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Bank Lending Standards, Loan Demand, and the Macroeconomy: Evidence from the Emerging Market Bank Loan Officer Survey

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Abstract

Despite renewed interest spurred by the global financial crisis, identifying a bank loan supply shock from demand-side factors remains challenging. While existing sigh-restriction studies often rely on the bank lending rate and the loan volume to identify a loan supply shock, they implicitly assume that the observed interest rate always equates supply and demand for loans. Using bank loan officer survey from eight emerging market economies (EMEs), I document a distinct cyclical pattern of bank lending standards and loan demand in the EMEs from that in the U.S. or the Euro area. Using quarterly Korean data, I demonstrate that a conventional sign-restriction approach could result in a misguided interpretation of credit slowdown when credit rationing or non-price lending terms exist. To resolve this issue, I propose an alternative identifying scheme by exploiting the information from bank loan officer survey and find that a negative loan supply shock has a strong adverse effect on output, followed by a decline in inflation and the policy rate.

Keywords: Bank loan officer survey, Sign-restriction VARs, Bank lending shocks, Emerging market economies, Credit market imperfections

JEL Classification: E32; E44; E51

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1 Introduction

Are credit shocks an important driver of output fluctuations? A large body of theoretical literature (Bernanke and Gertler [1989]; Holmstrom et al. [1997]; Kiyotaki and Moore [1997]) has established various models to understand how an exogenous shock to credit markets drives fluctuations in output. The recent episode of widespread credit crunches and recessions shortly after the collapse of Lehman Brothers further spurred a renewed interest in understanding the link between credit markets and the real economy using a quantitative framework (Gertler and Karadi [2011]; Gilchrist and Zakrajšek [2012]; Perri and Quadrini [2018]).

As earlier studies emphasized, however, identifying a credit supply shock is challenging; while declines in credit growth coincide with recessions, one cannot rule out potential credit demand effects in addition to credit supply effects (Bernanke and Lown [1991]; Bernanke and Gertler [1995]; Peek et al. [2003]).[1] Although a sign-restriction approach of Faust [1998], Canova and De Nicolo [2002], and Uhlig [2005] has been widely used to identify a credit supply shock, the variation of this approach often imposes restrictions on the price of credit—credit spreads or the bank lending rate—under the implicit assumption that the observed price always equates the demand and supply of loans.

However, if there exists credit rationing—as a result of information asymmetry or moral hazard (Laffont and Garcia [1977]; Stiglitz and Weiss [1981])—or non-price lending terms—such as non-interest rate charges, covenants and maturity, or a bank-firm relationship (Weinstein and Yafeh [1998]; Kang and Stulz [2000])—, the identifying assumption using price movements alone may fail to disentangle a supply shock from a demand side interpretation. To the extent to which emerging market economies (EMEs) are subject to various credit market imperfections, such an identification scheme is more likely to produce a biased estimate of the effect of bank lending shocks.

I address the identification issue by controlling for loan demand over business cycles using novel survey data from EMEs. Among the various types of credit, I exclusively focus on bank lending to the business sector because household credit often behaves differently from firm credit (Den Haan and Sterk [2011]) and bank lending is

[1] Another stream of the literature focuses on exogenous events to the bank credit supply as an attempt to establish causality between credit markets and economic activity. For example, see Peek and Rosengren [2000] for exploiting the Japanese banking crisis in early 1990s, Leary [2009] for the introduction of the certificates of deposits in early 1960s, and Chava and Purnanandam [2011] for the Russian crisis in 1998. However, these exogenous events have limited implications about the effect of credit supply shocks at a business cycle frequency due to their one-off nature.

a major source of financing in economies where alternative sources of direct financing such as corporate bond markets are not yet fully developed (Gyntelberg et al. [2006]; Khwaja and Mian [2008]). I aim to disentangle demand and supply factors in bank lending and evaluate their macroeconomic effects using a Bayesian sign-restriction Vector Autoregression (VAR) model *à* la Uhlig [2005]. To the best of my knowledge, this is the first attempt to apply a sign-restriction approach to bank loan officer survey data. I am prompted to use this strategy due to the contrasting pattern in bank loan officer survey between groups of emerging market and advanced economies.

Bank loan officer survey from EMEs provides information about bank lending standards and loan demand for the business sector, similar to the U.S. Federal Reserve Board's Senior Loan Officer Opinion Survey on Bank Lending Practices (SLOOS) and the Euro area Bank Lending Survey (BLS). Bank loan officer survey data have been used to identify credit supply shocks in the U.S. (Lown and Morgan [2006]; Bassett et al. [2014]; Becker and Ivashina [2014]) and more recently in the Euro area (Del Giovane et al. [2011]; Ciccarelli et al. [2015]; van der Veer and Hoeberichts [2016]), since tightened lending standards are associated with an adverse shock to credit supply.[2]

Nevertheless, one cannot simply identify changes in bank loan supply using changes in lending standards due to the obvious demand side interpretation. Tighter standards could signal some other negative disturbance to economic activity that reduces the demand for loans simultaneously. To overcome this problem, Bassett et al. [2014] adjusted lending standards for macroeconomic and bank-specific factors affecting loan demand by using bank-level data and obtained a cleaner measure of loan supply factors. Similarly, Becker and Ivashina [2014] used firm-level information on substitution from bank loans to corporate bonds and commercial paper to control for bank loan demand. Alternatively, Del Giovane et al. [2011], Ciccarelli et al. [2015], and van der Veer and Hoeberichts [2016] exploited detailed information on the factors behind tightened standards and reduced loan demand from BLS data to identify a credit supply shock.[3]

Unfortunately, such detailed information is not available in the bank loan officer survey from most EMEs. Instead, I use a sign-restriction approach of Faust [1998],

[2]For example, Gilchrist and Zakrajšek [2012] find a high correlation between changes in bank lending standards and the excess bond premium—their measure of credit market condition. See, among others, Dell'Ariccia and Marquez [2006] and Ravn [2016] for the structural interpretation of changes in bank lending standards as an outcome of information asymmetry between lenders and borrowers.

[3]In the BLS, banks also respond to more detailed questions about the factors affecting their decisions about credit standards, the specific terms and conditions for approving loans, and their assessment of the determinants of the demand for loans.

Canova and De Nicolo [2002], and Uhlig [2005] to separate loan supply from loan demand factors reflected in survey data. Formally, I impose sign restrictions on lending standards, loan demand, and volume of bank loans to jointly identify bank loan demand and supply shocks. Although a sign-restriction approach has been widely used to identify credit supply shocks in advanced economies (Busch et al. [2010]; De Nicolò and Lucchetta [2011]; Helbling et al. [2011]; Meeks [2012]; Hristov et al. [2012]; Finlay and Jääskelä [2014]; Halvorsen and Jacobsen [2014]; Gambetti and Musso [2017]), applications in EMEs are very limited.

To the best of my knowledge, Tamási and Világi [2011] (Hungary) and Houssa et al. [2013] (South Africa) are the only existing studies of EMEs. However, these studies often impose a restriction on output, which prevents studying the short-term impact of a loan supply shock on output, or use corporate bond spreads to identify a bank loan supply shock, probably because of the limited data availability. By imposing restrictions on demand and supply factor proxies from the survey data instead, I obtain a cleaner measure of a loan supply shock, which is less subject to criticism raised by Musso et al. [2011] on the identification of a credit supply shock using a sign-restriction approach—"while there is consensus on how to identify monetary policy and housing demand shocks, it is somewhat harder to come up with restrictions for identifying credit supply shocks."

As Ciccarelli et al. [2015] showed, both lending standards and loan demand are strongly procyclical in the SLOOS and BLS data.[4] However, using similarly constructed bank loan officer survey data from eight EMEs (Chile, Estonia, Hungary, Korea, Poland, Russia, Thailand, and Turkey), I find a different pattern in the data of these economies from that in the U.S. and the Euro area. Unlike advanced economies, loan demand is acyclical or even countercyclical in most of the EMEs where survey data are available. Moreover, during the period of financial distress, there is a clear sign of credit rationing—an excess demand for bank loans under the observed lending rate—, suggesting that a standard identifying assumption may not work for these economies.

EMEs are an ideal place to study the real effects of credit supply shocks. One salient feature of EMEs compared to advanced economies is the heavy reliance on the banking sector as a source of financing. Firms' inability to easily substitute bank loans with another source of financing, such as commercial paper or corporate bonds, is a necessary condition for a fully operating credit channel (Oliner and Rudebusch [1996]; Driscoll [2004]). The credit channel is less clear if firms freely substitute

[4] In other words, bank lending standards tighten and loan demand decreases during recessions.

their borrowing from banks with direct financing. This partly explains why earlier empirical studies on the U.S. find mixed evidence related to the credit channel (for example, Kashyap et al. [1993] versus Oliner and Rudebusch [1996]).

Given the best data availability among EMEs, especially for high frequency data on bank loans towards the business sector and the amount of corporate bonds outstanding, I choose the Korean economy as a unit of the Bayesian VAR analysis. While these data are crucial in identifying a bank lending shock and its transmission mechanism, the Korean economy also well approximates the average behavior in bank loan officer survey from the eight EMEs. I first show that standard sign restrictions relying on the price-quantity framework result in misidentification of bank lending shocks, thereby emphasizing the importance of considering the presence of credit rationing or non-price lending standards when identifying bank lending shocks.

I find that an adverse loan supply shock has a substantial negative effect on output, while a negative loan demand shock does not have a recessionary effect. Depending on the VAR model specifications, loan supply shocks account for $10-15\%$ of output fluctuations in Korea, which is in line with previous studies of other countries using a sign-restriction approach (for example, Meeks [2012] on the U.S., Hristov et al. [2012] on the Euro area, Halvorsen and Jacobsen [2014] on the U.K. and Norway, and Helbling et al. [2011] on the G7 countries). However, during the peak of the global financial crisis, this shock contributed to 40% of output declines, suggesting its asymmetric role during crisis periods. When I extend a baseline model to jointly identify other structural shocks (monetary policy, aggregate supply, and aggregate demand shocks) embedded in a standard small-scale New Keynesian framework, I obtain similar results from the baseline model.

Using data from Korean corporate bond markets, I further provide a rationale for the contrasting effects of a loan supply shock and a loan demand shock in EMEs. I find that the identified negative loan supply shock acts as a tightening in economy-wide credit supply. The identified negative loan demand shock, however, is associated with an increase in alternative financing via public debt markets. As a result, when a decrease in bank loan demand is accompanied by the substitution with corporate bond issuance driven by relaxed credit constraints, the observed decline in bank loans is followed by expansions, not recessions.

