Foreign Banks and Monetary Policy in Central and Eastern Europe*

Preliminary Version

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Abstract

We provide new evidence on the bank lending channel of monetary policy using bank-level panel data from Central and Eastern Europe economies. We examine loan granting behavior of 440 banks in the period between 1998 and 2012. Our findings are: i) banks adjust their loans to changes in host country's monetary policy, ii) foreign-owned banks are less responsive to monetary policy of a host country than domestic-owned banks, iii) contrary to previous studies we document that the effects i) and ii) are present not only in the times of a crisis, but also in normal times. Using a DSGE model with the bank lending channel we present two mechanisms that can explain the second effect. First, foreign banks may have access to funds from parent banks, which makes them less dependent on the cost of money in a host country. Second, foreign banks may have a competitive advantage in a sense that they serve more profitable borrowers and therefore their loan portfolio adjusts less. The first mechanism renders monetary policy less effective in the level of foreign banks penetration, while the second one does not. We derive testable implications of the two hypotheses and show that data do not unambiguously favor one over the other.

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1 Introduction

Financial liberalization has led to an increased integration of financial markets over the last 30 years. The emerging and developing countries, however, entered this process with under-capitalized and weak banks. In result, large shares of the financial sector in these countries are controlled by subsidiaries of foreign banks. Thus, the financial integration was accompanied by a development of asymmetric cross-border owner-subsidiary relationships.

We explore the consequences of this asymmetric integration in the particular area of the Central and Eastern Europe (CEE). Banks dominate financial structure of the CEE economies and most of these banks are majority foreign-owned. As of 2009 the share of the majority foreign-owned banks in the total assets of the banking sector in the CEE economies is greater than 80 percent on average. For the other European Union members this number stands at 25 percent[1]. The relationship between bank ownership and the growth of credit is currently receiving an increased interest in the literature starting with Peek and Rosengren (1997), who show that Japanese-owned banks in the US contracted their lending significantly in a response to a slump in the Japanese stock market. Micco and Panizza (2006) show, using the world-wide sample of 119 countries in the years 1995-2002, that the lending of state-owned banks is less responsive to macroeconomic shocks than that of privately-owned banks .

The CEE transition countries have become a natural field for empirical studies of foreign-owned banks behavior. Bonin et al. (2005) find that in the CEE countries foreign-owned banks are more cost-efficient and provide better services, Naaborg and Lensink (2008) in the similar sample find a somewhat contrary result, that foreign-owned banks are less profitable. de Haas and van Lelyveld (2006) is the first study that looks at the relationship between a foreign ownership in the CEE countries and the growth of credit. They show that in the years 1993-2000 there is a positive relationship between foreign banks and the private sector credit growth, during crisis periods domestic banks contract their credit base, while greenfield foreign banks do not, and that the conditions in a home country matter for the foreign bank growth in a host country. Aydin (2008) studies the period 1988-2005 and further confirms that credit growth is higher in foreign banks. However, contrary to the former, she shows that conditions in a home country do not matter for the credit granting behavior of a foreign bank in a host country. Allen et al. (2013) show that during domestic financial crises foreign banks provide credit, while government banks contract and that the reverse has happened during the global financial crisis of 2008[2]. None of the cited studies however, pay attention to monetary policy in host countries and whether foreign and domestic banks reactions to changes in interest rates are different. That is, in other words, how presence of foreign banks affects the bank lending channel

[1] Own calculations based on Claessens and Van Horen (2013). In 2009 in the eleven CEE economies this number varies between 64 and 99 percent. In the non-CEE EU economies foreign bank penetration is more heterogeneous and varies from 2 percent (Spain and Netherlands) to 95 percent (Luxembourg), with Ireland, Belgium and Luxembourg having more than 50 percent of their banking system foreign-owned.

[2] Another contributions that look at the role of foreign banks during the global financial crisis in a wider geographical setting are Adams-Kane et al. (2013), Ongena et al. (2013), while Popov and Udell (2012) use paired firm-banking data in 16 CEE economies to show, *inter alia*, that firm's access to credit reflects the balance sheet conditions of foreign parent bank.

of the monetary policy transmission.

