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The Role of the Real Exchange Rate in Credit Growth in Central and Eastern European Countries: A Bank-Level Analysis*

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Abstract
This study analyzes the effects of macroeconomic and bank-level variables on the loan growth of banks in Central and Eastern European countries (CEECs) for the period between 1999 and 2010. Differences between private, state, domestic and foreign banks are analyzed by using the ownership structures of banks. We show that, unlike macroeconomic factors and other bank-level variables, leverage growth and equity growth have consistently significant effects on the loans of both domestic and foreign banks. The real exchange rate turns out to be a significant factor only for foreign banks. The latter result is important in understanding the transmission of global shocks to domestic credit. The results are robust to different specifications.

1. Introduction

Domestic credit growth has been noted as one of the most important signals of a financial crisis in the international finance literature. It is therefore crucial for policymakers to know the determinants of credit growth in order to proactively protect their economies. Based on the findings in the international finance literature on the relationship between credit growth and cross-border capital flows, this study tries to identify the effects of bank-specific and macroeconomic supply-side factors on credit growth in Central and Eastern European countries (CEECs). Special attention is given to the effects of the real effective exchange rate and bank leverage.

CEECs have witnessed an economic transformation during the last two decades as a result of the transition to market economies, which accelerated during the EU membership process of these countries. Some key features of the transformation include financial liberalization, rapid credit growth and privatization of commercial banks, as well as a general increase in the number of foreign banks operating in these countries. CEECs have gradually liberalized foreign direct investment (FDI) flows before portfolio flows, capital inflows before capital outflows and long-term flows before short-term flows (von Hagen and Siedschlag, 2010). The advantages and disadvantages of liberalization of financial markets have been debated in the literature. Kaminsky and Schmukler (2008) empirically show that short-term disadvantages of financial market liberalization such as increased volatility of financial markets are compensated, in the long-term, by regulations and

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reforms that would improve financial institutions. The short-term disadvantages of liberalization are given as risky behavior of banks (Schneider and Tornell, 2004) and lending boom-bust cycles in imperfect financial markets (Tornell *et al.*, 2003). To illustrate, for instance, during 2001–2010 domestic credit reached 38% of gross domestic product (GDP) in Bulgaria, while it was 30% in Romania and 23% in Hungary. On the bank ownership side of the story, the number of foreign banks operating in these countries increased to 262 in 2011 from 118 in 1997, while the number of domestic banks decreased to 123 in 2011 from 241 in 1997. This transformation of the financial markets and the banking sector in particular has raised questions about both the domestic lending of banks and their ownership statuses. Concerning domestic credit, it is the question of sustainable credit growth and the consequences of economic shocks. On the ownership side, the focus is on the added value of foreign banks to the efficiency of the banking sector and their role as a transmission channel of shocks in their parent countries. It is argued that a foreign-owned bank might carry shocks in the parent company's economy to the domestic economy, thereby making a country exposed to shocks in other countries. Therefore, policymakers would be interested in the determinants of credit growth in order to keep track of it as an indicator of a financial crisis and the role of foreign banks in the stability of their respective economies. Accordingly, the banking sector can be regulated to mitigate possible negative effects of credit growth and bank ownership structures.

The aim of this study is to investigate supply-side factors, namely banks' balance sheet elements and macroeconomic indicators, on the growth rate of commercial bank loans. The study first refers to the recent findings in the literature on the link between capital flows and domestic credit growth. Based on this link, focus is placed on the real exchange rate, leverage, leverage growth and equity growth, which are the crucial elements of the recent model by Bruno and Shin (2015) that tries to explain the relationship between cross-border capital flows and liquidity. Appreciation of the real exchange rate is empirically found to be one of the two most consistent predictors of a financial crisis by Gourinchas and Obstfeld (2012), who find the most important one to be the credit growth. Therefore, this study tries to gauge the relationship between two important variables at the bank level. Regarding the previous results in the literature on the differences between domestic and foreign banks, we further analyze whether the ownership of banks makes a difference on the sign and size of the effect. Subsamples of domestic and foreign banks, namely government-owned and private domestic banks and greenfield and takeover foreign banks, are considered in order to identify the effects of the features of each ownership status.

Our findings underline the importance of the variables under consideration and point to the difference of foreign banks. Leverage growth and equity growth are the only variables that are consistently significant in all subsamples and under all robustness checks. None of the other bank-level or macroeconomic variables is found to be significant in all specifications and subsamples. Another robust result is that the real exchange rate is significant with the expected sign for the pooled sample and for the foreign bank subsample. When foreign banks are divided into further subsamples, the effect of the real exchange rate has a consistently significant effect only for the greenfield banks.

The study is organized as follows: Section 2 provides a review of the literature on the linkages of capital flows and credit growth, describes key variables and their theoretical roles in the linkages, and summarizes the literature on the effects of bank ownership on domestic credit growth. Section 3 describes the dataset and variables used in the regressions, while Section 4 introduces the econometric methodology used in the study. Section 5 reports the main findings and robustness checks. Section 6 concludes the paper.

2. Literature Review

The empirical analysis of the study relies on models and empirical findings provided in the literature on the relationship between capital flows and domestic credit growth, the effect of bank ownership on bank lending, and the influence of the real and the nominal exchange rates on lending behavior.

First of all, the empirical literature provides evidence on a significant relationship between the cross-border capital flows and domestic credit growth. The evidence implies that there is a positive correlation between domestic growth and capital flows. Magud *et al.* (2014) find that capital flows have a significantly positive effect on domestic credit growth in emerging European countries for the period between 1999 and 2008, to which the authors refer as the "credit boom" period. Similarly, for 27 European countries between 2003 and 2008, Lane and McQuade (2014) find that increasing capital inflows as a result of financial integration, especially debt flows, significantly increase credit growth. Intuitively, the link can be explained by the increasing financial potential of the banking sector (Lane and McQuade, 2014). With financial integration, banks now add foreign depositors, borrowing on the interbank money market, international bonds and foreign portfolio investors to their funding sources.

Bruno and Shin (2015) built a model to explain changes in cross-border credit movements by focusing on equity, leverage and the real exchange rate. In this model, a bank tries to maximize the market value of its equity based on the balance sheet equation and the leverage constraint. In this context, the level of leverage refers to the rate a bank can transform a dollar increase in capital into lending. The model of Bruno and Shin (2015) implies that if the real effective exchange rate increases (e.g. because of local currency appreciation or US dollar depreciation), borrowing by local banksfrom global banks will increase at the aggregate level and cross-border flows will increase. It will have a similar effect as a decrease in credit risk. The model also implies that the real effective exchange rate is directly linked to the leverage decisions of banks and that both leverage and leverage growth are positively correlated with cross-border loans. The real exchange rate, however, is the only variable that is shown to be consistently significant and to have the theoretically correct sign in their empirical exercise.

Even though the model does not explain the domestic lending behavior of commercial banks *per se*, its implications can be used to explain changes in the domestic lending behavior of banks by the link between cross-border flows and credit growth. Variables that affect cross-border banking movements are expected to have effects similar to those of domestic credit growth since the cross-border borrowings of banks can be used as a source for financing domestic lending. In the case of real effective

exchange rate appreciation, a decline in credit risk or a decline in leverage or leverage growth, banks would borrow more from international markets and lend in domestic markets, thus playing an intermediary role between international markets and domestic residents. The intuition for leverage is in line with Adrian and Shin (2010), who show that if a bank's leverage decreases, it will try to increase its balance sheet by either borrowing from abroad, lending domestically or using both channels.

Empirical evidence for the effect of leverage in credit growth is presented in Adrian and Shin (2014), who point out the link between the balance sheets of financial intermediaries and their lending activities. If a financial intermediary has a strong balance sheet, *ceteris paribus*, it will find that it is much easier to lend. According to Adrian and Shin (2014), the leverage of banks is procyclical and linked to their decisions on new assets, loans and securities purchases.

A similar argument regarding the effect of the real exchange rate on credit growth is based on the Fisherian channel of the transmission of capital flows (von Hagen and Siedschlag, 2010), which can be summarized as follows:[1] In countries with fixed exchange rate regimes, the relative prices of non-tradable goods will increase after an appreciation of the real exchange rate and the central banks will try to stabilize the nominal value of the exchange rate. Therefore, producers of non-tradables will face a lower real interest rate and larger cash flows. This, in turn, will increase the value of their assets that can be used as collateral for bank loans. Thus, demand for credit will increase.