The rest of the paper is organized as follows. Section 2 documents a contrasting cyclical pattern of the bank loan officer survey data in the eight EMEs from that in the U.S. and the Euro area. Section 3 illustrates the issues with identification of a loan supply shock using a sign-restriction approach when credit rationing or non-price lending terms exist and proposes an alternative approach using the survey data. Section 4 presents the key findings by estimating a baseline model with the Korean data and discusses the mechanism at work. Section 5 provides a series of robustness checks, including an extension to the small-scale New Keynesian model. Section 6 concludes.

2 Data and stylized facts

This section documents novel evidence on credit market imperfections prevalent in EMEs by comparing a cyclical pattern of bank lending standards and loan demand from bank loan officer survey in the eight EMEs with that in the U.S. and the Euro area. Although such data have been available for the U.S. since 1991Q4 in the current format, similar data are available for much shorter periods in most countries even including the Euro area and Japan. Moreover, bank loan office survey data were rarely used to identify a bank lending shock in the emerging economy context. I fill this gap in the literature by collecting survey data from the eight EMEs (Chile, Estonia, Hungary, Korea, Poland, Russia, Thailand, and Turkey).

2.1 Bank loan officer survey: benchmark advanced economies

I first document a cyclical pattern of bank lending standards and loan demand in advanced economies using bank loan officer survey data from the U.S. and the Euro area. U.S. data are taken from the Federal Reserve Board's Senior Loan Officer Opinion Survey on Bank Lending Practices (SLOOS) and Euro area data are taken from the Bank Lending Survey (BLS). See the Appendix A.1 and A.2 for further details on the U.S. and Euro area survey data.

Figure 1 shows lending standards and demand for business loans in the U.S. from 1991Q4 to 2017Q2 (top) and the Euro area from 2003Q1 to 2017Q1 (bottom). An increase in the index of lending standards denotes relaxed lending standards for new loans.[5] Over business cycles, lending standards move closely with loan demand in both economies and both fall sharply during recessions, suggesting that both lending standards and loan demand are procyclical in advanced economies.

[5] For consistency across countries, I reverse the sign of the lending standards in the original data if an increase denotes tightening.

2.2 Bank loan officer survey: EMEs

In this section, I document a cyclical pattern of lending standards and loan demand in the eight EMEs in Figure 2. I download bank loan officer survey data of the EMEs from Haver Analytics that are available for more than seven years and check the main questionnaires across countries from their central bank websites. I only focus on the questions regarding lending towards the business sector, not the household sector for consistency with the U.S. and Euro area data. When compared to Figure 1, the EME data show an interesting cyclical pattern: there is a much weaker co-movement between lending standards and loan demand over business cycles. While lending standards are largely procyclical, loan demand is acyclical or even countercyclical in most EMEs. Moreover, loan demand increased (probably except for Chile) in the run-up to the global financial crisis, though bank loan growth fell sharply and banks substantially tightened their lending standards at the same time. This novel finding suggests that a conventional approach using the bank lending rate could be misleading in identifying the effect of bank lending shocks.[6]

Table 1 summarizes the pattern found in Figure 1 and Figure 2. The average correlation between bank lending standards and loan demand is only 0.19 from the eight EMEs, while it is 0.70 in the U.S. and 0.61 in the Euro area.[7] Credit market imperfections in the EMEs explain this distinct pattern: Bank loan demand may increase during bad times if firms have limited access to market finance, as they look to finance countercyclical liquidity needs for management of inventories and trade payables (Gertler and Gilchrist [1993]).

By looking at C&I loan data, Gertler and Gilchrist [1993] found a strong countercyclical demand for short-term credit to finance inventory accumulation in the initial stages of U.S. recessions. With credit market imperfections, preference for bank debt over public debt during bad times is likely to be more pronounced in EMEs than the U.S. economy. To the extent to which banks tighten their lending standards during recessions, the observed correlation between the two factors need not be positive. If credit rationing occurs due to the non-price factors in a market for bank loans,

[6] Differences in the questionnaires do not explain this finding because the EME bank loan officer survey takes SLOOS as a benchmark and asks essentially the same questions (see Appendix for the sources and the coverage of surveys and the examples of main questionnaires for the eight EMEs). Thus, the compatibility of survey is not a main concern here.

[7] The difference is not simply explained by a (potentially) poor quality of bank loan officer survey in EMEs. Using similarly conducted bank loan officer survey from 2000Q1 to 2015Q4 in Japan where the majority of firms heavily relies on bank financing via lending relationships (Weinstein and Yafeh [1998]; Kang and Stulz [2000]), I find that the correlation is only −0.05 and loan demand from the business sector also sharply increased in Japan shortly after the collapse of Lehman Brothers.

the information from bank loan officer survey becomes useful in identifying a bank lending shock.

2.3 Korean macroeconomic data

Again, I choose the Korean economy for the Bayesian VAR analysis given the best data availability among EMEs, especially for high frequency data on bank loans towards the business sector and the amount of corporate bonds outstanding which are crucial in identifying a bank lending shock and its transmission mechanism. The baseline VAR model includes four variables in their growth rate: d_t (loan demand), s_t (lending standards), l_t (total bank loans to the business sector), and y_t (real GDP).[8] Given the structure of bank loan officer survey data,[9] Δd_t and Δs_t can be understood as the changes in these variables shown in Figure 2. For a stationarity, I use the year-on-year growth rate of a volume of loans Δl_t and real GDP Δy_t in the VAR system.

Figure 3 shows the evolution of the six macroeconomic variables of interest at a quarterly frequency, including the inflation rate and the policy rate measured by the overnight call rate that are also used in the extended model in Section 5.3. Although Korea is a small open economy, using a closed economy framework is largely innocuous to the extent to which bank lending towards non-financial firms is dominated by nationwide domestic banks in Korea (Banker et al. [2010]). Moreover, Korea has adopted a flexible exchange rate regime throughout the period of analysis, which has mitigated the direct impact of foreign shocks on domestic bank lending. Thus, for the sake of parsimony of the model, I abstract from foreign variables and the exchange rate. Moreover, most existing studies using a sign-restriction approach to identify credit supply shocks in the small open economy context do not include the exchange rate in their VAR system (Busch et al. [2010]; Helbling et al. [2011]; Hristov et al. [2012]; Gambetti and Musso [2017]). Even if some studies do, they do not impose any restrictions on the exchange rate to identify credit supply shocks (Tamási and Világi [2011]; Finlay and Jääskelä [2014]).

Bank lending standards and loan demand from the survey data are also added to the graphs of bank lending growth and the bank lending rate to the business sector to illustrate the problem of identification scheme based on the bank lending rate.[10]

[8] Total bank loans to the business sector are deflated by the Consumer Price Index (CPI) to obtain a real series.

[9] The questions always ask changes in lending standards or loan demand relative to three months ago.

[10] While I use the weighted composite indicator for bank lending standards and loan demand throughout the paper, all of the results are robust to the use of the indicator specific to small-and-medium sized enterprises. The correlation between the composite indicator and the SME indicator is 0.88 for lending standards and 0.83 for loan

For example, a sharp drop in the bank lending rate, supported by an expansionary monetary policy in the run-up to the global financial crisis masks an excess demand in the bank loan market (reflected in an increase in loan demand and a decline in both lending standards and loan growth), implying that credit rationing or non-price lending terms exist during the period of financial distress. If one takes a standard sign-restriction approach using quantity (the volume of loan) and price (the bank lending rate) information alone, a decline in loan growth is likely to be attributed to a decline in loan demand, thereby resulting in heavily misguided policy implications.

3 Empirical framework

3.1 Identification strategy

Figure 4 and 5 highlight an empirical difficulty of identifying a loan supply shock from a loan demand shock using aggregate data. Both supply (l^s) and demand (l^d) of bank loans depend on the bank lending rate (r) and other factors (Θ_s and Θ_d), which shift the supply and demand curves. For the supply curve, such factors include the bank deposit rate, the cost of evaluating the credit-worthiness of borrowers, the minimum reserve ratio, and so on. The need for working capital, the cost of direct financing, and the availability of trade credit are an example of the bank loan demand shifter. However, there are (often unobservable) factors simultaneously shifting the supply and demand curves towards the same direction (i.e., $\Theta_s \cap \Theta_d \neq \emptyset$) as illustrated in Figure 4. Such factors include the expectation about the future prospects of the economy, uncertainty surrounding the course of monetary policy, and so on. Therefore, what one observes from aggregate data is likely a combination of loan supply and demand shocks.

Recently, a sign-restriction approach of Uhlig [2005] has been applied to identify a credit supply shock because this approach uses simple economic theories for identification rather than an (often) arbitrary timing assumption in standard recursive identifications. Figure 4 illustrates typical sign restrictions based on simple price theory to identify a loan supply shock from demand-side factors. A negative loan supply shock is identified by an increase in the price of loans (the bank lending rate) and a decrease in the quantity of loans from the observed data. By the same token, a negative loan demand shock is identified by a decrease in the price of loans and a decrease in the volume of loans. Nevertheless, it is clear from Figure 4, a negative

demand.

loan supply shock—identified by the relative movements in the price of loans—cannot fully eliminate the negative demand shock interpretation.

The identification problem only gets worse if there exists credit rationing or non-price terms in a lending contract as a result of asymmetric information. Lown and Morgan [2006] and Ravn [2016] show theoretically and empirically that bank lending standards obtained from bank loan officer survey effectively summarize various non-price lending terms in the typical bank business loans. Thus, I interpret bank loan officer survey as useful information to identify a bank lending shock in the presence of credit rationing. With information asymmetry, the observed r from data does not necessarily equate the demand and supply of bank loans so that $l^* = l^s = l^d$ always holds. In this case, either an excess supply or an excess demand can exist: $l^* = \min\{l^s, l^d\}$ as in the disequilibrium model of a credit market by Laffont and Garcia [1977]. Figure 5 illustrates the case of credit rationing.[11] Bank loan officer survey can improve identification by exploiting information beyond the bank lending rate. By imposing a non-negative sign restriction on the demand factors directly, I can further eliminate the negative loan demand shock interpretation, which is not allowed in the identification scheme using the bank lending rate.

3.2 Pure sign-restriction approach

I briefly summarize a pure sign-restriction approach here, though Uhlig [2005] provides more detail. Instead of relying on restrictions based on the timing of shocks, this identification approach can produce impulse responses consistent with theoretical predictions. Consider a VAR model in a reduced form:

$$Y_t = \sum_{p=1}^{P} B_p Y_{t-p} + u_t, \tag{1}$$

$$u_t \sim N(0, \Sigma),$$

where Y_t is an $n \times 1$ vector of observed economic variables; B_p are $n \times n$ matrices of autoregressive coefficients; and u_t are an $n \times 1$ vector of reduced-form residuals with variance-covariance matrix Σ. I estimate the VAR using Bayesian techniques, with prior and posterior distributions of the reduced-form VAR following an n-dimensional Normal-Wishart distribution.

