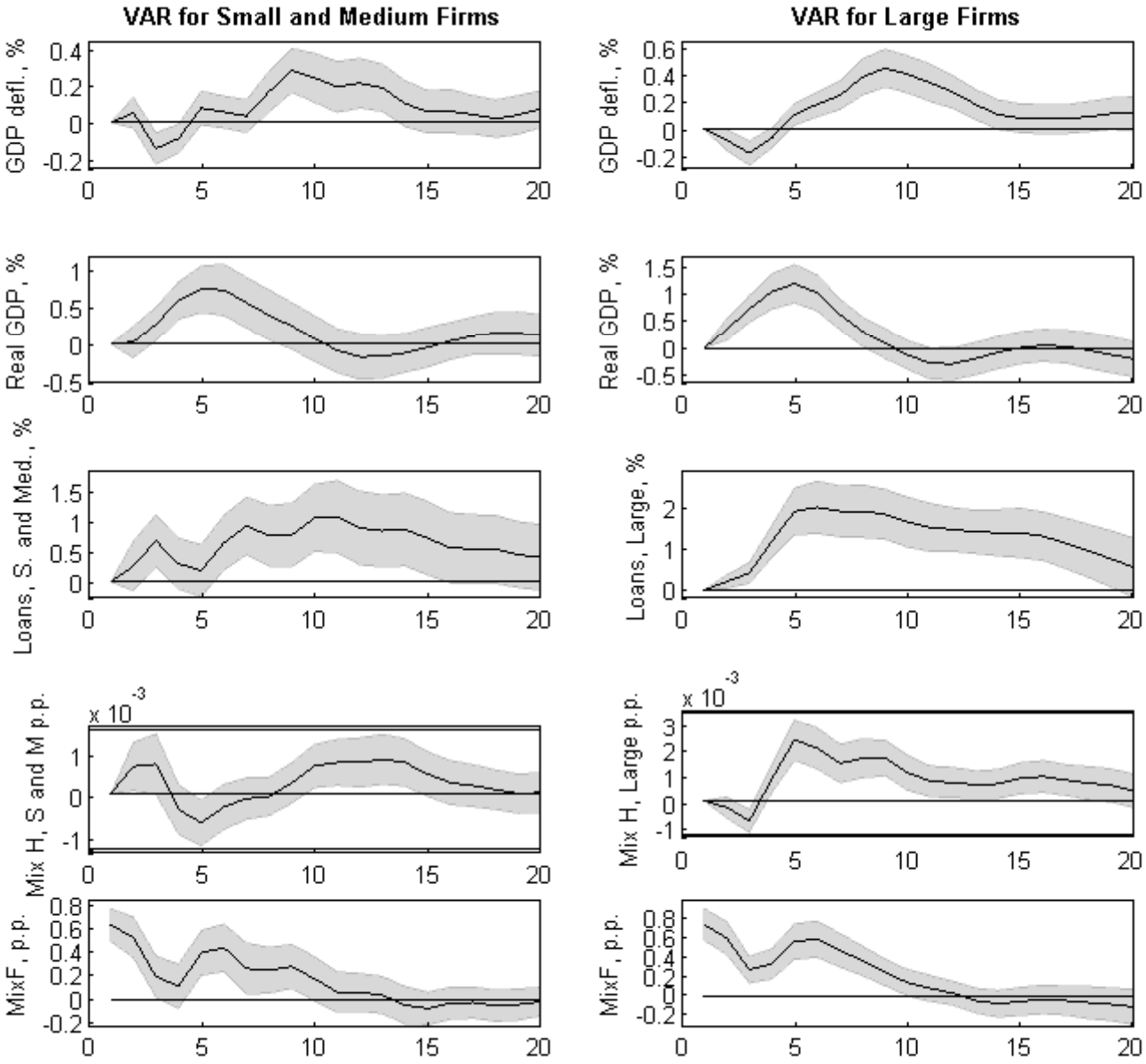
banks than small firms. We show here that our results are not materially different across firm sizes.