The explanation above holds for economies with fixed exchange rates. The effect of deviations from the fixed exchange rate regime has also been questioned in the literature. Magud *et al.* (2014) empirically show that the flexibility of exchange rates has a negative impact on credit growth during credit boom periods. Their study is carried out using the *de facto* exchange rate regime classification of Reinhart and Rogoff. The results suggest that countries with less flexible exchange rates will have more credit growth and it is argued that this relationship might be explained by the absorption of capital inflows due to the appreciation of exchange rates in a purely floating exchange rate regime, while in a fixed exchange rate regime the effect will not be totally sterilized and the non-sterilized part of the inflows will lead to greater credit expansion than would be the case in a floating exchange rate regime (Magud *et al.*, 2014). Another argument given by Montiel and Reinhart (2001) is that in a fixed exchange rate regime, banks might consider the fixed level of the exchange rate as a guarantee on foreign claims and look for more foreign funding. Finally, it is argued that incentives to borrow in foreign currencies might be higher in credible fixed exchange rate regimes (Magud *et al.*, 2014). The role of exchange rate regimes in lending behavior at the bank level is tested by dropping the real exchange rate from the regressions and adding the regime variable.

Lane and McQuade (2014) assume that the effect of financial integration works through its impact on domestic banks (i.e. financial integration increases the financing opportunities for domestic banks). However, the composition of bank ownership has undergone another transformation that has been argued to affect credit growth in European emerging markets. For instance, Aydin (2008) analyzes the reasons

[1] The line of arguments in von Hagen and Siedschlag (2010) is based on Calvo and Reinhart (2000), Calvo (2002) and Calvo *et al.* (2004).

for the rapid credit growth in CEECs and the role of bank ownership. The study shows that economic growth and deepening of financial markets in these countries during their transition to market economies were important for credit growth during the 1990s. It is pointed out that foreign banks facilitated credit growth in these economies and loans by foreign banks were higher on average than the loans provided by domestic banks. An interesting result of the study is that the funding of bank loans has changed over time. During the 1990s, foreign banks behaved like domestic banks and used customer deposits as a source of loans; later, however, they started to borrow more from their parent banks or other major banks (Aydin, 2008) to finance loans.

Cull and Martinez Peria (2010) study the consequences of foreign bank participation in developing countries. According to their findings, the efficiency of the banking sector increases after the market entry of foreign banks and the sector becomes more stable. This increase in the efficiency of the banking sector is also confirmed in a previous study by Claessens *et al.* (2001). The result relating to stability justifies the implications of Crystal *et al.* (2002), who find that foreign bank participation leads to less volatile credit growth. Cull and Martinez Peria (2010) also argue that foreign bank participation increases access to financing.

Bruno and Hauswald (2014) find three real effects of the increase of foreign bank participation. First, the existence of foreign banks relaxes financial constraints in the market, which means that domestic residents have greater access to financing through the international links of the foreign banks (i.e. multinational banks and parent banks). Second, they overcome informational barriers to lending. Third, they mitigate the legal obstacles of debt contracting. Finally, Brown *et al.* (2011) show that foreign owned banks are more likely to reject loan applications than domestic banks, especially loan applications from small and government-owned firms. The authors argue that foreign owned banks "cherry pick" (i.e. are more selective) firms in host countries; therefore, only applications from big and transparent firms are approved.

3. Data

This study uses bank-level micro variables, foreign exchange regime specification and macroeconomic indicators. The dataset covers the years 1999 to 2010 and includes 14 Central and Eastern European emerging market economies, namely Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, the Russian Federation, Slovakia, Slovenia, Turkey and Ukraine.

The banking data comes from an unbalanced yearly dataset that has been used by de Haas *et al.* (2012). The dataset uses the Bankscope database of *Bureau van Dijk* for the bank specific data. The initial dataset contains information on 1,777 different banks. However, the availability of data for each bank changes throughout the years. The first reason for this is the addition of new banks to the dataset and deletion of existing ones, which might be due to several reasons such bankruptcy, acquisition or merger. The second reason is that not all variables in the dataset are consistently reported by each bank.

The dataset reports changes in the ownership structure of banks. This feature of the dataset allows us to analyze the impact of bank ownership on domestic credit

Table 1 Number of Foreign and Domestic Banks

	Number of Banks			
	Domestic		Foreign	
	1999	2010	1999	2010
Bulgaria	21	11	9	21
Croatia	44	21	9	28
Czech Republic	17	12	18	32
Estonia	7	4	7	8
Hungary	9	11	26	39
Latvia	20	14	6	11
Lithuania	9	4	5	7
Poland	26	16	32	58
Romania	19	9	11	25
Russia	184	945	17	66
Slovakia	15	4	10	19
Slovenia	21	16	7	11
Turkey	47	30	10	25
Ukraine	32	43	7	35
Total	471	1140	174	385

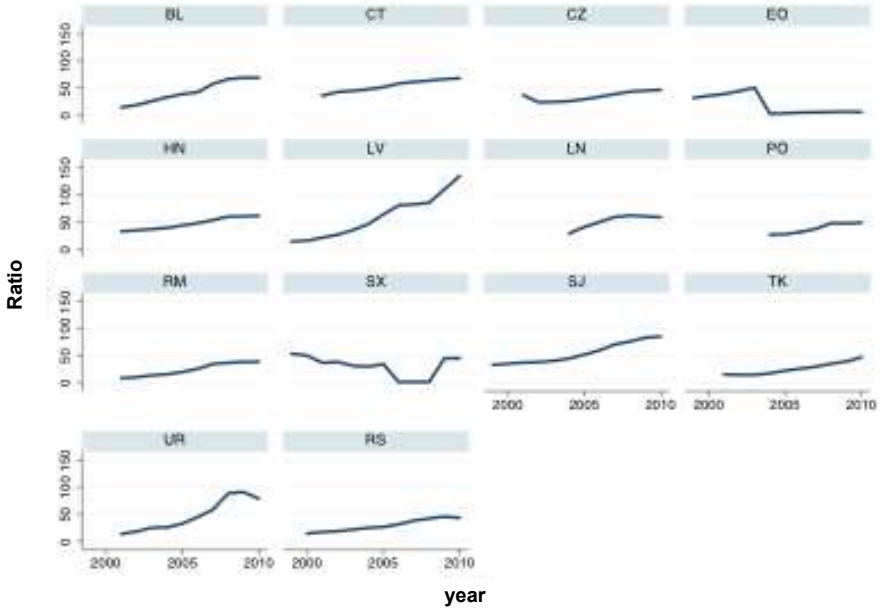
Notes: The number of foreign and domestic banks for each country used in the dataset. The table gives the number of banks that exist in the dataset.

growth. *Table 1* reports the number of domestic and foreign banks in each country for the years 1999 and 2010. The first observation in the table is the increasing number of foreign banks and a drop in the number of banks in each country. The only exceptions are the Russian Federation and Ukraine. Even though the number of foreign banks is higher in these countries in 2010 compared to 1999, the number of domestic banks also increased in the same period, especially in Russia, where the number of domestic banks increased by a factor of eight. At the same time, the number of foreign banks in Russia grew from 17 to 66.

A crucial aspect of the dataset is its compatibility with the aggregate values of domestic credit in CEECs, as other financial institutions can also provide credits to customers. The World Development Indicators (WDI) database published by the World Bank reports both domestic credit provided to the private sector *in general* and domestic credit provided to the private sector *by banks* both as a ratio to GDP. According to these series, as shown in *Figure 1* and *Figure 2*, the banking sector provides most of the credit to the private sector and, in some cases almost, all of the domestic credit. Therefore, the results of the study are expected to have implications not only on the lending behavior of the banking sector, also on the total domestic credit growth in CEECs.

At the bank level, domestic credit is provided by the *gross loans* variable in the dataset (de Haas *et al.*, 2012). Within the loan variables that give different loan categories of banks, *gross loans* is selected for two reasons. First, unlike the subcategories of loans, there are fewer missing values in this variable. Second, *gross*

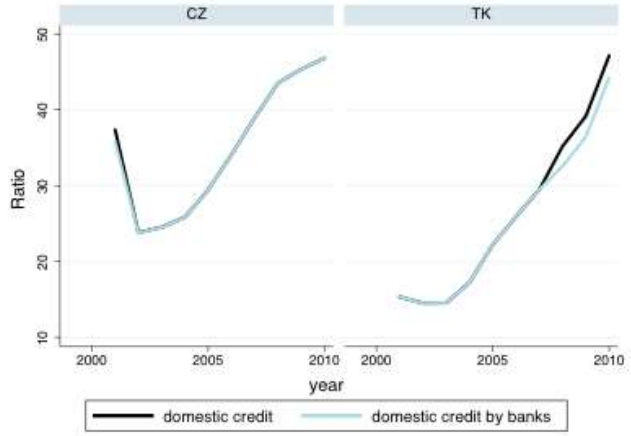
Figure 1 Domestic Credit by Banks



Note: Domestic credit to the private sector provided by banks as a share of GDP for all countries in the sample.