[11] Without loss of generality, I focus on an excess demand for bank loans in the example, which is more relevant for EMEs.

Because the reduced-form residuals u_t bear no structural interpretation, I incorporate additional restrictions to identify structural shocks. As in Faust [1998], Canova and De Nicolo [2002], and Uhlig [2005], I identify shocks by imposing sign restrictions. Consider an $n \times n$ matrix A, which relates reduced-form residuals u_t to structural shocks ϵ_t,

$$u_t = A\epsilon_t, \tag{2}$$

$$\Sigma = E[u_t u_t'] = AE[\epsilon_t \epsilon_t']A' = AA'.$$

For any orthogonal matrix Q such that $QQ' = I_n$ and $\Sigma = AQQ'A$, there is also an admissible decomposition for which $u_t = AQ\tilde{\epsilon}_t$ and $\tilde{\epsilon}_t \tilde{\epsilon}_t{}' = I_n$, where $\tilde{\epsilon}_t$ denotes the (many) different structural shocks implied by alternative identification. Although different orthogonal matrices Q produce different signs and magnitudes of the impulse responses, discriminating among them from data is not possible, as they imply identical VAR representations. Therefore, for any decomposition $\Sigma = AA'$, there exist infinitely many identification schemes $AQ^{(k)}$ for $k = 1, 2, ..., \infty$, such that $\Sigma = AQ^{(k)}Q^{(k)\prime}A'$. Following Rubio-Ramirez et al. [2010], an orthogonal matrix $QQ' = I$ is generated from a QR decomposition of some random matrix W, which is drawn from an $N(0, I_n)$ distribution.

Unlike Uhlig [2005] who identifies only one (monetary policy) shock, I attempt to identify multiple structural shocks simultaneously:

(i) Draw $d = 1, ..., m$ models from the posterior distribution of the VAR (a model d consists of VAR parameters $B_j^{(d)}$ and a covariance matrix $\Sigma^{(d)}$).

(ii) For $j = 1, 2, ...,$ draw randomly from the m models.

(iii) Choose $A = \tilde{A}^{(j)}$, where $\tilde{A}^{(j)}$ is any Cholesky decomposition of $\Sigma^{(j)}$, such that $\Sigma^{(j)} = \tilde{A}^{(j)}\tilde{A}^{(j)\prime}$.

(iv) For each j, draw random matrices $Q^{(k(j))}$, $k(j) = 1, ..., K$ until the impulse response functions implied by B_p^j and the identification schemes $\tilde{A}^{(j)}Q^{(k(j))}$ satisfy the sign restrictions. If all the sign restrictions are satisfied, I define the combination of model j and identification scheme $\tilde{A}^{(j)}Q^{(k(j))}$ an accepted model.

(v) Iterate over (ii) - (iv) until 200 models are accepted. I assign an equal positive weight to the accepted draws and assign a zero weight to those that violate the restrictions.

3.3 Agnostic identification

I do not attempt to identify every structural shock in the system of the economy because fully identifying the underlying shocks requires further sign restrictions and is not necessarily desirable for our purpose (for example, Uhlig [2005]). The approach taken in this paper identifies a loan supply and demand shock by imposing sign restrictions on three variables Δd_t, Δs_t, and Δl_t and remains agnostic about the response of Δy_t. This is a notable departure from earlier analyses (Busch et al. [2010]; Tamási and Világi [2011]; Hristov et al. [2012]) that impose a sign restriction on output to identify a credit supply shock.[12] In practice, a contraction in bank lending does not necessarily lead firms to immediately change their current production. Instead, it is in later periods that production will be restricted by a lower availability of funding. Moreover, remaining agnostic about the response of output helps me distinguish a credit-specific demand shock from an aggregate demand shock, thereby highlighting a distinct role of credit market imperfections in EMEs.

While a decline in the volume of bank loans must follow both adverse loan supply and demand shocks, a negative loan supply shock should not decrease loan demand and a negative loan demand shock should not decrease loan supply to identify each shock jointly. These restrictions are intuitive and similar to the assumption in the model of Hülsewig et al. [2006]. Joint restrictions on lending standards and loan demand allow for clean identification of a loan supply shock from a loan demand shock even with the presence of credit rationing. Although it is applied to an entirely different data set, my identification strategy shares many characteristics with Helbling et al. [2011] who similarly controlled for an endogenous credit response to expected fluctuations in future activity using sign-restriction VARs. To purge the potential demand channel, Helbling et al. [2011] required that the decline in credit not be followed by a decrease in productivity or an increase in default rates. As a result, both papers do not have to impose any restriction on the response of output.

I simultaneously identify multiple structural shocks rather than one structural shock as in Uhlig [2005].[13] Identifying each structural shock one at a time does not guarantee the orthogonality of the multiple shocks, thus casting doubt on the identified shocks are truly *structural*. As in Helbling et al. [2011], I limit the baseline

[12]For example, Busch et al. [2010] and Tamási and Világi [2011] impose a restriction on output for two quarters without simultaneously identifying aggregate demand or aggregate supply shocks, which may contaminate their "identified" credit supply shock. Hristov et al. [2012] impose a restriction on output for a year, which does not follow an agnostic approach to identify a real effect of credit supply shocks.

[13]Because the number of structural shocks is still less than the number of variables, this model is partially identified.

model to the identification of only two shocks (loan supply and loan demand shocks) due to computational burden.[14] Table 2 summarizes the sign restrictions used in the baseline VAR model. The symbol "?" indicates that the signs of the responses are indeterminate *a priori*. As the growth rate of bank loans is highly persistent, I use four lags ($p = 4$) in the baseline model. Following Uhlig [2005], all restrictions are imposed for two quarters ($k = 2$) following the initial shock. Later, I evaluate the sensitivity of the results to these specifications.

Several papers in this stream of the literature, including Helbling et al. [2011], Tamási and Világi [2011], and Finlay and Jääskelä [2014], impose restrictions on the price and quantity of loans to identify a loan supply shock. Whereas a standard banking model, such as Hülsewig et al. [2006] suggested the bank loan rate as a conceptually correct measure of the price of loans, most existing studies measure bank loan prices by corporate bond spreads, such as Baa - Aaa spreads. However, such restrictions implicitly assume that bank loans and financing via corporate bonds are a perfect substitute.[15] Moreover, corporate bond spreads contain rich information on the state of the macroeconomy beyond the price of credit per se, thereby serving as a strong business cycle indicator (Gilchrist and Zakrajšek [2012]; Faust et al. [2013]), although Peek et al. [2003] emphasized that a measure of loan supply factors should not be a leading indicator of weakening demand to provide an economic interpretation of a loan supply shock. In that case, a decline in output following negative credit supply shocks is not necessarily evidence related to the credit channel, but an artificial outcome of spurious restrictions. Using information from bank loan officer survey avoids this problem and achieves a clean identification of loan supply shocks.

4 Baseline results

Before I present the main results using a novel identification scheme, I show that standard sign restrictions relying on the price-quantity framework result in misidentification of bank lending shocks and highlight the importance of considering the presence of non-price lending standards when identifying bank lending shocks. This could be particularly true for EMEs where factors other than the interest rate may play a

[14]This simultaneous identification scheme implies that the second shock is identified by drawing an impulse vector orthogonal to the first impulse vector and conforms the pre-imposed sign restrictions. The more orthogonal conditions are imposed, the harder it is to obtain impulse vectors satisfying sign restrictions.

[15]De Nicolò and Lucchetta [2011] and Hristov et al. [2012] are the only studies that use bank loan rates as a price indicator. Nevertheless, none of the existing studies using a sign-restriction approach considered the possibility of disequilibrium in a credit market.

significant role. For example, government often provides loans towards small-medium enterprises via development banks or limits the lending rate that commercial banks charge towards the business sector. Also, a long-term relationship between banks and firms can be more important than the interest rate when banks make lending decisions.

4.1 Misspecification in a standard approach

Following the much of the literature in the advanced economy context, I impose restrictions on the spread between the bank lending rate and the deposit rate (sp_t) and the volume of bank loans (Δl_t). This identifying assumption corresponds to Table 3, and the rest of the identification procedure is exactly same as the baseline model discussed in Section 3.2 and 3.3. Figure 6 shows the effect of a negative loan supply shock and demand shock on output growth respectively. Under the conventional identification scheme using the bank lending spreads, a negative loan supply shock does not have any significant impact on output. This finding is clearly at odds with any theoretical predictions and the existing empirical evidence, indicating poor identification of a loan supply shock. Moreover, the effect of a loan supply shock is not distinguishable from that of a loan demand shock in a qualitative sense, preventing any meaningful policy implications.[16]

I then study the effects of bank loan supply and demand shocks on the Korean economy using an alternative preferred identification strategy in three steps. First, I derive the impulse responses of the variables in the VARs to the identified shocks. Second, I compute the variances of credit growth and output growth attributed to these shocks. Third, I decompose historical output growth into the parts explained by each of structural shocks to evaluate the role of bank loan supply shocks over business cycles.

4.2 Impulse responses

Figure 7 shows the responses of the four variables to adverse bank loan supply shocks. The solid lines plot the median impulse responses and shaded areas note their 16th and 84th percentile bands from 200 accepted draws.[17] A decline in the business

[16] The qualitative feature of the responses does not depend on the length of the sign restrictions or the lag orders of the VAR system. Using the bank lending rate itself instead of the spread generates even an expansionary response of GDP to a negative loan supply shock. These results are available upon request.

[17] Note that the median and confidence intervals are computed from all impulse responses that satisfy the sign restrictions. Using Paustian [2007] and Fry and Pagan [2011]'s terminology, the confidence intervals reflect both

sector bank loans follows an adverse loan supply shock, by construction. However, the response is quite persistent in that a decline in bank loans lasts more than two years despite the two-quarter restriction. I impose no restrictions on the response of output, leaving it open agnostically by design, yet find a strong negative effect on real GDP. Although I use a conservative approach, the quantitative effect of the identified loan supply shocks is still substantial (0.7% drop in real GDP after one year), which is in line with Meeks [2012]'s findings for the U.S. (1% drop in industrial production), and Hristov et al. [2012] for the Euro area (0.6% drop in real GDP) using a similar sign-restriction approach.

A vast body of empirical literature, including Lown and Morgan [2006], Helbling et al. [2011], Hristov et al. [2012], Meeks [2012], and Bassett et al. [2014] focused only on credit supply shocks rather than credit demand shocks because it is difficult to distinguish the latter from aggregate demand shocks.[18] Unlike these earlier studies, I explicitly disentangle loan demand shocks from loan supply shocks. Figure 8 shows that a decline in bank loans due to lower demand is rather temporary and reverses after one year. A decrease in the volume of bank loans due to reduced demand has an expansionary effect on output, which seems somewhat puzzling. However, using a sign-restriction VAR approach, Peersman [2011] also finds that loan demand shocks and supply shocks have opposite effects on Euro area output.[19] According to Peersman [2011], this is because exogenous loan demand shocks capture the consequences of changes in the access to alternative forms of finance or shifts in borrowers' preferred volume of lending. In Section 4.5, I will further analyze the response of an alternative form of financing (corporate bond markets) to these shocks to obtain economic interpretation of this finding.