Unfortunately, the flow of funds statistics does not distinguish sectors by firm sizes. To obtain the loan series by firm sizes, we use firm annual sales levels (from the end-of-year balance sheets) as a proxy for size. Based on this metric, we group firms in two groups: small and medium sized firms, and large firms. We define small and medium sized firms as the ones below the 90th percentile of sales distribution. We repeat this year by year. Because the distribution of sales is skewed, this still allocates about half of all sales in value terms to large firm group. With the firms allocated – year by year – into the two groups, we use the information about their end-of-year liabilities to banks to split the aggregate value of firm liabilities to banks in the flow of funds statistics into these two groups. In this way we obtain firm liabilities to banks by firm size. Note that we match the annual growth rate of each group's liabilities to banks by construction. We then obtain quarterly loan series by weighting the quarterly growth of aggregate liabilities to banks by the annual growth rates of liabilities to banks in each group. This gives us quarterly growth rates that are a weighted average of the annual growth rate in each group and the aggregate quarterly growth rates. We then apply the growth rates to initial levels of liabilities to banks in each group. The results are reported in Figure 12 below.[22]

As Figure 12 shows, the results are qualitatively similar for small and medium-sized firms (left column) and for large firms (right column). In both cases, an increase in the foreign funding supply to banks ($MixF$) increases lending of banks to firms and therefore firm loans. Output increases in both cases, and so does inflation, after a delay. There is only a qualitative difference in that the increase in loans, output, and inflation tends to be smaller in the case of the VAR with small and medium-sized firms.

[22]Results are reported for recursive identification only, but are robust for identification with sign restrictions.

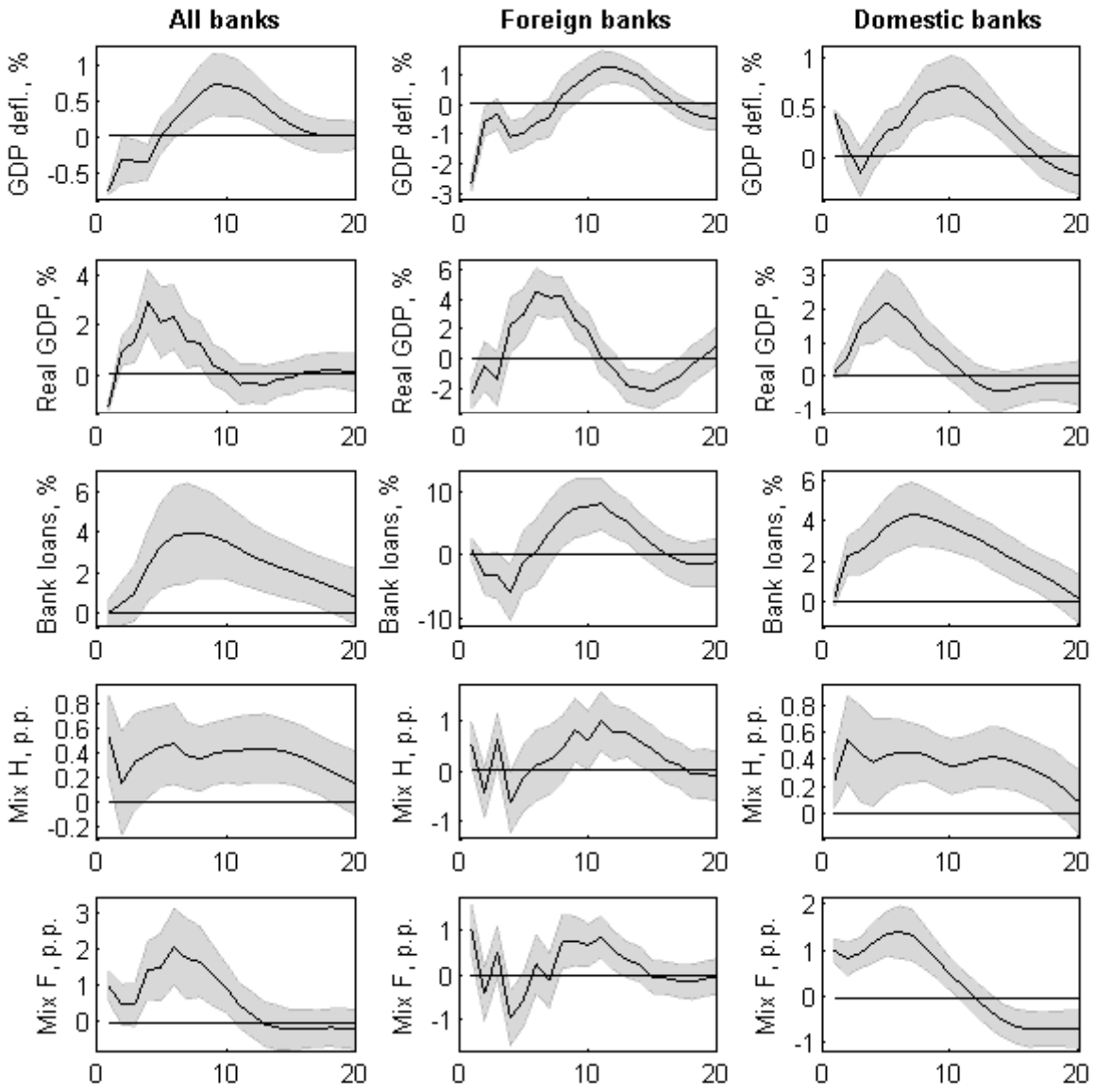
Figure 12: Effects of an expansionary bank funding shock, by firm size