The bank lending channel pioneered by Bernanke and Blinder (1992) on aggregate data and Kashyap and Stein (2000) on bank-level data assumes that, at the bank-level, deposits and other financing are imperfect substitutes. Therefore, when a central bank raises interest rates, the supply of credit at the bank level goes down. The only contribution in the literature that studies the bank lending channel in the CEE economies (pooled together with Latin America and South-East Asia economies) is Wu et al. (2011). Using bank level data for the period of 1996-2003 they show that foreign banks are less responsive to monetary shocks in host countries. After a monetary policy contraction the growth of credit in foreign banks goes down less compared to domestic banks (and the reverse is true after a monetary policy expansion). They suggest that the most convincing mechanism that can explain those differences is an access of foreign banks to funding from parent banks through an internal capital market. However, a close inspection of their results shows that the existence of the bank lending channel and differences between domestic and foreign banks reactions are only present during periods of crises and not in tranquil times.

In this paper we contribute to the empirical literature by documenting that lending by foreign banks is less responsive to both tightening and loosening of host country's monetary policy in both tranquil times and during financial crisis. We collect data on credit growth and ownership for 440 banks in the eleven CEE countries[3] in the years 1998-2012. We regressthe real rate of growth of net credit on the foreign ownership dummy, the change in the monetary policy rate and their interaction (plus bank-level and macroeconomic controls). Next, we explicitly control for the effects of the global financial crisis, and finally we run a battery of robustness checks to control for possible endogeneity issues and different monetary policy regimes. At each stage we employ three different empirical strategies: pooled OLS, quasi-experimental differences-in-differences and a system GMM estimation. The existence of the bank lending channel and the differences between domestic and foreign banks in both crisis and normal times comes out as a robust finding of the empirical part of this paper.

Next, we build a theoretical, stylized DSGE model with the bank lending channel and show that the observed data patterns can be driven by the two equally plausible mechanisms: the internal capital market as in Wu et al. (2011) (later referred to as the *internal market hypothesis*) and a market segmentation that favors foreign banks (later referred to as the *market segmentation hypothesis*). The bottom line of the theoretical analysis is that observing a different *micro* lending behavior of foreign and domestic-owned banks on its own is not a sufficient statistic for deriving conclusions on shifts in the *aggregate* lending channel.

The first explanation assumes that foreign-owned banks may trade easily within the financial conglomerate they are a part of, which would make host country monetary policy less relevant for their operations. Foreign-owned banks could also be forced to transfer liquidity in the case of a direct dependence, especially when a parent bank is in troubles.

[3] Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia.

The second explanation assumes that the links with a parent bank are not important for the credit granting behavior of a foreign bank in a host country, but instead assumes that foreign banks operate their business differently than domestic banks. We highlight two possible rationales. First, a foreign bank may inherit credit relationships with firms that are clients of its parent bank. When there is selection into foreign expansion, then foreign-owned banks lend to more productive companies. Such credit is less sensitive to changes of host country's monetary policy because of implicit costs embedded in adjusting terms of contracts. De Haas and Naaborg (2006) find that an acquisition of a domestic bank by a foreign bank leads to a bias in the acquired bank's lending towards large multinational companies. Second, if foreign-owned banks have better know-how (e.g. screening technology or marketing) then they grant credit to more reliable customers which can still service their liabilities under higher interest rates. In this world, domestic banks have larger shares of contracts that are prone to termination because of an increase in interest rates. Bonin et al. (2005) shows evidence that foreign banks indeed bring know-how into the CEE economies banking sector.

Our theoretical model borrows from the framework put forth in Gerali et al. (2010) and Gambacorta and Signoretti (2014). This environment facilitates handling bank ownership heterogeneity by using of the analytically tractable monopolistic competition framework[4]. We put the two hypotheses to race in the model. Most importantly, we demonstrate that while the *internal market hypothesis* implies weakening of the bank lending channel in the aggregate, the *market segmentation hypothesis* does not. Despite its ability to reproduce observed differential loans responses to monetary shocks, the model falls short of replicating the size of these differences. Using the panel data from the empirical part of the paper we show that data do not unambiguously favor one over the other and at this stage we can assert that both can be at play.

2 Empirical Analysis

2.1 Data

We construct our sample using bank-level and macroeconomic data. Our primary source of data is Bankscope, a commercial database provided by Bureau van Dijk. Bankscope provides a large set of standardized and comparable bank-level data in a form of a panel. Our sample with identified ownership structure includes 440 banks in the CEE countries active for at least one year between 1998 and 2012 (out of the total number of 514 banks registered in Bankscope) giving rise to a total number of 4008 bank-year observations. Schmitz (2004) compares Bankscope data with the IFS data and finds that approximately 70% to 90% of total banking assets is covered by Bankscope for the CEE countries. Mathieson and Roldos (2001) on the other hand estimate data coverage to be about 90% of the total banking assets in the CEE countries. The coverage of Bankscope data increases in time due to market

[4] albeit at the expense of shutting down other margins of dynamic competition like entry, exit and bank size

concentration and data quality improvements.