Source: World Bank, WDI.

Figure 2 Domestic Credit Comparison



Notes: Comparison of domestic credit and domestic credit provided by banks as shares of national GDP for the Czech Republic and Turkey. Dashed lines represent overall domestic credit as a share of GDP.

Source: World Bank, WDI.

loans successfully summarizes the domestic credit provided by banks. *Table 2* reports the correlation of the ratio of the aggregated gross loans provided by the banks in the dataset to GDP with the domestic credit provided by banks as a share of GDP.'

Table 2 Correlation of Gross Loans and Domestic Credit

	Correlation
Bulgaria	0.95
Croatia	0.95
Czech Republic	
Estonia	0.22
Hungary	0.87
Latvia	0.97
Lithuania	0.95
Poland	0.68
Romania	0.96
Russia	0.93
Slovakia	0.75
Slovenia	0.97
Turkey	0.94
Ukraine	0.84

Notes: Correlation of aggregated gross loans as a share of GDP with domestic credit provided by banks as a share of GDP for each country in the sample.

Table 3 Key Variable Values

		2001	2005	2008	2009	2010	All
Credit growth	All	0.19	0.22	0.27	-0.003	0.03	0.22
	Foreign	0.24	0.21	0.16	0.02	-0.06	0.25
	Domestic	0.16	0.23	0.3	-0.01	0.03	0.21
Leverage	All	8.1	7.3	7.6	7.0	5.9	7.4
	Foreign	9.0	9.6	9.7	9.1	5.9	9.3
	Domestic	7.7	6.5	7.2	6.6	5.9	6.8
Equity growth	All	0.16	0.14	0.23	0.03	0.17	0.2
	Foreign	0.19	0.1	0.12	0.08	0.1	0.21
	Domestic	0.14	0.17	0.26	0.02	0.17	0.2

Note: Values of key variables over time for the pooled sample, foreign banks, and domestic banks.

There is a strong positive correlation between the real value of domestic credit and the proxy variable in most of the countries. For Estonia, the correlation coefficient is 0.22; for other countries, it goes up to 0.97. These correlations also support the use of the dataset as a proxy for the aggregate banking sector data.

Values for credit growth, leverage and equity growth for certain years are given in *Table 3*. The table also distinguishes the values for the foreign and domestic bank subsamples. As displayed in the table, foreign banks are characterized by higher credit growth, leverage and equity growth even though the pattern changes for some years and is more apparent for leverage. Domestic banks and the whole sample suffer from negative credit growth in 2009, while foreign banks experience shrinkage in credit in 2010.

Changes in the foreign exchange regimes are collected from the annual reports on *Exchange Arrangements and Exchange Restrictions* of the International Monetary Fund (IMF). The IMF classifies exchange rate regimes under four broad categories, which are hard pegs, soft pegs, floating regimes (market determined exchange rates) and residual. There are nine separate subcategories under the first three categories, which can be listed from the least flexible to the most flexible as no legal tender, currency board, conventional peg, stabilized arrangement, crawling peg, crawl-like arrangement, pegged exchange rate arrangements, floating and free floating. Exchange rate regimes that do not fit in any of these categories are grouped under "residual".

Macro variables and other financial indicators are retrieved from two sources. The annual GDP growth, consumer price index (CPI) and domestic debt as a share of GDP data are from the World Bank WDI database, and the national currency per US Dollar data are from the International Financial Statistics database of the IMF.

The definitions of the variables used in the study are as follows:

- *Baseline bank-specific variables*
  - *Leverage* is defined by the logarithm of ratio of assets to assets minus liabilities of a bank.
  - *Leverage growth* is the first difference of the *Leverage* variable.
  - *Equity growth* is generated by taking the difference of the logarithm of equities of a bank.
- *Macro variables*
  - ΔRER is the change in the real effective exchange rate of a country. RER follows the definition used in Bruno and Shin (2015), which is logarithm of the nominal exchange rate times the ratio of US inflation and domestic inflation.
  - ΔGDP is the year-on-year GDP growth in a country.
  - $\Delta Debt/GDP$ is the growth of the ratio of gross debts to GDP.
  - $\Delta M2$ is the growth of money stock (M2) in an economy.
  - *Inflation* is the inflation rate in a country.
  - *VIX* is the Chicago Board Options Exchange Market Volatility Index (VIX).
- *Other bank-specific variables*
  - *Deposits growth* is generated by taking the difference of the deposits of a bank.
  - *Profitability* is the return on equity in percent.
  - *Loan quality* is the ratio of loan loss reserves to gross loans.
  - *Loan/deposit ratio* is the ratio of net loans to short-term funding in percent.
  - *Efficiency* is the ratio of cost to income in percent.
  - *Liquidity* is the ratio of liquid assets to the sum of deposits and short-term funding.

In order to avoid the effects of possible mergers and acquisitions, the credit growth variable is trimmed if the value of the variable exceeds the 99th percentile. Descriptive statistics of the variables are given in *Table 4*. *Table 5* reports the correlation of the credit growth variable with bank-level variables and macroeconomic

Table 4 Summary Statistics

Variable	Mean	Std. Dev.	Min.	Max.	No
Credit growth	0.217	0.331	-1.115	1.102	6974
Leverage	8.446	22.353	-100.385	1589.499	5720
Leverage growth	0.0	0.357	-2.12	4.868	5357
Equity growth	0.206	0.348	-5.403	3.915	6957
RER	-0.059	0.097	-0.269	0.267	6959
ΔM2	0.208	0.126	-0.63	0.945	6946
ΔGDP	0.036	0.055	-0.18	0.122	6974
ΔDebt/GDP	-0.012	0.051	-0.391	0.162	6830
Inflation	0.792	0.166	0.193	1.011	6974
Deposits growth	0.146	0.857	-10.092	10.878	6324
Profitability	10.051	27.297	-611.584	917.951	6960
Loan quality	6.586	7.662	-2.392	100.0	6366
Loan/deposit ratio	100.497	76.647	0.0	991.39	6891
Efficiency	72.011	25.629	0.159	475.303	6940
Liquidity	55.292	58.213	0.0	967.981	6902
VIX	0.223	0.118	0.107	0.461	6974

indicators. Credit growth has a negative correlation with Δ*RER* and a positive correlation with leverage, leverage growth and equity growth; however, the correlation with the leverage variable is small compared to other correlation values.

4. Econometric Methodology

The panel data regression equation used in the study can be given as follows:

$$\Delta GL_{it} = c + \sum_{k=1}^{m} \alpha_k macrolevel_{it}^{k} + \sum_{j=1}^{n} \beta_j banklevel_{it}^{j} + \varepsilon_{it}$$

where Δ*GL* is the growth of gross loans for bank *i* at time *t*, *m* is the number of macro-level variables, *n* is the number of bank-level variables and $\varepsilon_{it} \sim IID\left(0, \sigma_{\varepsilon}^{2}\right)$ is the error term. Δ*RER*, *GDP*, *Debt/GDP* and Δ*M2* are included as *macrolevel* variables. The macro-level variables are included in all regressions except the one with the VIX variable. For the *banklevel* variables, different permutations of the bank-level variables are used. Baseline bank-specific variables are first used one-by-one, then all together and with other bank-specific variables in order to see their robustness to inclusion of other variables.