Notes: Impulse responses to a 1 s.d. shock to the *MixF*. The responses are percentage deviations from initial values, while *MixH* and *MixF* are in percentage points. Shaded areas are 90 percent confidence bands, generated using bootstrap with 1000 draws.

Robustness to subsamples To address the concern that the entry into the ERM II or the adoption of the euro were important structural breaks, we perform the analysis for the period since the entry in the ERM II (same identification scheme, same specification as in the main text). The results are shown in Figure 13 and are not materially different from the results reported in the main text.

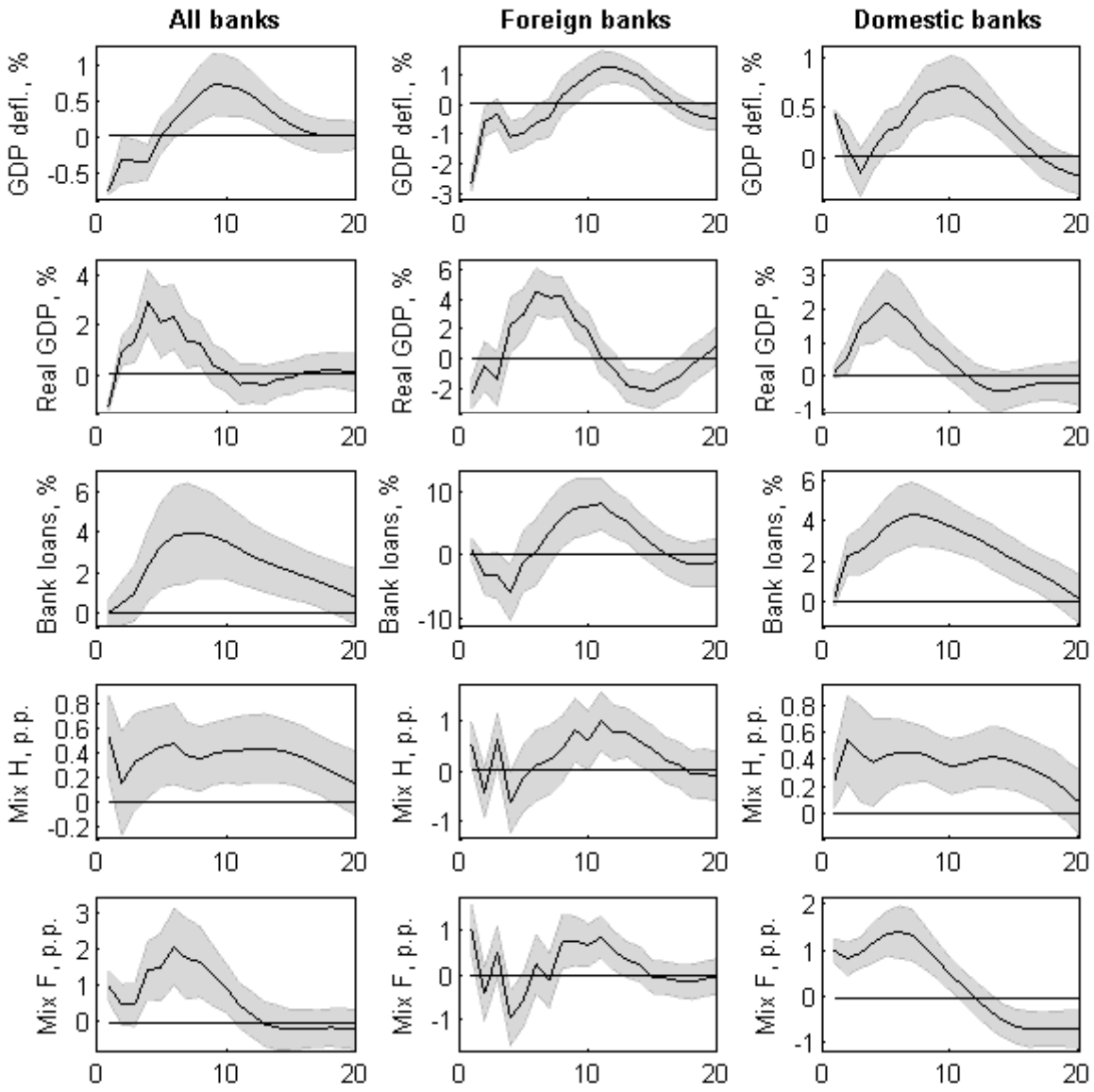
Figure 13: Effects of an expansionary bank funding shock, identification with sign restrictions, since the entry in ERM II.