4.3 Variance decomposition

I evaluate the quantitative importance of these structural shocks in explaining the variation in bank loans and real GDP. Table 4 shows that loan supply shocks explain

sampling uncertainty and modeling uncertainty stemming from the non-uniqueness of the identified shocks. I check the sensitivity of the results using a median target method by Fry and Pagan [2011] in Section 5.2.

[18] Finlay and Jääskelä [2014] is an exception, as they identify both credit supply and demand shocks by imposing sign restrictions on the volume of credit and credit spreads for three small open economies (Australia, Canada, and the U.K.). However, using corporate bond spreads as a price indicator of bank credit is questionable because corporate bond spreads are known to be an independent business cycle indicator via a risk channel (for example, Gilchrist and Zakrajšek [2012], and Faust et al. [2013]).

[19] It is also consistent with Friedman and Kuttner [1993] and Bernanke and Gertler [1995]'s arguments that after a negative shock, bank loan demand may increase to finance working capital and inventories due to limited access to market finance.

about 10% of the variation in each variable after five years, within the range of 10 and 20% for output demonstrated in earlier studies using a sign restriction approach (Meeks [2012]; Hristov et al. [2012]; Helbling et al. [2011]; Finlay and Jääskelä [2014]; Halvorsen and Jacobsen [2014]). After five years, a loan demand shock explains 20% and 12% of the variation in bank loans and real GDP, respectively. Overall, loan supply and demand shocks are not a dominant driver of output fluctuations in Korea, though they play a non-negligible role.[20]

4.4 Historical contribution of loan supply shocks

In this step, I show the historical contribution of the structural shocks over business cycles, focusing on the global financial crisis period in particular. Using a DSGE model augmented with financial frictions, Perri and Quadrini [2018] claimed that credit shocks are more relevant than productivity shocks in explaining the global financial crisis. Faust et al. [2013] found that the ability of credit market variables to forecast economic activity is stronger during recessions than expansions. Taken together, bank loan supply shocks may also have an asymmetric importance over business cycles despite their moderate importance in variance decomposition (Table 4).

Figure 9 shows the historical decomposition of real GDP growth during the sample period. Loan supply shocks contributed to 40% of Korean output declines during the global financial crisis, which is consistent with earlier findings for other regions that demonstrate a moderate role of loan supply shocks for the whole sample, but a substantially larger role during recessions (Meeks [2012]; Gambetti and Musso [2017]).

4.5 Discussion of the results

Using data from the Korean bank loan officer survey, I find an expansionary effect of a negative bank loan demand shock. A standard model without frictions in which a firm's demand for credit is determined by the expectation of the demand for its products predicts a recessionary effect of a negative credit demand shock. However, my finding is consistent with the prediction of theories on the choice between bank loans and publicly traded debt (Diamond [1991]; Chemmanur and Fulghieri [1994]; Hale [2007]) that the preference for public debt over bank debt is more likely for projects with a high quality (less uncertainty on future cash flows of the project,

[20] A variance decomposition exercise here should be taken with caution because I identified only a subset of structural shocks. See Fry and Pagan [2011] for further details.

higher collateralized value, and so on), so one would expect higher relative demand for bank debt in recessions.

In this case, a reduction in demand for bank loans may signal the improvement in access to other sources of financing via mitigated information asymmetry problems. To test this hypothesis, I use data on outstanding corporate bonds. My identifying assumption is similar to that of Becker and Ivashina [2014] who interpreted firms' switching from bank loans to corporate bonds or commercial paper as a result of the contraction in bank-specific credit supply rather than a decline in demand for general credit. By comparing the responses of the growth of outstanding corporate bonds to each of the structural shocks, I can identify whether the identified structural shocks truly capture supply and demand factors for bank loans.

First of all, Figure 10 compares the outstanding amount of bank loans to the business sector by depository institutions with the outstanding amount of corporate bonds from 1998Q3 to 2015Q4 (in trillion won).[21] It is clear that Korean firms, in aggregate, still heavily rely on indirect financing via banks than direct financing via public debt markets. This is in sharp contrast to the U.S. where outstanding corporate bonds of the non-financial corporate sector are more than three times larger than the amount of bank loans extended in 2016Q1 (Choi [2018]).[22] Nevertheless, the (year-on-year) growth in bank loans are more procyclical than the growth in outstanding corporate bonds as in the U.S. economy.

To check how corporate bond markets respond to a bank loan supply and demand shock respectively, I place the year-on-year growth rate of outstanding corporate bonds (Δb_t) before the output growth. Similar to bank loans, outstanding corporate bonds are deflated by the CPI in the analysis. While I do not need this variable to identify a loan supply and demand shock, the addition of corporate bonds helps diagnose the channel through which a loan supply and demand shock affect output. I use the same set of sign restrictions from Table 2 and also remain agnostic about the response of the growth of corporate bonds.

Figure 11 compares the responses of the growth of corporate bonds to a negative loan supply shock and a negative loan demand shock. The contrasting responses shed light on the contrasting responses of output found in Figure 7. Despite the non-negative restriction on loan demand, the growth rate of corporate bonds declines

[21]Data are taken from Bank of Korea. By 2015Q4, outstanding bank loans are 783 trillion won (705 billion USD) and outstanding corporate bonds are 189 trillion won (170 billion USD).

[22]It is still true that the relative size of the corporate bond market in Korea is still larger than most EMEs (Gyntelberg et al. [2006]), implying that the real effect of adverse bank lending shocks we found in this paper may underestimate the effect in other EMEs.

significantly after a negative loan supply shock, suggesting that firms' access to the public debt market is also hampered during the period with tightened bank lending standards. On the other hand, the growth rate of corporate bonds increases significantly after a negative loan demand shock, implying that firms switch from indirect to direct financing.

Three important implications about the relationship between the banking sector and the real economy can be drawn from Figure 11. First, the identified negative loan supply shock corresponds to a economy-wide contraction in credit supply, which serves as a driver of output fluctuations. Second, a reduction in outstanding bank credit without a negative loan supply shock is associated with eased access to an alternative source of financing, implying economy-wide relaxed credit constraints. Third, the strong negative effect of loan supply shocks on output in EMEs where bank financing dominates public debt financing is consistent with Choi [2018] who finds that the effect of bank lending shocks in the U.S. has substantially declined over time with the development of its public debt markets.

5 Robustness checks

5.1 Alternative VAR specification

Following Uhlig [2005], I imposed sign restrictions for the two quarters following the structural shock. However, setting the length of the sign restrictions is still an open choice. I test the sensitivity of the baseline results by varying the sign restriction horizons ($k = 1$ and 3). I also check robustness by changing the lag orders of the VAR system ($p = 2$ and 6). Figure 12 shows that none of these changes affect the qualitative effects of the identified loan supply and demand shocks on output.[23]

5.2 Median model

I plotted the pointwise posterior medians of the impulse response functions from 200 accepted draws to summarize a dynamic response of each variable to a loan supply (demand) shock. However, Fry and Pagan [2011] and Inoue and Kilian [2013] criticized the use of the medians over different impulse response functions because the medians at each horizon are likely obtained from different accepted models, which

[23] The results of the forecast error variance decomposition, which are similar to those in Table 4, are available upon request.

makes an economic interpretation difficult. Following Fry and Pagan [2011], I compute the responses of the median model determined by minimizing the distance between the impulse responses of each of the accepted models and the median impulse responses over a fixed horizon (20 quarters). I measure the distance by the sum of the squared difference between the impulse responses of the accepted models and the median impulse responses. Consistent with findings of Busch et al. [2010], I find a negligible difference (Figure 13).

5.3 Extended model

So far, I have imposed minimal sign restrictions to identify only two structural shocks in a small VAR system and studied their effects on output, ignoring variables related to prices and monetary policy. From an econometric point of view, a model may require a large number of sign restrictions to ensure the identification of the structural shocks (Faust [1998]; Paustian [2007]). In this case, increasing the number of identified innovations can help uncover the correct sign of the impulse response functions of interest at the expense of computational burden. I assess the robustness of the results by extending the baseline VAR model to include additional variables using a small-scale New Keynesian framework.

However, the theoretical effects of a loan supply shock on the price level and the policy rate are indeterminate. For example, a negative loan supply shock may decrease inflation because of the contraction in aggregate demand induced by the decrease in credit volume (Curdia and Woodford [2010]; Gertler and Karadi [2011]). In contrast, the same shock may increase inflation via the increase in the cost of credit or real wages (Gerali et al. [2010]), which induces monetary policy tightening. Therefore, I do not impose any restrictions on these variables when identifying loan supply and loan demand shocks and let the data speak, similar to Busch et al. [2010], Hristov et al. [2012], and Gambetti and Musso [2017].

I choose the restrictions deliberately to rule out the potentially confounding influences of other fundamental shocks such as aggregate demand, aggregate supply, and monetary policy shocks on my results. An aggregate demand shock, such as a consumption, preference, or investment demand shock moves inflation, policy rates and output in the same direction, while a negative aggregate supply shock, such as a technology, oil price, or labor supply shock moves inflation and output in opposite directions and increases the policy rate. Finally, a monetary policy shock moves policy rates in the opposite direction to output and inflation. I do not impose any restrictions on the three variables related to bank loans to identify any of these structural shocks.

However, identifying all structural shocks simultaneously is a burdensome computation because more matrices $Q^{(k(j))}$ will be discarded to obtain impulse responses that satisfy the restrictions. I take an indirect approach: instead of identifying five orthogonal structural shocks simultaneously,[24] I identify each of the three new structural shocks with the existing loan supply and demand shocks and check whether the newly added structural shock influences the results. Table 5 summarizes the identification restrictions for all structural shocks in the extended model. I repeat the variance decomposition of the extended model to gauge their quantitative importance in explaining bank loans, real GDP, inflation, and the policy rate.

I start estimating the extended model by identifying contractionary monetary policy shocks together with negative loan supply and demand shocks. Simultaneous identification of monetary policy shocks is important as it tests whether shifts in banks' loan supply directly influence economic activity independent of the existence of a bank lending channel of monetary policy tightening (Kashyap et al. [1993]). The key to identifying a negative loan supply shock from a bank lending channel of monetary policy tightening is the sign of the policy rate response: if negative loan supply shocks induce monetary policy loosening, its negative effect on output is independent of the bank lending channel. I also estimate the same extended model by additionally identifying negative aggregate supply and demand shocks in turn to check the robustness of my findings.