The regressions use a fixed effects model with year dummies and clustering of countries. The year dummies are added to the regressions for two reasons. The first reason is that empirical evidence suggests that banking behavior in lending might be different between normal times and financial crisis years (Peek and Rosengren, 2000; Goldberg, 2002; Peria *et al.*, 2002; Everaert *et al.*, 2015). By using year dummies, the effect of the crisis is assumed to be grasped by allowing the intercept to change every year. The second reason is that, as pointed out by Roodman (2006), inclusion

Table 5 Correlation Matrix

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Credit growth	(1)	1															
Leverage	(2)	0.024	1														
Leverage growth	(3)	0.26	0.22	1													
Equity growth	(4)	0.38	-0.21	-0.54	1												
Δ*RER*	(5)	-0.34	-0.02	-0.12	-0.27	1											
Δ*M*2	(6)	0.14	-0.051	0.078	0.084	-0.2	1										
Δ*GDP*	(7)	0.39	-0.0097	0.13	0.28	-0.76	0.39	1									
Δ*Debt*/*GDP*	(8)	0-.27	0.048	-0.11	-0.17	0.39	-0.45	-0.6	1								
Inflation	(9)	-0.3	0.022	-0.15	-0.13	0.27	-0.48	-0.49	0.71	1							
Deposits growth	(10)	0.27	0.012	0.22	0.1	-0.11	0.026	0.11	-0.081	-0.09	1						
Profitability	(11)	0.11	0.034	-0.099	0.25	-0.083	0.041	0.11	-0.1	-0.072	0.043	1					
Loan quality	(12)	-0.29	-0.044	-0.073	-0.15	0.086	-0.0088	-0.1	0.061	0.09	-0.1	-0.12	1				
Loan/deposit ratio	(13)	-0.029	-0.063	-0.069	-0.041	0.058	0.01	-0.1	0.078	0.17	-0.1	-0.037	-0.0022	1			
Efficiency	(14)	-0.22	-0.015	-0.017	-0.17	0.18	-0.068	-0.23	0.15	0.25	-0.078	-0.25	0.12	0.04	1		
Liquidity	(15)	-0.12	-0.049	-0.088	0.066	-0.011	0.016	-0.018	0.00084	0.092	-0.083	-0.012	0.14	0.17	0.067	1	
VIX	(16)	-0.32	0.012	-0.12	-0.24	0.73	-0.41	-0.88	0.48	0.36	-0.095	-0.074	0.071	0.086	0.18	0.014	1
Observations		6974															

Notes: Correlation matrix of the variables used in the study. The correlation values are for the whole sample.

of time dummies makes correlation across individuals (i.e. banks in our case) less likely after an idiosyncratic shock. The variance estimator is clustered at the country level to handle the possibility of correlation in the error term.

Before estimation of the fixed effects model, the Hausman test (Hausman, 1978) is used to decide on fixed effects versus random effects models. According to the test statistics, the random effects model is significantly rejected.[2]

The expected signs of the variables and differences between domestic and foreign banks can be given as follows: The leverage variable measures a bank's capability of turning extra capital into lending while the difference variable shows the capability based on the existing capital stock. Both variables are expected to have a positive effect on credit growth. For foreign banks, which are assumed to have better international financial borrowing conditions, the effects of these variables are expected to be higher.

The impact of country-specific economic conditions is measured by the macro control variables. A high economic growth rate is expected to have a positive impact on credit growth, while an increase in debt-to-GDP growth is expected to have a negative impact since accumulating debt might increase financial risk in a country. The money stock growth variable measures the effect of currency restrictions. In order to hedge itself against currency risk or benefit from changes in the foreign exchange markets, a bank should be able to borrow domestically, buy foreign exchange and deposit it or vice versa. A currency mismatch would mitigate this option. Therefore, $\Delta M2$ is expected to have a positive sign and the effect is expected to be more significant for foreign banks.

The expected sign of inflation is ambiguous. Although inflation increases nominal credit, at the same time it is associated with a drop in credit growth (see e.g. Égert *et al.*, 2006) because of its negative impact on growth, creation of uncertainty due to the increased volatility of high inflation rates and the unwillingness of banks to lend when they experience high inflation rates.

In addition to the macro control variables, separate regressions will be carried out using the VIX index. This variable is used to analyze the impact of global risk on domestic loans. As global risk increases, domestic credit is expected to decrease. For foreign banks, which are more likely to be influenced by global conditions due to their relations with their parent banks, the magnitude of the impact is expected to be higher.

Deposits growth measures the effect of the funding conditions of an individual bank on credit growth (de Haas and Lelyveld, 2014). A bank with better funding conditions is expected to have a higher rate of credit growth. The effects of other bank-level variables are ambiguous and they are added to the regressions as control variables.

[2] The results are available upon request. It must be noted that the random effects model is not significantly rejected for small model specifications of state-owned banks. However, for the largest model this is not the case and the insignificance of the fixed effects model for these cases does not affect the main conclusions derived from the regressions.

Table 6 Pooled Sample Regressions

	1	2	3	4	5
Leverage	0.0057** (2.38)			0.0013 (1.03)	0.0029** (2.42)
Leverage growth		0.16*** (19.72)		0.47*** (20.60)	0.51*** (26.20)
Equity growth			0.22*** (14.91)	0.54*** (29.25)	0.61*** (31.11)
Δ*RER*	-0.68*** (-4.79)	-0.67*** (-4.68)	-0.58*** (-5.32)	-0.28** (-3.01)	-0.23*** (-3.78)
Δ*M2*	-0.082 (-0.75)	-0.11 (-0.84)	-0.054 (-0.73)	-0.0026 (-0.04)	0.0028 (0.05)
Δ*GDP*	2.39*** (3.26)	2.26** (2.95)	1.72** (2.76)	0.92** (2.47)	0.63 (1.60)
Δ*Debt*/*GDP*	-1.18** (-2.17)	-1.35*** (-3.12)	-0.45 (-1.28)	-1.07*** (-4.44)	-0.72*** (-4.12)
Inflation	0.77*** (3.05)	0.59** (2.54)	0.53*** (3.19)	0.40*** (3.07)	0.41** (2.44)
Deposits growth					0.017*** (10.77)
Profitability					-0.00060 (-1.63)
Loan quality					-0.011*** (-22.73)
Loan/deposit ratio					0.0014*** (21.25)
Efficiency					-0.00052* (-1.88)
Liquidity					-0.0014** (-2.85)
Constant	-0.49** (-2.84)	-0.20 (-1.27)	-0.24** (-2.20)	-0.18* (-2.10)	-0.078 (-0.81)
No	5624	5289	6771	5289	4675
R overall	0.205	0.261	0.276	0.488	0.519
R between	0.094	0.162	0.192	0.447	0.430
R within	0.274	0.312	0.306	0.472	0.575
No of banks	1338	1318	1396	1318	1198

Notes: Regression results for the pooled sample. Fixed effects regression with time fixed effects and country is chosen to be the group variable for the variance estimator. *t*-statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

5. Empirical Results

5.1 Baseline Results

Table 6 displays the estimation results for various specifications for the pooled sample. The exact specification does not substantially change the results, though GDP growth becomes insignificant in the richest specification (5) and leverage in specification (4) when leverage growth is also included. Note that the number of banks in the sample changes slightly due to data availability in the range from 1,198 to 1,396 depending on the specification. The R^2 substantially increases from 0.205 to 0.519: adding bank-specific variables therefore significantly adds to the explanatory

Table 7 Private Domestic Banks Regressions

	1	2	3	4	5
Leverage	0.0096*** (14.20)			-0.0017* (-1.98)	0.0025 (1.49)
Leverage growth		0.15*** (14.51)		0.45*** (18.55)	0.49*** (25.21)
Equity growth			0.23*** (12.17)	0.51*** (21.04)	0.61*** (41.92)
Δ*RER*	-0.55** (-2.35)	-0.81*** (-3.86)	-0.56*** (-4.03)	-0.38** (-2.51)	-0.24 (-1.57)
Δ*M2*	-0.047 (-0.46)	-0.00077 (-0.01)	-0.048 (-0.57)	0.11* (1.88)	0.092* (2.09)
Δ*GDP*	2.02* (2.02)	1.97* (1.96)	1.63* (1.88)	0.75 (1.37)	0.35 (0.75)
Δ*Debt*/*GDP*	-1.55 (-1.71)	-1.81** (-2.47)	-0.39 (-1.00)	-1.48*** (-3.34)	-1.29*** (-3.22)
Inflation	0.49* (2.03)	0.32 (1.74)	0.27 (1.22)	0.31** (2.26)	0.24 (1.32)
Deposits growth					0.016*** (21.50)
Profitability					-0.00021 (-1.09)
Loan quality					-0.010*** (-39.32)
Loan/deposit ratio					0.0015*** (39.94)
Efficiency					-0.00081*** (-3.23)
Liquidity					-0.0019*** (-22.80)
Constant	-0.24 (-1.57)	-0.15 (-1.12)	-0.13 (-0.90)	-0.18* (-1.95)	0.0092 (0.08)
No	3978	3810	4589	3810	3541
R overall	0.245	0.272	0.304	0.482	0.508
R between	0.150	0.187	0.265	0.529	0.428
R within	0.286	0.313	0.310	0.458	0.575
No of banks	1021	1009	1071	1009	939

Notes: Regression results for the domestic private banks subsample. Fixed effects regression with time fixed effects and country is chosen to be the group variable for the variance estimator. *t*-statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

power of the model. The sample regressions therefore corroborate the findings by Bruno and Shin (2015) at the bank level.