Notes: Impulse responses to a 1 p.p. shock to the Mix F. The responses are percentage deviations from initial values, while Mix H and Mix F are in percentage points. Shaded areas are 90 percent confidence bands, generated using bootstrap with 1000 draws.

We also re-run the VARs only for the period since the adoption of the euro. The results are shown in Figure 14 below. Our main message that the expansionary response of bank lending, output and inflation (after a delay) to an expansionary shock to bank funding from abroad holds in this shorter sample for the aggregate and for domestic banks. For foreign-owned banks, the results are not so clear-cut, but not inconsistent with the main message that the expansion of credit and output after an expansionary shock to foreign funding supply are more delayed than for domestic banks (even without adjusting for the structure of liabilities). We emphasise however that these results are based on a very short sample and should be interpreted with considerable caution.

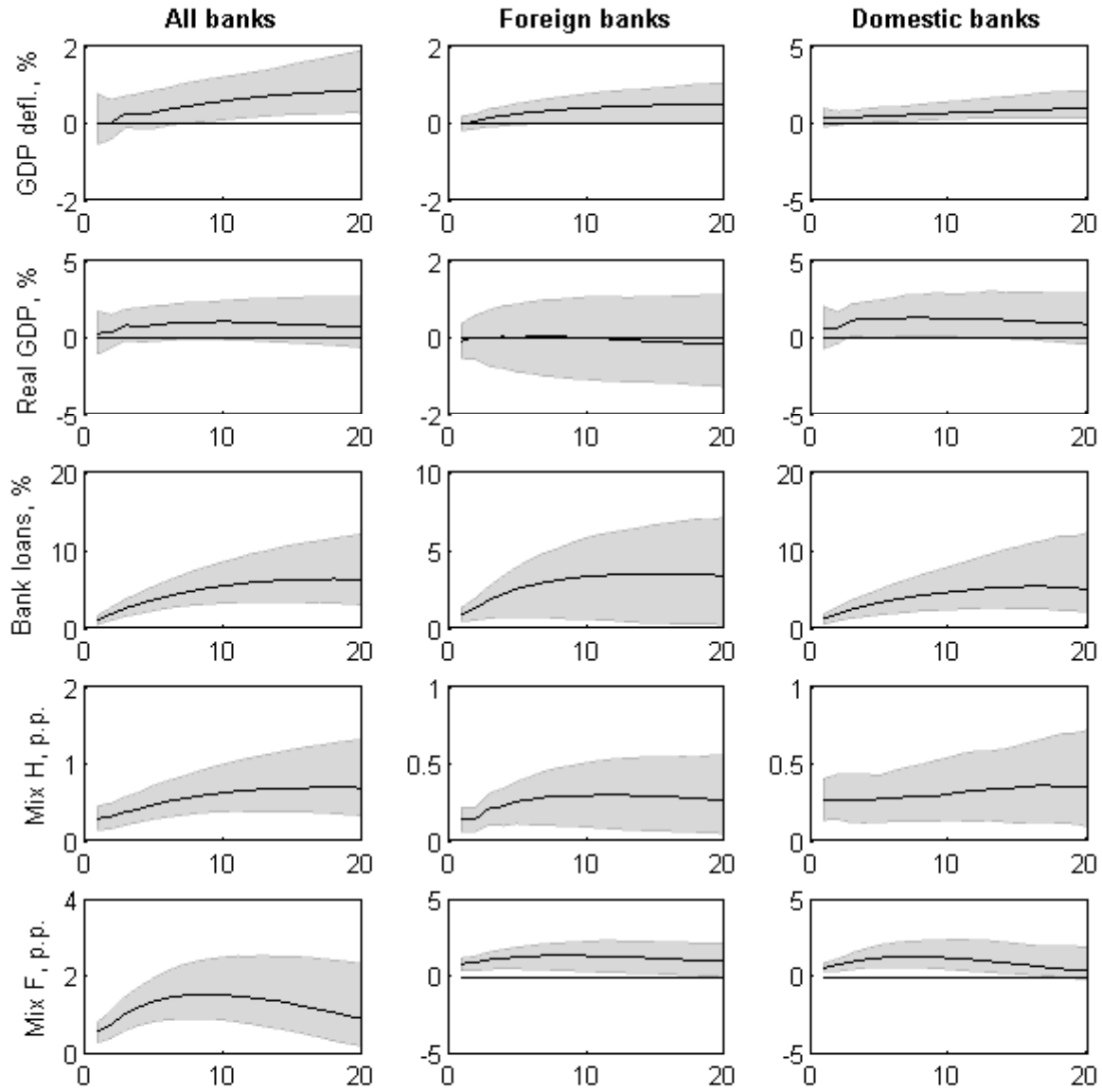
Figure 14: Effects of an expansionary bank funding shock, identification with sign restrictions, since the adoption of the Euro.