Figures 14 and 15 show the responses of the four variables (loan volume, real GDP, inflation, and policy rate) to both loan supply and demand shocks. When jointly identified with a monetary policy shock, their effects on loan volume and output are similar to those in the baseline model (see Figures 7 and 8), and negative loan supply shocks are followed by declines in inflation and policy rates, suggesting an independent credit supply channel from a bank lending channel of monetary policy. These findings are consistent with theoretical predictions by Curdia and Woodford [2010] and Gertler and Karadi [2011]. When jointly identified with aggregate supply and aggregate demand shocks, the effects of loan supply shocks do not change much. Moreover, a decrease in loan volume still has an opposite effect on output, inflation, and the policy rate when it is driven by a decline in loan demand, emphasizing the importance of identifying the factors behind the decrease in the volume of bank loans.

[24] When identifying the five structural shocks simultaneously, I did not obtain sufficient number of correct draws of the impulse vectors from 10^6 draws.

Table 6 shows the forecast variance decomposition of the four aggregate variables explained by structural shocks in each specification. To save space, I only report the results at the 20-quarter horizon. Additional structural shocks hardly change the importance of loan supply shocks in explaining output fluctuations in the baseline model, and the share of output variation explained by loan supply shocks is still between 10 and 20%. The last three rows in Table 6 show the share of macroeconomic variables explained by each of three additional structural shocks in the extended model.

6 Conclusion

This paper provides a perspective on the link between a credit supply shock and the macroeconomy by applying a sign-restriction approach to bank loan officer survey data in EMEs. In these economies, a standard identifying assumption using the bank lending rate together with the volume of loans may result in biased estimates because of credit rationing or non-price lending terms. If excess demand for bank loans exists during the period of financial distress, the standard identification scheme fails when it is most needed. Interestingly, the simple but unique feature in bank loan officer survey from EMEs is consistent with the theoretical predictions under credit market imperfections, thereby providing insights into identifying a bank lending shock.

Based on the information contained in emerging market bank loan officer survey, I provide an alternative identification scheme to identify a bank lending shock and find that an observed decline in bank loans is associated with the opposite economic outcomes depending on the drivers of the decline: a negative loan supply shock has a strong adverse effect on output, followed by a decline in inflation and the policy rate, whereas a negative loan demand shock does not have a recessionary effect. From detailed Korean data, I show that the substitutability of bank loans with direct financing via the corporate bond market is key to understanding the contrasting effect on output of a loan supply shock from that of a loan demand shock.

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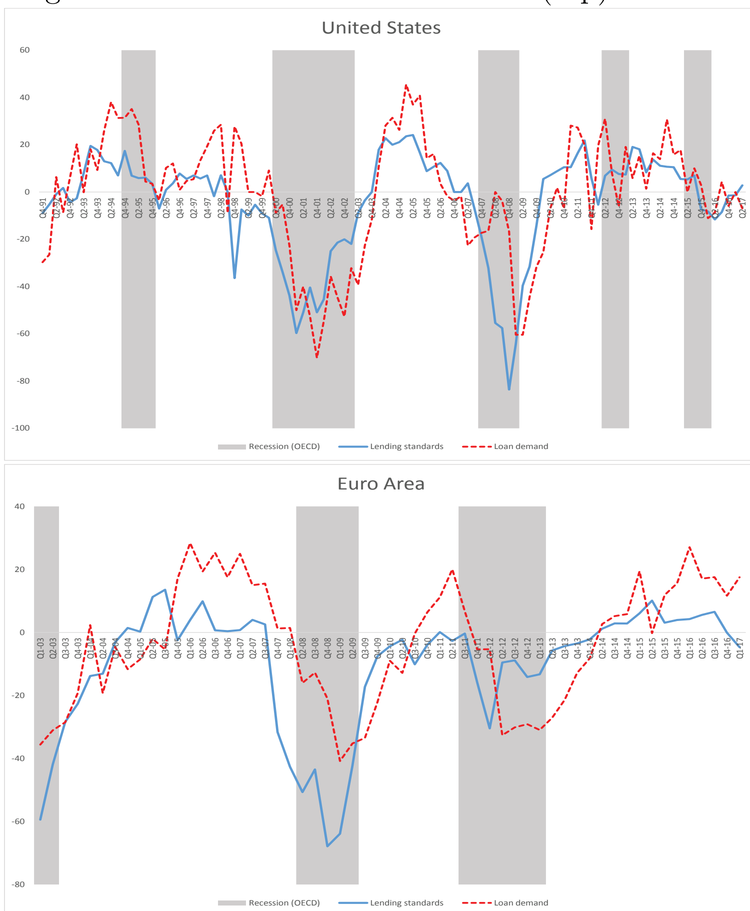
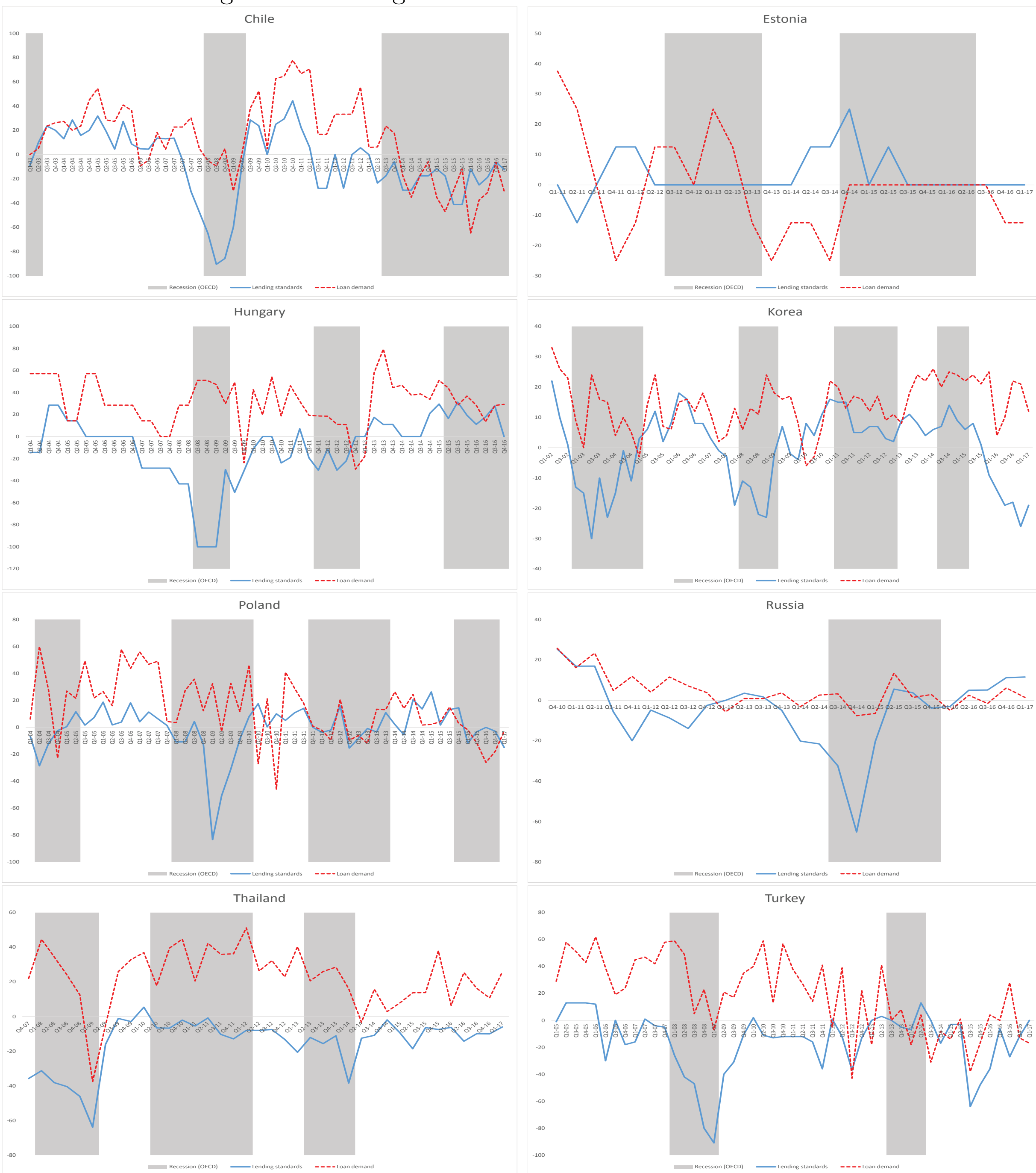
Figures and Tables

Figure 1: Lending standards and loan demand: U.S. (top) and Euro area (bottom)



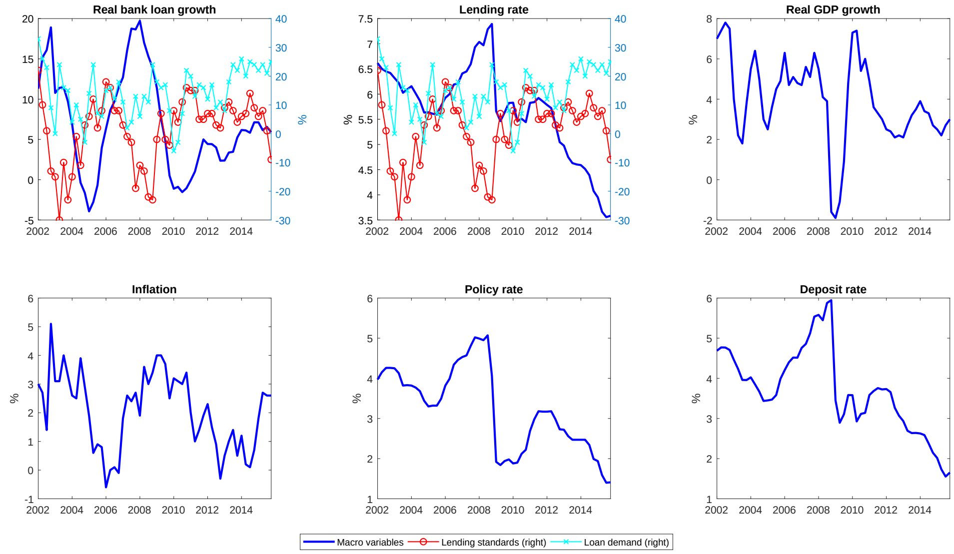
Note: These graphs show changes in lending standards towards new loans (solid) and loan demand (dashed) for the business sector in the U.S. (top) and the Euro area (bottom). The sign of the lending standards in the original data is reversed so that a decrease denotes tightening. See Appendix A.1 and A.2 for further details on the construction of indices.