The results show that credit growth shows a close link with both macroeconomic and bank-specific variables. While the former certainly model credit demand, the latter can to some extent be interpreted as capturing supply-side factors. According to our analysis and for the full sample, the change in the debt/GDP ratio is negatively linked to credit growth, whereas inflation is positively linked to credit growth. As nominal credit growth will in general be affected by inflation, this also gives insights on whether inflation is detrimental to real private credit growth. With a coefficient

Table 8 State-owned Banks Regressions

	1	2	3	4	5
Leverage	0.0044 (0.55)			-0.00066 (-0.10)	0.0058 (0.56)
Leverage growth		0.16*** (5.08)		0.49** (2.90)	0.40* (2.07)
Equity growth			0.16*** (3.42)	0.54** (3.04)	0.47** (2.44)
Δ*RER*	-0.77*** (-3.44)	-0.69** (-2.57)	-0.57** (-2.36)	-0.15 (-0.50)	-0.10 (-0.34)
Δ*M2*	0.14 (0.82)	0.084 (0.45)	0.11 (0.73)	0.20** (2.69)	0.054 (0.66)
Δ*GDP*	3.96*** (3.41)	3.59*** (3.81)	3.12** (2.81)	2.08** (2.49)	1.63* (2.02)
Δ*Debt*/*GDP*	-0.76 (-1.38)	-0.57 (-0.97)	-0.25 (-0.71)	-0.31 (-0.55)	0.28 (0.45)
Inflation	1.71*** (3.68)	1.12*** (3.33)	1.36** (2.73)	0.59* (1.81)	0.56 (1.67)
Deposits growth					0.034 (1.12)
Profitability					-0.0015 (-0.79)
Loan quality					-0.022*** (-4.56)
Loan/deposit ratio					0.0014* (1.98)
Efficiency					-0.0014 (-1.29)
Liquidity					-0.00015 (-1.08)
Constant	-1.02*** (-3.22)	-0.95*** (-3.40)	-0.80** (-2.27)	-0.58* (-2.13)	-0.080 (-0.44)
No	368	338	441	338	268
R overall	0.110	0.177	0.115	0.474	0.413
R between	0.003	0.026	0.028	0.412	0.420
R within	0.275	0.312	0.259	0.473	0.532
No of banks	76	74	79	74	62

Notes: Regression results for the state-owned banks subsample. Fixed effects regression with time fixed effects and country is chosen to be the group variable for the variance estimator. *t*-statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

of less than 1, inflation in fact dampens credit growth (Guo and Stepanyan, 2011). The positive coefficient of GDP growth as a standard explanatory variable for credit growth becomes insignificant when the full set of micro variables is added, meaning that its role is captured by one of those measures.

In the pooled sample, changes in the real exchange rate show a significantly negative sign, meaning that a depreciation of the domestic currency goes along with an increase of the credit volume.

Finally, a broad set of bank-specific variables turn out to be relevant. All coefficients except the one for profitability are significant. Both leverage and leverage

Table 9 Foreign Banks Regressions

	1	2	3	4	5
Leverage	0.0027** (2.19)			0.0019 (1.61)	0.0023*** (3.09)
Leverage growth		0.20*** (3.97)		0.54*** (5.29)	0.63*** (10.30)
Equity growth			0.19*** (6.57)	0.59*** (6.84)	0.70*** (11.31)
Δ*RER*	-0.62*** (-3.96)	-0.52*** (-3.70)	-0.63*** (-4.91)	-0.21** (-2.89)	-0.19** (-2.54)
Δ*M2*	-0.015 (-0.25)	-0.061 (-1.03)	-0.026 (-0.44)	-0.064* (-2.13)	-0.050* (-1.82)
Δ*GDP*	1.31** (2.53)	1.43** (2.33)	1.21** (2.62)	0.57** (2.42)	0.55* (1.88)
Δ*Debt*/*GDP*	-1.72*** (-3.82)	-1.70*** (-4.11)	-1.03* (-2.09)	-1.10*** (-3.94)	-0.39 (-1.39)
Inflation	0.87*** (3.06)	0.77*** (3.47)	0.59** (2.73)	0.34** (2.72)	0.23 (1.70)
Deposits growth					0.0052 (0.89)
Profitability					-0.00014 (-0.31)
Loan quality					-0.0029 (-0.81)
Loan/deposit ratio					0.0012*** (4.13)
Efficiency					0.0016*** (3.16)
Liquidity					-0.0014* (-2.03)
Constant	-0.45** (-2.30)	-1.13*** (-4.70)	-0.23 (-1.52)	-0.61*** (-4.78)	-0.67*** (-5.29)
No	1278	1141	1741	1141	866
R overall	0.190	0.274	0.251	0.497	0.613
R between	0.120	0.148	0.129	0.254	0.417
R within	0.307	0.396	0.334	0.552	0.679
No of banks	286	276	311	276	230

Notes: Regression results for the foreign banks subsample. Fixed effects regression with time fixed effects and country is chosen to be the group variable for the variance estimator. *t*-statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

growth show the expected positive relation with credit growth; the same applies to equity and deposit growth and the loan/deposit ratio, indicating a link between the ability to lend and credit growth. These coefficients therefore reflect the supply side of the credit market. The coefficient for loan quality is found to be significantly negative, indicating that a rapid credit expansion may happen at the cost of lower credit quality or that picking high-quality loans limits credit expansion.

Furthermore, we find that efficiency and liquidity are negatively linked with credit growth. As de Haas and van Lelyveld (2010) point out, the expected sign for these variables is indeterminate. This is because, on the one hand, liquidity ratios

Table 10 Greenfield Banks Regressions

	1	2	3	4	5
Leverage	0.0041 (1.63)			0.0011 (0.80)	0.0027*** (3.05)
Leverage growth		0.25*** (9.90)		0.59*** (8.46)	0.62*** (9.54)
Equity growth			0.19*** (4.33)	0.65*** (7.93)	0.73*** (8.61)
Δ*RER*	-0.68*** (-3.63)	-0.68*** (-4.84)	-0.56*** (-3.26)	-0.23*** (-3.04)	-0.18* (-1.88)
Δ*M2*	-0.015 (-0.20)	-0.052 (-0.78)	-0.062 (-0.86)	-0.068 (-1.64)	-0.019 (-0.52)
Δ*GDP*	1.39** (2.18)	1.63** (2.53)	1.17** (2.70)	0.56** (2.89)	0.35 (1.09)
Δ*Debt*/*GDP*	-1.38*** (-3.09)	-1.57*** (-3.61)	-0.79 (-1.50)	-1.03*** (-3.59)	-0.63* (-1.80)
Inflation	0.78** (2.53)	0.82*** (3.63)	0.56** (2.56)	0.36** (2.37)	0.40* (1.80)
Deposits growth					-0.013 (-1.48)
Profitability					-0.00071 (-1.26)
Loan quality					-0.0072** (-2.67)
Loan/deposit ratio					0.0013*** (3.76)
Efficiency					0.0015* (2.10)
Liquidity					-0.0012* (-1.82)
Constant	-0.41* (-2.05)	-1.17*** (-4.69)	-0.15 (-1.03)	-0.61*** (-3.52)	-0.23* (-2.00)
No	823	738	1079	738	539
R overall	0.139	0.236	0.214	0.528	0.632
R between	0.063	0.061	0.093	0.408	0.592
R within	0.258	0.374	0.284	0.547	0.665
No of banks	164	157	178	157	127

Notes: Regression results for the greenfield (foreign) banks subsample. Fixed effects regression with time fixed effects and country is chosen to be the group variable for the variance estimator. *t*-statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

may reflect risk aversion and thus a moderate expansion of credit and *vice versa* or, on the other hand, because high excess liquidity may enable banks to rapidly expand their credit portfolios.

The analysis for the subsamples in *Tables 7–11* shows some remarkable differences between the groups. Concerning the macro variables, the link between GDP and credit growth breaks is particularly pronounced for state-owned banks. While there are no consistent differences between the subsamples in the coefficients of money growth, the debt/GDP ratio and inflation, the macroeconomic variables turn out to differ between subsamples but do not show a consistent pattern.