Notes: Impulse responses to a 1 s.d. shock to the *MixF*. The responses are percentage deviations from initial values, while *MixH* and *MixF* are in percentage points. Shaded areas are 90 percent confidence bands, generated using bootstrap with 1000 draws.

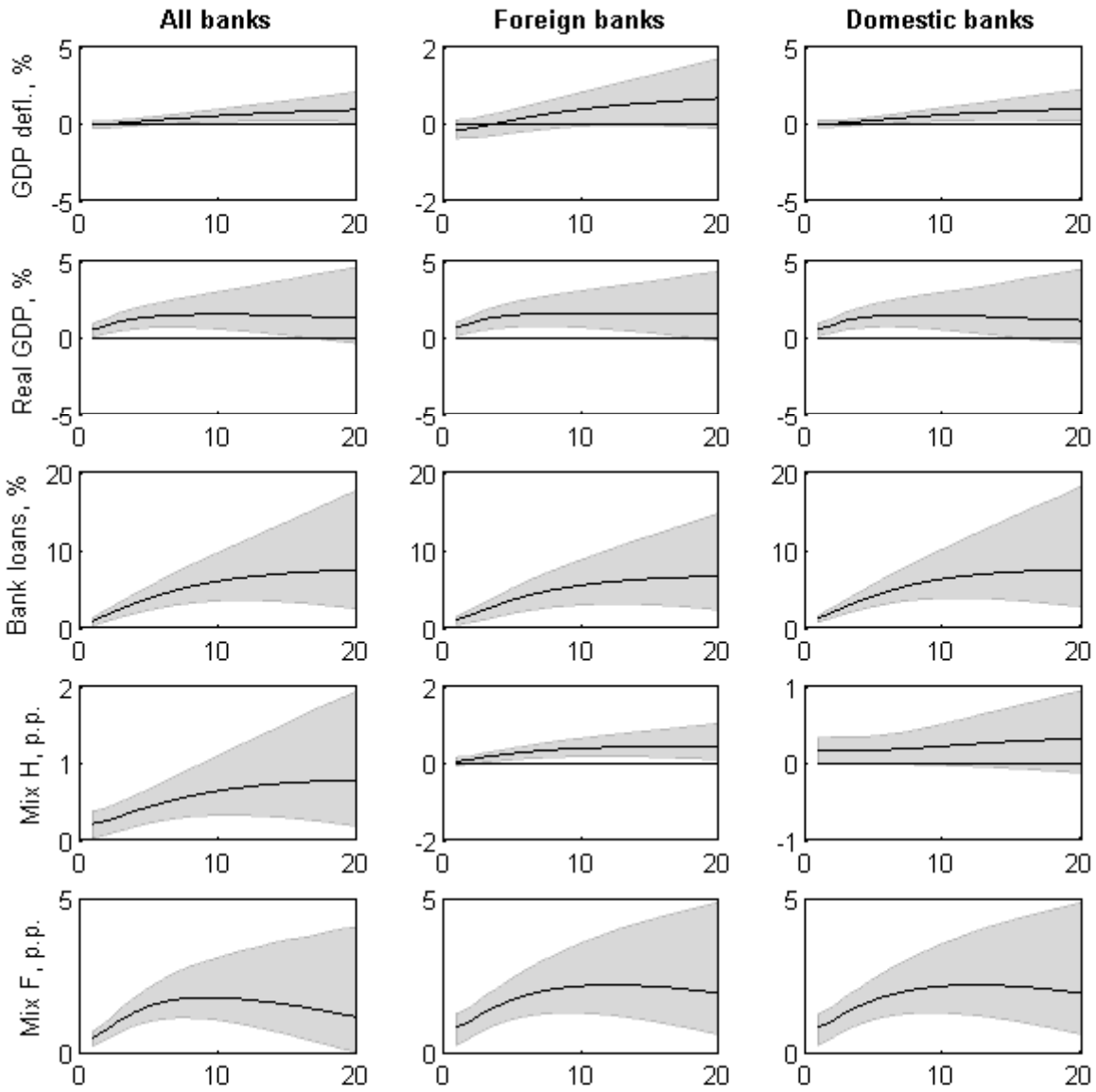
C Results using Bayesian estimation

Figure 15: Effects of an expansionary foreign funding supply shock, sign and narrative restriction using Bayesian method.



Notes: We estimate Bayesian VAR with three lags and Minnesota prior, using the toolbox by Canova and Ferroni (2020). The shaded area report 68% credible sets, based on 1000 draws from the posterior distribution.

Figure 16: Effects of an expansionary foreign funding supply shock, instrumental variable approach.



Notes: We estimate instrumental variable SVAR with three lags and Minnesota prior. As an instrument we use BIS data on (log of) outstanding amount of loans and deposits to banks in Developing Europe. Developing Europe comprises: Albania, Belarus, Bosnia, and, Herzegovina, Bulgaria, Croatia, Czech, Republic, Hungary, Montenegro, North, Macedonia, Poland, Romania, Russia, Serbia, Turkey and Ukraine. The shaded area report 90% credible sets, based on 1000 draws from the posterior distribution.

D Some statements used for narrative sign restrictions

This appendix cites some of the key statements from policymakers and institutions that we used to place narrative sign restrictions.

> ”The business models of Slovene banks before the financial crisis were based on heavy funding on international financial market and aggressive lending to