Figure 2: Lending standards and loan demand: 8 EMEs



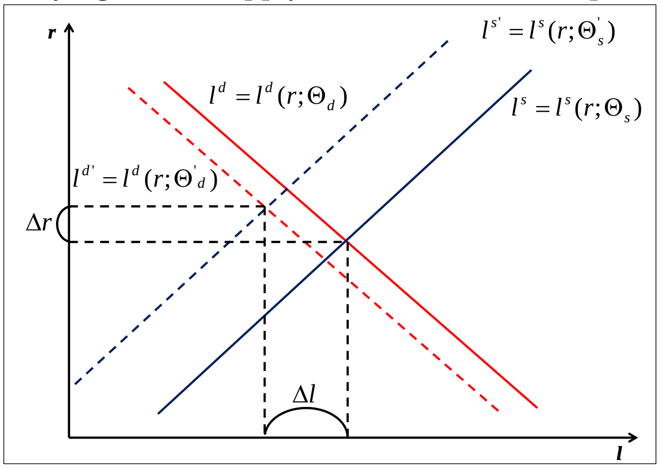
Note: This graph shows changes in lending standards towards new loans (solid) and loan demand (dashed) for the business sector in EMEs. The signs of the lending standards in the original data are reversed so that a decrease denotes tightening. See Appendix A.3 for further details on the construction of indices.

Figure 3: Macroeconomic data: Korea



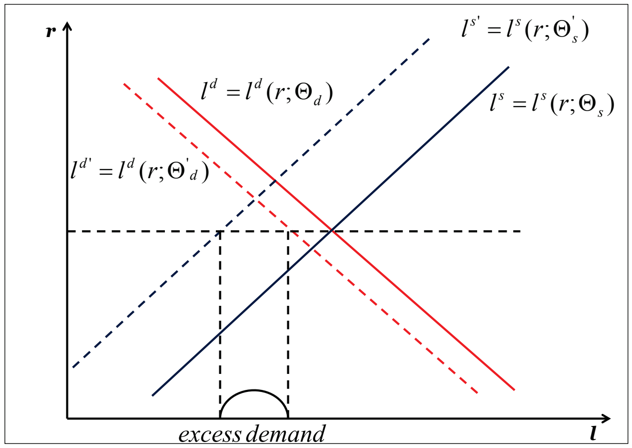
Note: The bank loan growth rate, real GDP growth rate, and inflation rate are the year-on-year growth of CPI deflated total bank loans to the business sector, real GDP, and the level of CPI, respectively. The policy rate is measured by the overnight call rate. All data are taken from Bank of Korea.

Figure 4: Identifying a loan supply shock: without non-price lending terms



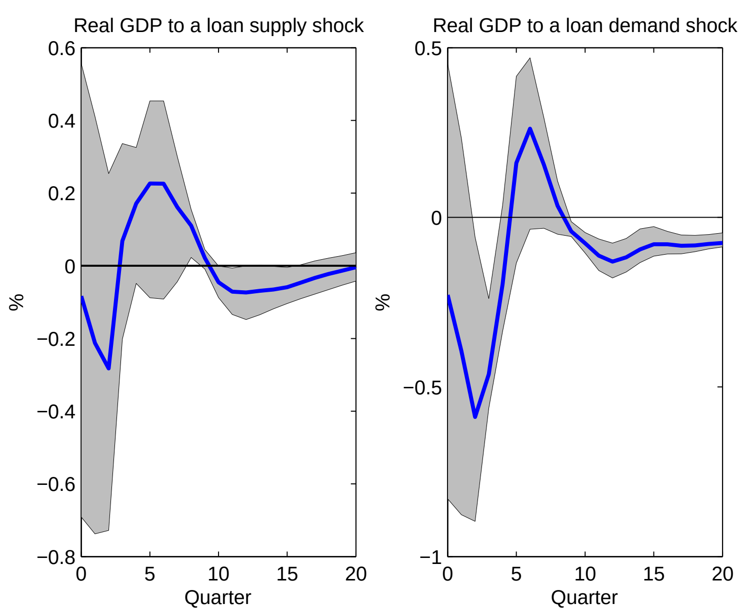
Note: This graph illustrates a negative loan supply shock when the bank lending rate equates the demand and supply of loans.

Figure 5: Identifying a loan supply shock: with non-price lending terms



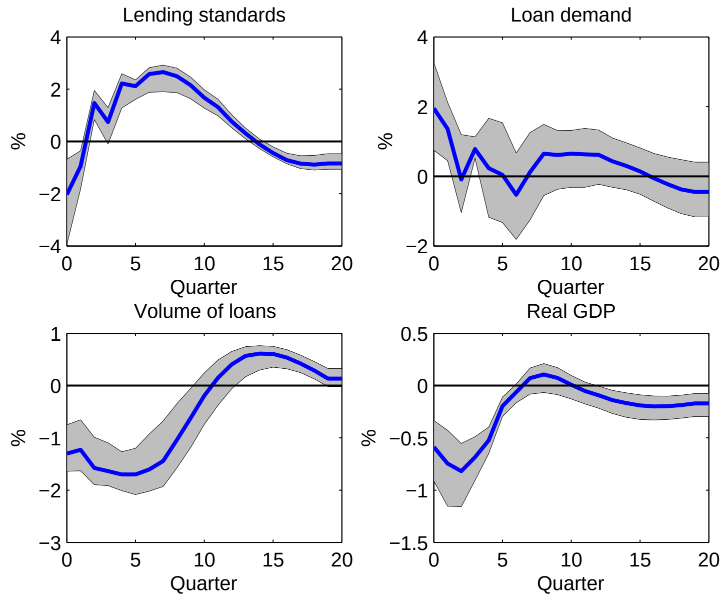
Note: This graph illustrates a negative loan supply shock with credit rationing when the bank lending rate does not equate the demand and supply of loans

Figure 6: The response of real GDP to the identified shocks



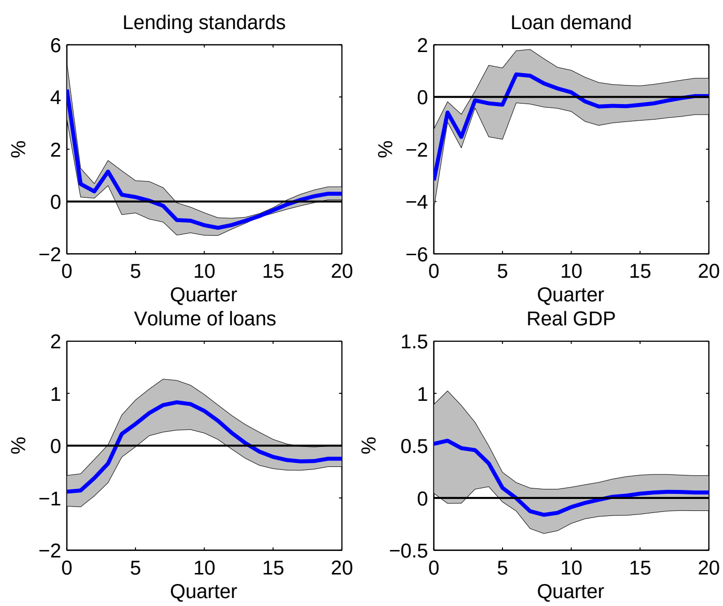
Note: A negative loan supply shock (left) and a loan demand shock (right) are identified by restrictions on the lending spreads and bank loan growth. Solid blue lines plot the median impulse responses and the shaded areas note their 16th and 84th percentile bands from 200 accepted draws.

Figure 7: The responses to a negative loan supply shock



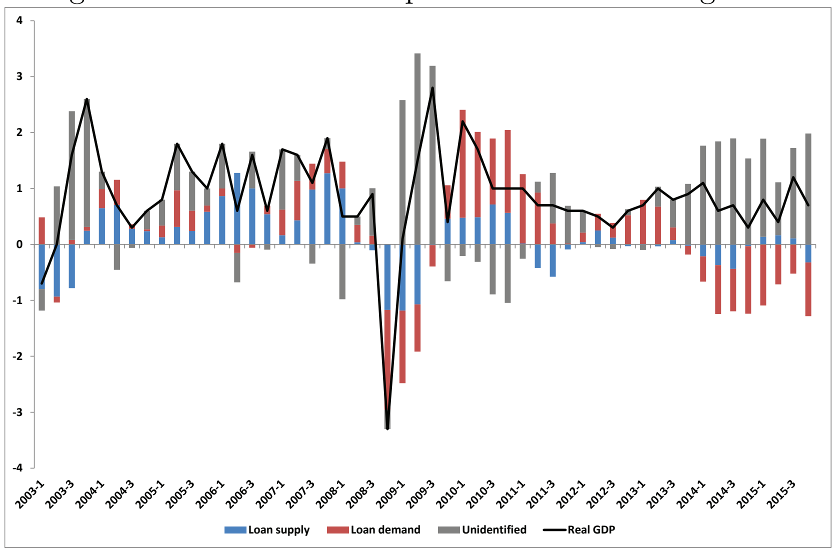
Note: Solid blue lines plot the median impulse responses and the shaded areas note their 16th and 84th percentile bands from 200 accepted draws.

Figure 8: The responses to a negative loan demand shock



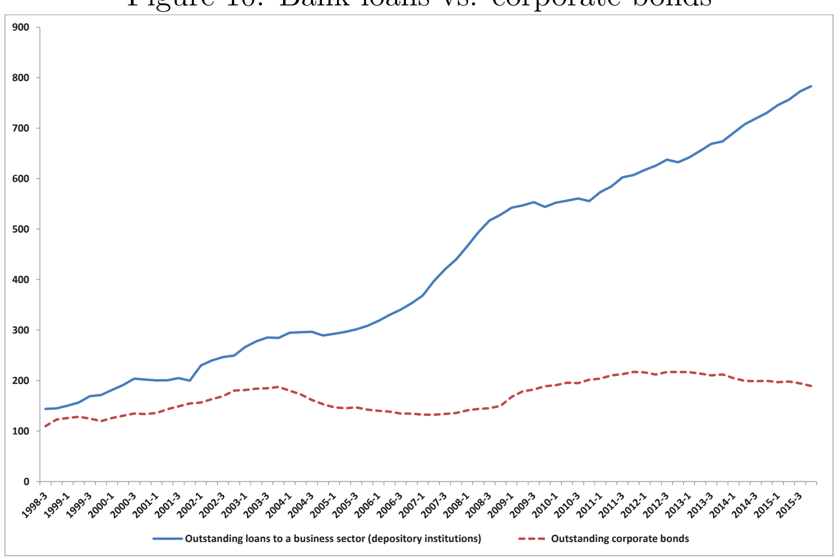
Note: The solid blue lines plot the median impulse responses and the shaded areas note their 16th and 84th percentile bands from 200 accepted draws.