Table 11 Takeover Banks Regressions

	1	2	3	4	5
Leverage	0.0015** (2.43)			0.0025** (2.43)	-0.0013 (-0.45)
Leverage growth		0.11 (1.03)		0.42* (1.92)	0.71*** (8.95)
Equity growth			0.17*** (3.47)	0.46*** (3.12)	0.71*** (12.16)
Δ*RER*	-0.50*** (-3.42)	-0.25 (-1.44)	-0.72*** (-5.12)	-0.073 (-0.49)	-0.17 (-1.50)
Δ*M2*	-0.055 (-0.78)	-0.16** (-2.54)	0.056 (0.79)	-0.15** (-2.67)	-0.14 (-1.58)
Δ*GDP*	1.34*** (3.52)	1.32** (2.73)	1.17* (1.90)	0.72** (2.51)	1.16*** (3.34)
Δ*Debt*/*GDP*	-2.39*** (-3.43)	-1.60*** (-3.27)	-1.74** (-2.27)	-1.00* (-1.94)	0.33 (1.01)
Inflation	1.08** (2.90)	0.52 (1.66)	0.77** (2.90)	0.063 (0.20)	-0.37 (-1.05)
Deposits growth					0.012** (2.34)
Profitability					0.00034 (0.50)
Loan quality					0.011** (2.65)
Loan/deposit ratio					0.00090*** (3.08)
Efficiency					0.0018 (1.50)
Liquidity					-0.0041*** (-4.73)
Constant	-0.57** (-2.33)	-0.060 (-0.27)	-1.11*** (-4.08)	0.14 (0.70)	0.35 (1.31)
No	455	403	662	403	327
R overall	0.302	0.400	0.317	0.514	0.587
R between	0.182	0.273	0.160	0.232	0.327
R within	0.461	0.506	0.453	0.608	0.769
No of banks	122	119	133	119	103

Notes: Regression results for the takeover (foreign) banks subsample. Fixed effects regression with time fixed effects and country is chosen to be the group variable for the variance estimator. *t*-statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Leverage growth and equity growth all have the expected signs and are consistently significant at the 1% level in every specification. They seem to be the main drivers of credit growth in all bank categories. Similar to Bruno and Shin (2015), however, we do not see the same consistency in the leverage variable, with the coefficient also being quite small. Other variables except loan quality and loan-to-deposits ratio do not give consistently significant results. Inflation is only significant for the greenfield banks subsample. These results provide empirical evidence for the model developed in Bruno and Shin (2015) with micro data.

The sign of the real exchange rate variable is still intuitively correct, but it is significant throughout only for the subsample of foreign banks. In contrast, for domestic private banks, the coefficient in absolute terms is larger than the one for foreign banks, but it loses its significance in the specification with all bank-level variables. The picture for (domestic) state-owned banks is similar. In summary, we do find some evidence that the real exchange rate channel is typical for foreign banks, but we cannot conclude that it exclusively works through these banks. It also seems to affect private domestic banks to some extent and, to an even lesser extent, state-owned banks.

5.2 Effect of Flexible Exchange Rate Regimes

The previous subsection analyzed the impact of real exchange rate changes on the growth rate of loans and found that—for the full sample—a depreciation of domestic currencies goes along with increased credit growth. A related question deals with the impact of the exchange rate regime on credit growth. One would expect credit growth to be higher under a pegged exchange rate regime for a couple of reasons. First, Magud *et al.* (2014) describe how capital inflows create a link between the exchange rate regime and credit expansion. While under a floating exchange rate capital inflows appreciate the domestic currency, there will be no further effects on monetary aggregates. This only partly holds under a fixed regime, when the central bank is forced to intervene. The reason for this is that sterilization of the intervention is costly and therefore in most cases incomplete and the monetary base is expanded. As a consequence, more rigid exchange rate regimes are likely to be accompanied by stronger credit growth when capital flows in. Second, as Montiel and Reinhart (2001) point out, deposit insurance for claims acquired by foreign depositors on domestic banks coupled with a pegged (e.g. guaranteed) exchange rate reduces the banks' cost of attracting external funds. Accordingly, they increase their lending capacity. At the same time, a pegged exchange rate creates incentives for taking on debt in a foreign currency.

Therefore, we drop the changes in the real exchange rate and replace them with a dummy variable, which takes the value of one if the regime is flexible and zero if it is rigid. Instead of the nine regimes defined by the IMF, floating exchange rate regimes are taken to represent the positive value in the dummy variable in order to avoid further fragmentation of the data in the subsample regressions. Other regimes are taken to be the rigid regimes. The results are displayed in *Table 12*. For the pooled sample, we find a highly significant relation between the flexibility of the exchange rate regime and credit growth, corroborating the findings by Magud *et al.* (2014): If the exchange rate regime moves towards a more flexible one, credit growth increases. This relation, however, no longer remains significant when we turn to the subgroups of banks. Although the sign of the coefficient remains positive for all bank groups, it is no longer significant.

5.3 Effect of VIX

Finally, we follow the approach of Bruno and Shin (2015) and use the VIX index as a proxy for global leverage. The rationale is that when global risk increases, capital inflows to emerging markets will decrease (Forbes and Warnock, 2012).

Table 12 Exchange Rate Regime Regressions

	1	2	3	4	5	6
Leverage	0.00056*** (5.12)	0.00041*** (3.42)	0.0025 (1.43)	0.0057 (0.58)	0.00056** (2.50)	-0.0019 (-0.73)
Leverage growth	0.52*** (29.09)	0.65*** (11.09)	0.49*** (24.56)	0.40* (2.07)	0.64*** (9.97)	0.73*** (9.87)
Equity growth	0.62*** (33.23)	0.70*** (11.44)	0.61*** (43.86)	0.47** (2.46)	0.73*** (8.96)	0.72*** (12.62)
ER Regime	0.035*** (3.24)	0.014 (1.13)	0.020 (1.07)	0.050 (1.11)	0.013 (1.19)	0.0076 (0.28)
Δ*M2*	0.015 (0.31)	-0.053 (-1.59)	0.094* (2.05)	0.053 (0.81)	-0.017 (-0.49)	-0.16 (-1.67)
Δ*GDP*	0.69* (1.92)	0.51* (1.88)	0.36 (0.79)	1.72** (2.35)	0.28 (0.85)	1.14*** (3.50)
Δ*Debt*/*GDP*	-0.62** (-2.38)	-0.23 (-0.84)	-1.24** (-2.52)	0.42 (0.87)	-0.54 (-1.64)	0.52 (1.64)
Inflation	0.61*** (3.38)	0.20 (1.45)	0.37 (1.15)	0.91 (1.69)	0.43* (1.80)	-0.46 (-1.37)
Deposits growth	0.016*** (10.73)	0.0043 (0.71)	0.015*** (20.23)	0.032 (1.06)	-0.014 (-1.66)	0.011** (2.35)
Profitability	-0.00052 (-1.60)	-0.00026 (-0.59)	-0.00019 (-1.20)	-0.00099 (-0.55)	-0.00089 (-1.63)	0.00029 (0.43)
Loan quality	-0.011*** (-19.22)	-0.0040 (-1.42)	-0.010*** (-38.58)	-0.022*** (-4.37)	-0.0081*** (-3.77)	0.0093** (2.40)
Loan/deposit ratio	0.0014*** (20.78)	0.0011*** (4.02)	0.0015*** (39.51)	0.0015* (1.97)	0.0012*** (3.68)	0.00087** (2.86)
Efficiency	-0.00039 (-1.55)	0.0016*** (3.21)	-0.00078*** (-3.32)	-0.0011 (-1.06)	0.0014* (2.07)	0.0019 (1.49)
Liquidity	-0.0014** (-2.90)	-0.0014* (-1.99)	-0.0019*** (-24.08)	-0.00018 (-1.19)	-0.0011* (-1.79)	-0.0042*** (-5.37)
Constant	-0.39** (-2.55)	-0.66*** (-3.75)	-0.18 (-0.60)	-0.69 (-1.19)	-0.29 (-1.51)	0.39 (1.33)
No	4685	876	3541	268	543	333
R overall	0.487	0.594	0.500	0.358	0.622	0.564
R between	0.385	0.392	0.419	0.375	0.588	0.303
R within	0.574	0.676	0.575	0.535	0.664	0.769
No of banks	1199	231	939	62	127	104

Notes: Results for regressions with the exchange rate regime variable. The columns report results for (1) the pooled sample, (2) domestic private banks, (3) state-owned banks, (4) foreign banks, (5) greenfield banks and (6) takeover banks, respectively. Fixed effects regression with time fixed effects and country is chosen to be the group variable for the variance estimator. *t*-statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Therefore, an increase in the VIX should go along with a decrease in bank loans due to a reduction in capital flows.