increase or retain market share. As a result, the onset of the global financial crisis hit Slovene banks particularly hard. The availability of foreign funding of Slovene banks shrank and funding costs increased. The resulting liquidity crunch put a strain on corporate operations and an increasing number of firms resorted to delayed or non-settlement of financial liabilities to banks. [...] Matters came to a head in the second quarter of 2013 following the international bail-out of Cyprus [...]. The contagion spread to Slovenia. Slovenia's sovereign long-term debt was downgraded and the availability and cost of funding for banks on wholesale markets came under further pressure." (Jazbec (2016))

The following quote argues that the foreign funding shock at the onset of the crisis was neutralised and implies that it would be less appropriate to place narrative restrictions on foreign funding shock at the onset of the crisis, since this shock was to a large degree neutralised by the government guarantee:

"The fall of the American investment bank Lehman Brothers in September 2008, which signified the onset of the international financial crisis, and the consequent difficulties of several US investment and commercial banks, did not directly affect the Slovenian banking system owing to its relatively low direct exposure in terms of both the volume of foreign trade and the size of the financial flows. The financial crisis was reflected in increased loss of trust – on one hand among bank depositors, and on the other hand lack of trust on the market led to a suspension of interbank financing. This suspension, due to the high proportion of foreign loans in the sources of financing of the Slovenian banking system, led to an exceptional increase in liquidity risk for the Slovenian banking system, which in the first wave of the effects of the global financial crisis on the Slovenian system (in 2008) was neutralised by the government through the issuance of unlimited guarantees on all deposits and the issuance of government guarantees for refinancing banks on international financial markets." (Bank of Slovenia (2015b), p. 22-23)