Figure 9: Historical decomposition of real GDP growth



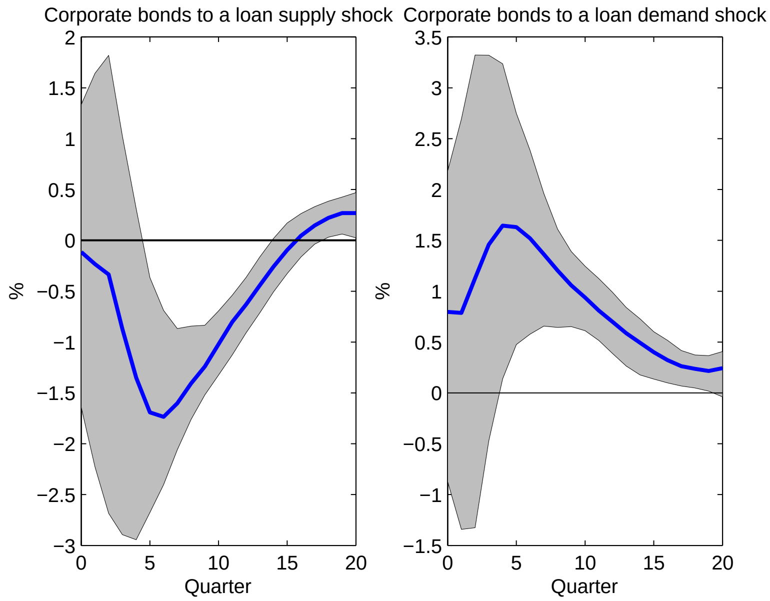
Note: Solid black line denotes the actual real GDP growth rate in Korea. Blue and red bars denote the contribution of loan supply and loan demand shocks in real GDP growth, respectively. Two unidentified shocks make up the balance of the changes in GDP growth.

Figure 10: Bank loans vs. corporate bonds



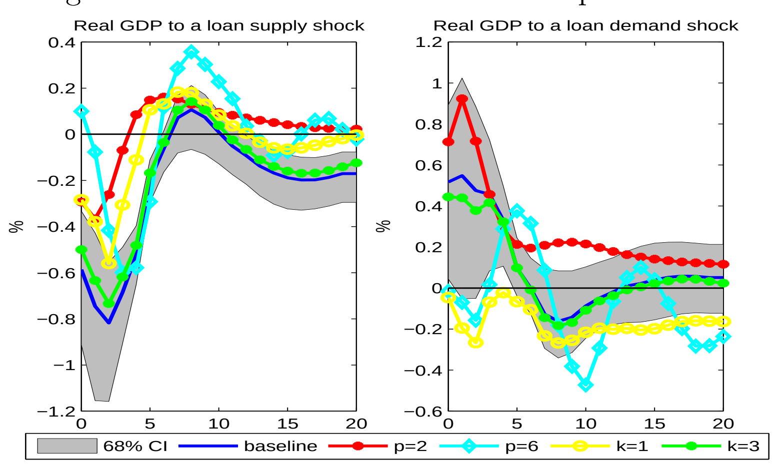
Note: Units are in trillion won (nominal).

Figure 11: The response of the growth of outstanding corporate bonds to the identified shocks



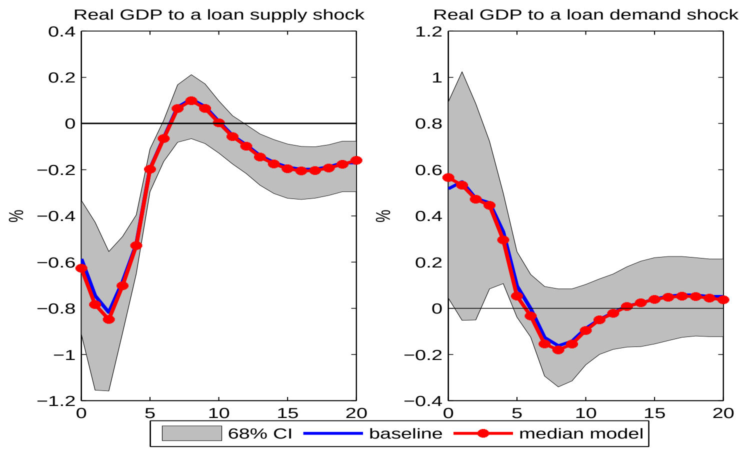
Note: Solid blue lines plot the median impulse responses and the shaded areas note their 16th and 84th percentile bands from 200 accepted draws.

Figure 12: The IRFs in an alternative specification



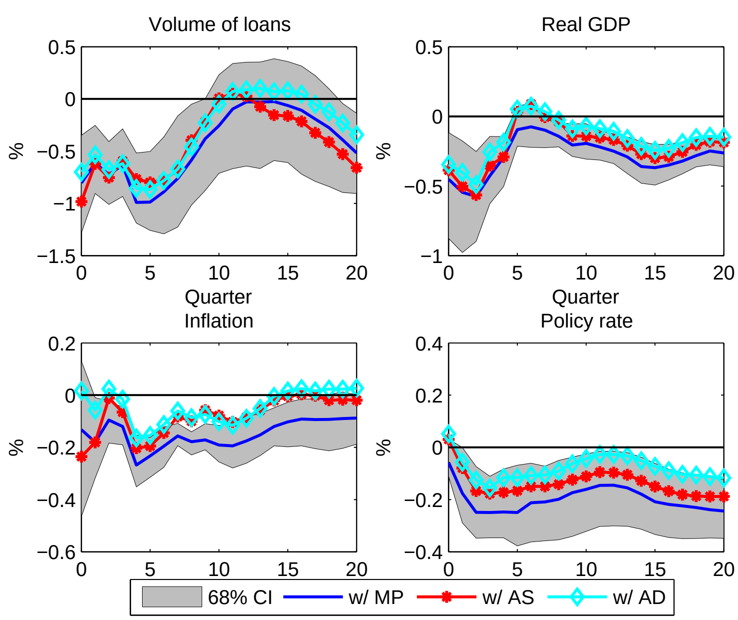
Note: Solid blue lines plot the median impulse responses and the shaded areas note their 16th and 84th percentile bands from 200 accepted draws of the baseline model ($p = 4$ and $k = 2$). $p = 2$ and $p = 6$ correspond to the VAR model estimated with 2 and 6 lags, respectively. $k = 1$ and $k = 3$ correspond to the VAR model imposing restrictions for 1 and 3 quarters, respectively.

Figure 13: IRFs in a median model



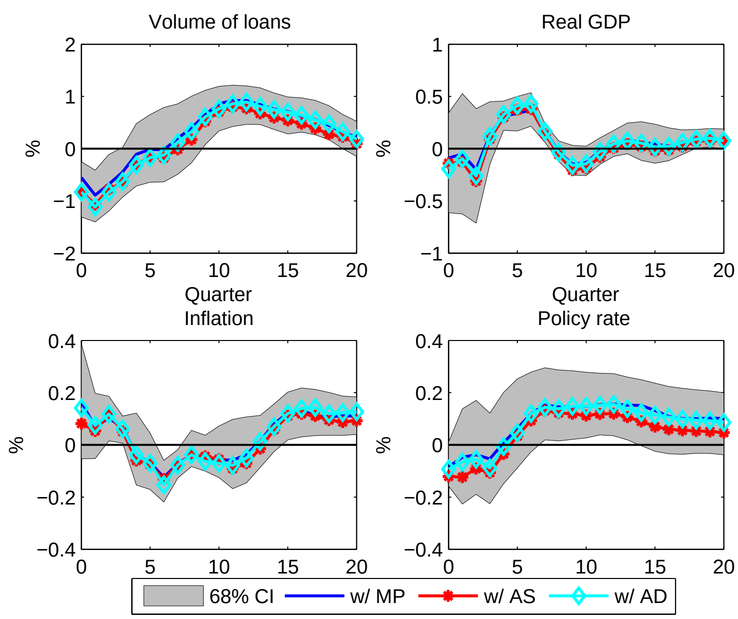
Note: Solid blue lines plot the median impulse responses and the shaded areas note their 16th and 84th percentile bands from 200 accepted draws of the baseline model. Circled red lines plot the impulse responses from a median model.

Figure 14: Responses to a negative loan supply shock



Note: Solid blue lines plot the median impulse responses and the shaded areas note their 16th and 84th percentile bands from 200 accepted draws of the extended model in which loan supply and loan demand shocks are identified with monetary policy shocks. Red circled and blue diamond lines plot the median impulse responses of the extended model in which loan supply and loan demand shocks are identified with aggregate supply and aggregate demand shocks, respectively.

Figure 15: Responses to a negative loan demand shock



Note: Solid blue lines plot the median impulse responses and the shaded areas note their 16th and 84th percentile bands from 200 accepted draws of the extended model in which loan supply and loan demand shocks are identified with monetary policy shocks. Red circled and blue diamond lines plot the median impulse responses of the extended model in which loan supply and loan demand shocks are identified with aggregate supply and aggregate demand shocks, respectively.

Table 1: Correlation between lending standards and loan demand

Country	Correlation	Period
	Advanced economies	
U.S.	0.70	1991Q1-2017Q2
Euro area	0.61	1991Q1-2017Q1
	Emerging market economies	
Chile	0.58	2003Q1-2017Q1
Estonia	-0.42	2011Q1-2017Q1
Hungary	0.04	2002Q3-2016Q4
Korea	0.18	2002Q1-2017Q1
Poland	-0.01	2004Q1-2017Q1
Russia	0.53	2010Q4-2017Q1
Thailand	0.39	2007Q4-2017Q1
Turkey	0.25	2005Q1-2017Q1
EM average	0.19	

Note: This table shows a correlation between lending standards and loan demand in bank loan officer survey data. Bank loan officer survey data of emerging economies available for more than seven years are taken from Haver Analytics. Bank loan officer survey data for Hungary is at a semi-annual frequency before 2009Q1.

Table 2: Sign restrictions on a contractionary shock (baseline preferred model)

Structural shock	Δd_t	Δs_t	Δl_t	Δy_t
Loan supply shock	≥ 0	≤ 0	≤ 0	?
Loan demand shock	≤ 0	≥ 0	≤ 0	?

Note: Restrictions imposed for two quarters. ? indeterminate responses *a priori*.

Table 3: Sign restrictions on a contractionary shock (conventional misspecified model)

Structural shock	Δsp_t	Δl_t	Δy_t
Loan supply shock	≥ 0	≤ 0	?
Loan demand shock	≤ 0	≤ 0	?

Note: Restrictions imposed for two quarters. ? indeterminate responses *a priori*.