The results of the regressions with the VIX index as an additional variable are displayed in *Table 13*. The sign for the real exchange rate remains negative when the VIX is added. The coefficient for the VIX itself, however, shows the expected sign only for domestic banks. For the other bank groups, the coefficient is insignificant and positively signed. This means that for all groups other than domestic banks, credit growth increases in line with global uncertainty.

Table 13 VIX Regressions

	1	2	3	4	5	6
Leverage	0.0054** (2.21)	0.0093*** (14.50)	0.0041 (0.58)	0.0027* (1.97)	0.0013 (1.48)	0.0041 (1.54)
Δ*RER*	-0.46** (-2.18)	-0.29 (-1.04)	-0.35 (-1.25)	-0.46** (-2.27)	-0.38* (-1.84)	-0.49* (-2.08)
VIX	0.16 (0.95)	-0.074 (-0.31)	0.54** (2.69)	1.18*** (5.88)	1.57*** (13.75)	1.04*** (4.12)
Constant	-0.097* (-2.04)	-0.046 (-0.70)	-0.17** (-2.63)	-0.52*** (-6.29)	-0.69*** (-12.95)	-0.48*** (-4.77)
No	5709	4030	375	1304	463	841
R overall	0.221	0.244	0.181	0.216	0.355	0.155
R between	0.132	0.150	0.127	0.163	0.229	0.094
R within	0.260	0.279	0.220	0.285	0.417	0.243
No of banks	1344	1027	76	287	122	165

Notes: Results for regressions with the VIX index. The columns report results for (1) the pooled sample, (2) domestic private banks, (3) state-owned banks, (4) foreign banks, (5) greenfield banks and (6) take-over banks, respectively. Fixed effects regression with time fixed effects and country is chosen to be the group variable for the variance estimator. *t*-statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

5.4 Robustness Checks

5.4.1 GMM Estimation

A robustness check with the generalized method of moments (GMM) is carried out for two reasons. The first reason is that previous studies such as de Haas and Lelyveld (2014) show that, at the bank level, there is a statistically significant relation between credit growth and its first lag. Therefore, a lagged credit growth variable is included in the regressions and the problems that such inclusion entails are solved by estimating the equation using a GMM estimator as suggested in the literature. The second reason is the possibility of endogenous relations of the bank-level variables.

The GMM model is estimated using the system GMM estimator for panel data developed by Holtz-Eakin *et al.* (1988) and Arellano and Bond (1991) (AB). The two-step GMM estimator is used to account for the possibility of heteroskedasticity in the data. The two-step GMM estimator is reported to give downward biased standard errors, so the finite sample correction of Windmeijer (2005) is employed. In the estimation of the models, lags of credit growth, leverage, leverage growth, equity growth, loan quality, loan-to-deposit ratio, and liquidity from the bank-level variables are assumed to be endogenous, while the macroeconomic variables are treated as strictly exogenous variables.

The regressions are carried out with the longest specification that used both macroeconomic variables and bank-level variables. The results of the GMM estimations are given in *Table 14*.[3] The results for leverage growth and equity growth are robust to the GMM estimation. The results show that for the pooled sample and

[3] The AB GMM estimations are sensitive to changes in the number of instruments and a Hansen *p*-value that is close to 1 indicates that there might be a problem with the number of instruments used (Roodman, 2006). The number of lags of the endogenous variables is constrained to get the best possible results from the regressions.

Table 14 Robustness, GMM Estimation

	1	2	3	4	5	6
Leverage	0.0082*** (2.83)	0.0076* (1.82)	0.0029 (0.29)	-0.00015 (-0.19)	-0.000011 (-0.01)	-0.00016 (-0.05)
Leverage growth	0.44*** (6.10)	0.36*** (4.90)	0.33* (1.92)	0.64*** (11.36)	0.83*** (7.34)	0.81*** (4.92)
Equity growth	0.58*** (9.71)	0.53*** (7.06)	0.46*** (3.31)	0.65*** (11.73)	0.85*** (6.16)	0.91*** (4.88)
Δ*RER*	-0.29*** (-3.07)	-0.48** (-2.49)	-0.20 (-0.66)	-0.14* (-1.68)	0.0084 (0.06)	-0.064 (-0.43)
Δ*M2*	0.033 (0.57)	0.066 (0.94)	0.058 (0.35)	-0.075 (-0.90)	-0.027 (-0.16)	-0.11 (-1.19)
Δ*GDP*	0.25 (0.97)	0.46 (1.29)	1.55 (0.88)	0.57** (2.34)	-0.072 (-0.18)	-0.081 (-0.14)
Δ*Debt*/*GDP*	-0.49** (-2.29)	-0.86*** (-3.18)	-0.79 (-0.54)	-0.34 (-1.27)	-1.50 (-1.59)	-0.84 (-1.15)
Inflation	-0.11 (-1.05)	0.058 (0.47)	-0.080 (-0.20)	-0.052 (-0.50)	0.14 (0.45)	-0.12 (-0.39)
Deposits growth	0.019 (0.66)	0.053* (1.90)	-0.0011 (-0.01)	0.0096 (0.46)	-0.063 (-1.27)	-0.018 (-0.20)
Profitability	0.0017* (1.72)	0.0012 (0.83)	-0.0024 (-0.76)	-0.00014 (-0.19)	-0.0013 (-0.84)	-0.00015 (-0.13)
Loan quality	-0.0087*** (-3.17)	-0.0082*** (-2.89)	-0.0070 (-1.14)	-0.0061 (-1.64)	-0.0091 (-0.94)	-0.012 (-1.37)
Loan/deposit ratio	0.00056** (2.03)	0.00083*** (3.09)	0.0020** (2.29)	0.00068** (2.22)	0.0015*** (2.87)	0.00086 (1.32)
Efficiency	0.00083 (1.49)	-0.000095 (-0.13)	0.00016 (0.07)	0.0029*** (4.54)	0.0014 (0.75)	0.00093 (1.04)
Liquidity	0.00019 (0.92)	-0.00051 (-1.28)	-0.00043** (-2.05)	-0.00016 (-0.18)	-0.00078 (-0.42)	-0.0018* (-1.87)
Δ*GL*(-1)	-0.19*** (-3.57)	-0.21*** (-3.73)	-0.24* (-1.95)	-0.14*** (-2.93)	-0.075 (-1.48)	-0.21*** (-2.94)
Constant	0.023 (0.20)	0.023 (0.20)	-0.0046 (-0.01)	-0.011 (-0.10)	-0.45 (-1.23)	0.29 (0.98)
No	3718	2705	230	783	488	295
Hansen *p*-value	0.126	0.878	0.972	0.901	0.817	0.393
AR(1) *p*-value	0.000	0.000	0.085	0.000	0.000	0.020
AR(2) *p*-value	0.981	0.923	0.624	0.769	0.607	0.590
No insts	296	296	75	236	76	74

Notes: Results for GMM estimations with the two-step Bond (2002) estimator with Windmeijer (2005) correction of standard errors. The leverage, leverage growth and equity growth variables are assumed to be endogenous; the macroeconomic variables are assumed to be exogenous. Δ*GL*(-1) denotes the first lag of the credit growth variable. Year dummies are included. The columns report results for (1) the pooled sample, (2) domestic private banks, (3) state-owned banks, (4) foreign banks, (5) greenfield banks and (6) takeover banks, respectively. *t*-statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

foreign banks, the real exchange rate variable is still significant. The real exchange rate is also significant for the domestic private banks and takeover banks but, as reported below, the results are not robust to other specifications.