Table 4: Forecast error variance decomposition (baseline model)

Structural shock	Horizon (quarters)	Bank loans	Real GDP
Loan supply shock	4	6.39	9.23
	12	9.09	11.21
	20	9.12	11.13
Loan demand shock	4	15.50	11.52
	12	19.86	12.01
	20	19.40	12.21

Note: The share of forecast error variance decomposition (percent) explained by (orthogonal) loan supply and loan demand shocks. The reported variance decomposition does not necessarily add up to 100 percent because there are other unidentified shocks that make up the balance.

Table 5: Sign restrictions on a contractionary shock (extended model)

Structural shock	Δd_t	Δs_t	Δl_t	Δy_t	π_t	i_t
Loan supply shock	≥ 0	≤ 0	≤ 0	?	?	?
Loan demand shock	≤ 0	≥ 0	≤ 0	?	?	?
Monetary policy shock	?	?	?	≤ 0	≤ 0	≥ 0
Aggregate supply shock	?	?	?	≤ 0	≥ 0	≥ 0
Aggregate demand shock	?	?	?	≤ 0	≤ 0	≤ 0

Note: Restrictions imposed for two quarters. ? indeterminate responses *a priori*.

Table 6: Forecast error variance decomposition (extended model)

Structural shocks	Identified with	Bank loans	Real GDP	Inflation	Policy rate
Loan supply shock	Monetary policy	8.93	10.10	13.70	8.20
	Aggregate supply	18.71	14.65	20.92	21.36
	Aggregate demand	7.09	10.23	9.05	5.16
Loan Demand shock	Monetary policy	11.84	10.78	11.72	11.81
	Aggregate supply	7.59	8.52	8.69	5.85
	Aggregate demand	13.14	13.76	13.24	16.50
Monetary policy shock		19.24	17.68	17.10	14.73
Aggregate demand shock		9.91	10.45	8.67	9.70
Aggregate supply shock		9.33	9.05	8.94	7.10

Note: Share of forecast error variance decomposition (percent) explained by (orthogonal) loan supply and loan demand shocks when they are identified with three additional structural shocks in turn. The last three rows show the share of macroeconomic variables explained by each of these additional structural shocks. The reported variance decomposition does not necessarily add up to 100 percent because there are other unidentified shocks that will make up the balance.

A Appendix: Bank Lending Survey Data

A.1 The U.S. Senior Loan Officer Survey

The U.S. bank loan officer survey was introduced in 1967, though the frequency and questions have changed several times since. The data are gathered from the quarterly Federal Reserve Board's Senior Loan Officer Opinion Survey on Bank Lending Practices (SLOOS) of senior loan officers at commercial banks. On the credit supply side, this survey queries banks about changes in their lending standards for the major categories of loans to households and businesses. On the credit demand side, it inquires banks as to whether they have experienced a change in loan demand from households and businesses.

The Federal Reserve Board usually conducts the survey four times annually, and up to 80 U.S. commercial banks participate in each. I only report changes in the lending standards and the loan demand from the business sectors at the aggregate level. The main questions used in this paper are, "Over the past three months, how have your bank's credit standards for approving applications for C&I loans or credit lines–other than those to be used to finance mergers and acquisitions–to large and middle market firms changed?" for lending standards and "Apart from normal seasonal variation, how has demand for C&I loans changed over the past three months?" for loan demand. See http://www.federalreserve.gov/boarddocs/SnLoanSurvey and Bassett et al. [2014] for a complete description of the panel selection criteria, wording of individual questions, and methods used to conduct the survey.

A.2 The Euro area bank lending survey

The national central banks of the Eurosystem request quarterly information on lending standards and the loan demand from a representative sample of banks in each country. By the end of 2015, 141 banks have participated. Although the survey provides information about both firms and households, I focus only on firm-related surveys. The main questions used in this paper are, "Over the past three months, how have your bank's credit standards as applied to the approval of loans or credit lines to enterprises changed?" for lending standards and "Over the past three months, how has demand for loans or credit lines to business loans changed at your bank, apart from normal seasonal fluctuations?" for loan demand. See Ciccarelli et al. [2015] for a complete description of the panel selection criteria, wording of individual questions, and methods used to conduct the survey.

A.3 Emerging market bank loan officer survey

A.3.1 Chile (2003Q1-2017Q1)

Title

Bank lending survey

Source

Central Bank of Chile

Coverage

Commercial lending towards large enterprises and SMEs by commercial banks

Main questionnaires for lending standards

Approval standards for commercial loans over the past three months: (a) Less restrictive to some degree, (b) No change, (c) More restrictive to some degree.

Main questionnaires for loan demand

Demand for new commercial loans (applications) to its bank over the past three months: (a) Stronger in some degree, (b) No change, (c) Weaker in some degree.

A.3.2 Estonia (2011Q1- 2017Q1)

Title

Bank lending survey

Source

The Bank of Estonia

Coverage

Commercial lending towards enterprises

Main questionnaires for lending standards

Changes in credit standards over the past three months

Main questionnaires for loan demand

Changes in demand for loans or credit lines over the past three months

Note

Diffusion index is the weighted difference between the share of banks reporting that credit standards have been tightened and the share of banks reporting that they have been eased. A positive diffusion index indicates that a larger proportion of banks have tightened credit standards, whereas a negative diffusion index indicates that a larger proportion of banks have eased credit standards. Demand index will therefore be positive if a larger proportion of banks have reported an increase in loan demand.

A.3.3 Hungary (2002Q3-2016Q4)

Title

Senior loan officer opinion survey on bank lending practices

Source

The Hungarian National Bank

Coverage

Corporate loans (Non-financial corporations (total))

Main questionnaires for lending standards

Please indicate your bank's willingness to grant loans or credit lines to enterprises now as opposed to the last period. (net change indicator)

Main questionnaires for loan demand

Apart from normal seasonal variation, how has demand for loans or credit lines to enterprises changed over the past period? (net change indicator)

Note

Up to 2008, survey is semi-annual.

A.3.4 Korea (2002Q1-2017Q1)

Title

Survey on Financial Institution Lending Practices

Source

The Bank of Korea

Coverage

Business sector loans by commercial banks (excluding Korea Development Bank and the export-import Bank of Korea)

Main questionnaires for lending standards

Over the past three months, how have your bank's lending standards towards loans to large-sized (or small and medium-sized) firms changed?

Main questionnaires for loan demand

Apart from seasonality, how has demand for loans from large-sized (or small and medium-sized) firms changed over the past three months?

Note

The index is constructed from the weighted average of the number of respondents, as follows:

$$DI = (1 \times \# \text{ of substantial increase} + 0.5 \times \# \text{ of somewhat increase}) \\ - (1 \times \# \text{ of substantial decrease} + 0.5 \times \# \text{ of somewhat increase}) \quad (3)$$

For the lending standards survey, a reading above zero means that the number of banks that restricted their lending compared to the last quarter outnumbered the number of lenders that eased their lending. For the loan demand survey, a reading above zero means the number of banks that experienced increased loan demand from the business sector compared to the last quarter outnumbered the number of lenders that experienced reduced loan demand.

A.3.5 Poland (2004Q1-2017Q1)

Title

Senior Loan Officer Survey: Corporate Sector

Source

National Bank of Poland

Coverage

Enterprise loans

Main questionnaires for lending standards

Over the last three months, how have your bank's credit standards for approving applications for loans or credit lines to large enterprises and SME changed? If your bank's policies have not changed over the last three months, please report them as unchanged even if they are restrictive or accommodative relative to longer-term norms. If a type of loans is not offered by your bank, please use the answer "not applicable".

Main questionnaires for loan demand

Over the last three months, how has the demand for loans or credit lines to corporate customers changed at your bank, apart from normal seasonal fluctuations? If a type of loans is not offered by your bank, please use the answer "not applicable".

Note

For lending standards, the difference between the percentage of responses "Eased considerably" and "Eased somewhat" and the percentage of responses "Tightened considerably" and "Tightened somewhat". A negative index indicates a tendency of tightening the credit standards. For loan demand, The difference between the percentage of responses "Increased considerably" and "Increased somewhat" and the percentage of responses "Decreased considerably" and "Decreased somewhat". A positive index indicates an increase in demand.

A.3.6 Russia (2010Q4-2017Q1)

Title

Bank Lending Condition Survey

Source

The Central Bank of the Russian Federation

Coverage

Bank lending to large and small/medium companies

Main questionnaires for lending standards

The parameter general lending conditions gives an assessment of the general changes in credit availability for each category of borrowers, its tightening indicates a decrease in availability of loans, easing – increase in availability.

Main questionnaires for loan demand

Parameters in the section Changes in demand for loans characterize current changes in demand for loans or expectations for the future changes.

Note

Indices of changes in bank lending conditions represent diffusion indices of tightening of bank lending conditions in comparison with the previous period. Weighted net percentage balance ("diffusion indexes") ranges from -100 (every bank eased from the previous period) and +100 (every bank tightened). Indices of loan demand are represented in percentage points and have values from -100 (all banks indicated significant decrease in demand for loans) up to +100 (all banks indicated significant increase in demand for loans). These indices are calculated using the following formula: $ID = N_{-2} + 0.5 \times N_{-1} - 0.5 \times N_{+1} - N{+}2$, where ID - diffusion index; percentage points

N_{-2}: share of banks reported about significant tightening of lending conditions;
N_{-1}: share of banks reported about moderate tightening of lending conditions;
N_{+1}: share of banks reported about moderate easing of lending conditions;
N_{+2}: share of banks reported about significant easing of lending conditions,

A.3.7 Thailand (2007Q4-2017Q1)

Title

Credit Conditions Survey

Source

Bank of Thailand

Coverage

Corporate loans

Main questionnaires for lending standards

Overall realized net change for credit standards.

Main questionnaires for loan demand

Overall realized net change demand for loans and credit lines.

Note

Credit Conditions Survey is conducted quarterly by the Bank of Thailand, reviewing opinions of senior loan officers. The questionnaires are sent out during end of the last month of the surveyed quarter and are compiled by the first month of the next quarter. The survey results are presented in Diffusion Index (DI) format which varies between -100 and 100. The DI is a weighted average score from a 5-level scale, with the weight for each financial institution corresponding to its outstanding loan market share. The DI can be interpreted as follows:

$DI < 0$ indicates credit contraction or tightening of credit policy

$DI = 0$ indicates unchanged credit growth or credit policy

$DI > 0$ indicates credit expansion or easing of credit policy.

A.3.8 Turkey (2005Q1-2017Q1)

Title

Bank Loans Tendency Survey

Source

Central Bank of the Republic of Turkey

Coverage

Loans to enterprises

Main questionnaires for lending standards

Overall realized net change for credit standards.

Main questionnaires for loan demand

Overall realized net change demand for loans and credit lines.

Note

Indices are measured in net percent (percent easing minus percent tightening).