Table 15 Robustness, Net Loans

	1	2	3	4	5	6
Leverage	0.0029**	0.0025	0.015	0.0018	0.0022**	-0.0015
	(2.31)	(1.51)	(1.70)	(1.66)	(2.35)	(-0.47)
Leverage growth	0.49***	0.46***	0.32	0.65***	0.64***	0.65***
	(18.79)	(19.32)	(1.80)	(7.79)	(7.43)	(6.64)
Equity growth	0.58***	0.59***	0.39*	0.69***	0.68***	0.69***
	(25.92)	(31.64)	(2.23)	(10.93)	(8.64)	(8.22)
Δ*RER*	-0.32***	-0.47*	-0.100	-0.21*	-0.22	-0.22
	(-4.94)	(-2.11)	(-0.35)	(-2.04)	(-1.74)	(-1.76)
Δ*M2*	-0.058	-0.012	0.071	-0.089*	-0.059	-0.18**
	(-1.21)	(-0.25)	(0.93)	(-1.94)	(-1.17)	(-2.30)
Δ*GDP*	0.72	0.49	1.61	0.66*	0.58	1.08**
	(1.58)	(1.10)	(1.64)	(2.04)	(1.42)	(2.40)
Δ*Debt*/*GDP*	-0.69***	-1.16***	0.29	-0.60*	-0.78*	0.12
	(-3.87)	(-3.41)	(0.50)	(-1.99)	(-2.04)	(0.28)
Inflation	0.39**	0.27	0.27	0.28	0.44	-0.35
	(2.59)	(1.20)	(0.71)	(1.26)	(1.53)	(-0.82)
Deposits growth	0.022***	0.021***	0.056	-0.0077	-0.019*	0.061
	(11.09)	(25.66)	(1.60)	(-0.65)	(-1.90)	(0.89)
Profitability	-0.00047	-0.000050	-0.0013	0.00016	-0.00016	-0.00023
	(-1.22)	(-0.19)	(-0.50)	(0.36)	(-0.31)	(-0.39)
Loan quality	-0.020***	-0.020***	-0.017***	-0.0083**	-0.0098***	-0.0028
	(-33.92)	(-28.65)	(-4.56)	(-2.78)	(-4.34)	(-0.51)
Loan/deposit ratio	0.0016***	0.0017***	0.0022**	0.00062*	0.00071*	0.00065
	(18.99)	(39.44)	(2.62)	(1.97)	(1.81)	(1.26)
Efficiency	-0.00031	-0.00047	-0.00080	0.0016**	0.0017*	0.0012
	(-0.98)	(-1.62)	(-0.90)	(2.60)	(2.11)	(1.00)
Liquidity	-0.0013**	-0.0021***	-0.00016	-0.0013*	-0.0011	-0.0034**
	(-2.32)	(-38.23)	(-1.68)	(-1.80)	(-1.46)	(-2.40)
Constant	-0.15	-0.039	-0.027	-0.65***	-0.24	0.45
	(-1.31)	(-0.20)	(-0.11)	(-3.04)	(-1.26)	(1.55)
No	3718	2705	230	783	488	295
R overall	0.511	0.484	0.464	0.677	0.643	0.713
R between	0.442	0.386	0.501	0.684	0.618	0.666
R within	0.600	0.606	0.559	0.709	0.690	0.785
No of banks	1109	860	61	214	119	95

Notes: Results with net loan growth instead of gross loan growth. The columns report results for (1) the pooled sample, (2) domestic private banks, (3) state-owned banks, (4) foreign banks, (5) greenfield banks and (6) takeover banks, respectively. Fixed effects regression with time fixed effects and country is chosen to be the group variable for the variance estimator. *t*-statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

5.4.2 Net Loans

As mentioned earlier, there are different definitions of loans provided by banks in the dataset and we choose to use gross loans, which are defined as net loans plus loan loss reserves. In order to check the robustness of the baseline results with a different definition of loans, regressions are carried out by defining credit growth as the change in net loans.

The regression results with the net loans credit growth variable are given in *Table 15*. The results for leverage growth and equity growth are robust to the new

Table 16 Robustness, Small Sample

	1	2	3	4	5	6
Leverage	0.0029** (2.42)	0.0025 (1.49)	0.0058 (0.56)	0.0023*** (3.09)	0.0027*** (3.05)	-0.0013 (-0.45)
Leverage growth	0.51*** (26.20)	0.49*** (25.21)	0.40* (2.07)	0.63*** (10.30)	0.62*** (9.54)	0.71*** (8.95)
Equity growth	0.61*** (31.11)	0.61*** (41.92)	0.47** (2.44)	0.70*** (11.31)	0.73*** (8.61)	0.71*** (12.16)
Δ*RER*	-0.23*** (-3.78)	-0.24 (-1.57)	-0.10 (-0.34)	-0.19** (-2.54)	-0.18* (-1.88)	-0.17 (-1.50)
Δ*M2*	0.0028 (0.05)	0.092* (2.09)	0.054 (0.66)	-0.050* (-1.82)	-0.019 (-0.52)	-0.14 (-1.58)
Δ*GDP*	0.63 (1.60)	0.35 (0.75)	1.63* (2.02)	0.55* (1.88)	0.35 (1.09)	1.16*** (3.34)
Δ*Debt*/*GDP*	-0.72*** (-4.12)	-1.29*** (-3.22)	0.28 (0.45)	-0.39 (-1.39)	-0.63* (-1.80)	0.33 (1.01)
Inflation	0.41** (2.44)	0.24 (1.32)	0.56 (1.67)	0.23 (1.70)	0.40* (1.80)	-0.37 (-1.05)
Deposits growth	0.017*** (10.77)	0.016*** (21.50)	0.034 (1.12)	0.0052 (0.89)	-0.013 (-1.48)	0.012** (2.34)
Profitability	-0.00060 (-1.63)	-0.00021 (-1.09)	-0.0015 (-0.79)	-0.00014 (-0.31)	-0.00071 (-1.26)	0.00034 (0.50)
Loan quality	-0.011*** (-22.73)	-0.010*** (-39.32)	-0.022*** (-4.56)	-0.0029 (-0.81)	-0.0072** (-2.67)	0.011** (2.65)
Loan/deposit ratio	0.0014*** (21.25)	0.0015*** (39.94)	0.0014* (1.98)	0.0012*** (4.13)	0.0013*** (3.76)	0.0009*** (3.08)
Efficiency	-0.00052* (-1.88)	-0.0008*** (-3.23)	-0.0014 (-1.29)	0.0016*** (3.16)	0.0015* (2.10)	0.0018 (1.50)
Liquidity	-0.0014** (-2.85)	-0.0019*** (-22.80)	-0.00015 (-1.08)	-0.0014* (-2.03)	-0.0012* (-1.82)	-0.0041*** (-4.73)
Constant	-0.078 (-0.81)	0.0092 (0.08)	-0.080 (-0.44)	-0.67*** (-5.29)	-0.23* (-2.00)	0.35 (1.31)
No	4675	3541	268	866	539	327
R overall	0.519	0.508	0.413	0.613	0.632	0.587
R between	0.430	0.428	0.420	0.417	0.592	0.327
R within	0.575	0.575	0.532	0.679	0.665	0.769
No of banks	1198	939	62	230	127	103

Notes: Results with banks that have at least seven consecutive years of observations. The columns report results for (1) the pooled sample, (2) domestic private banks, (3) state-owned banks, (4) foreign banks, (5) greenfield banks and (6) takeover banks, respectively. Fixed effects regression with time fixed effects and country is chosen to be the group variable for the variance estimator.*t*-statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

credit growth specification, while the exchange rate variable is only significant in the pooled sample and foreign bank regressions.

5.4.3 Small Sample

The baseline regressions use the banking data regardless of the survival time of banks during the study period. One criticism of this approach would be that the results might be driven by the banks that have only a few observations

in the dataset. This point is taken into account by repeating regressions with banks that have more than seven years of data.

Table 16 gives the results with the smaller dataset. As can be seen in the table, the number of banks in the pooled regressions drops to 1,198 from 1,338. The main points of the baseline regressions are confirmed with the smaller dataset.

6. Conclusions

This study analyzes the link between credit growth with supply-side bank-level and macroeconomic variables. It turns out leverage growth and equity growth are the dominating determinants. Furthermore, the real exchange rate has a significant impact through local banks. The variables we find to be relevant play a role in cross-border capital flows in the Bruno and Shin (2015) model.

We do not find that other macroeconomic variables play a prominent role; the same applies to bank-specific variables. The results are robust to a couple of modifications. Furthermore, we investigate whether credit growth is affected by the flexibility of the exchange rate regime. We do find that credit growth differs depending on the aggregate level. The coefficient of the exchange rate regime dummy has a negative sign, but the link becomes insignificant for all bank groups in the sample. Therefore, we conclude that the exchange rate regime plays a marginal role compared with the impact of the (real) exchange rate itself. Our results therefore are in conflict with those of Magud *et al.* (2014), who conclude that flexibility of exchange rate regimes has a negative influence of domestic credit growth.

Our analysis therefore revisits some previous findings from the literature, but adds to it by testing the role of the real exchange rate in the determination of loans at the bank level. This aspect is particularly interesting in the course and aftermath of the recent financial crisis, during which the US dollar appreciated against most emerging-market currencies. Our results might also provide guidance in policy-making as the US dollar returns to its pre-crisis value.

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