We use data on net loans to construct our dependent variable, the real rate of growth of net loans at the bank level. We also use Bankscope to construct four bank control variables: size, liquidity, capitalization and profitability[5]. The first one is a ratio of total assets of a bank in a given year to the sum of total assets in all banks in the same country in the same year. The remaining three are ratios of each bank's liquid assets, operating profit and total equity to total assets. All original variables are denominated in local currencies.

Identifying foreign-owned banks is the most important (and the most cumbersome) aspect of our data collection. We define a bank as foreign-owned if immediate shareholders owning more than 50 percent of its capital are located in a different country than the bank itself. The ownership data however, is not easily accessible. Bankscope does not provide a panel view of the ownership data, only the most recent record. We collected the data on banks' ownership using three sources: Claessens and Van Horen (2013) dataset, most recent records on Bankscope and investigating individual bank reports history both on Bankscope and outside this database (banks' websites). We use the same procedure to identify banks that are government-owned. Our final sample with identified ownership covers on average 97.25% of the volume of net loans reported in Bankscope. Tables 9 and 10 in the Appendix present data coverage of our sample broken down into individual countries and years. The coverage of the ownership data is reasonably balanced across both years and countries.

The second key variable in our study is the interest rate set by a central bank. We collect data on central bank monetary policy instruments from Eurostat and central bank websites. Our variable of interest is a change in the yearly average of the short term interest rate. The sample covers rich variation in the stance of monetary policy across countries. Between years 1998 and 2012 negative interest rate changes stood for about 60% of all covered cases. The pre-2008 sample is more balanced: negative changes correspond to 55% of all cases. We use the same sources for the macroeconomic controls, the growth rate of GDP, inflation and (for the robustness analyses) the euro exchange rates.

We document in detail the cross-section facts about foreign and domestic banks in Appendix A. We find that in our sample foreign-owned banks are larger than domestic banks, have lower liquidity and capitalization but are more profitable. We also find that the capitalization and liquidity measures were decreasing in time in both groups. The average size of a domestic bank declined sharply after 2002 which roughly corresponds to the end of the biggest wave of penetration of local markets by foreign banks.

[5] This similar set of controls is also used in related studies: Allen et al. (2013) use the same set plus a lagged ratio of deposits to total assets, de Haas and van Lelyveld (2006) use the same set plus a a net interest margin to measure efficiency, Wu et al. (2011) use size, liquidity, capitalization, cost efficiency and credit risk, while Aydin (2008) uses somewhat different measures for size, liquidity and capitalization, two measures for profitability plus a net interest margin, costs to income and deposits and loan loss provisions to total assets.

2.2 Panel Estimation

We estimate the model of the real rate of growth of loans of bank i in country j at time t, denoted by ΔL_{ijt}. To test if there are differences between foreign and domestic banks reactions to monetary policy we employ the following model specification:

$$\Delta L_{ijt} = \beta_1 FGN_{it} + \beta_2 \Delta MP_{jt} + \beta_3 \Delta MP_{jt} * FGN_{ijt} + \beta_4 \text{Bank}_{it} + \beta_5 \text{Economy}_{jt} + \beta_0 \quad (1)$$

We introduce the foreign ownership dummy FGN_{it} that takes one if more than 50% of capital is owned by shareholders located abroad and zero otherwise. If foreign banks have different credit policies then this estimate should be significant, as in Aydin (2008) and Allen et al. (2013), who find it to be significant and positive. Our main variables of interest are: the change in the monetary policy instrument in country j in time t denoted by ΔMP_{jt} and its interaction with the foreign dummy $\Delta MP_{jt} * FGN_{it}$. If the bank lending channel is at work then the first estimate will be significant and negative. If the bank lending channel operates differently in foreign and domestic banks then the second estimate will be significant. If foreign banks react more to changes in monetary policy then we should see a negative estimate, if on the other hand they react less, we should see positive estimate that is less in absolute value than the estimate of ΔMP_{jt}.

Apart from the foreign dummy we employ four bank controls $Bank_{it}$ of bank i in time t including size $Size_{it}$ (0), liquidity Liq_{it} (+/-), capitalization Cap_{it} (+) and profitability $Prof_{it}$ (+) with expected signs in parentheses[6]. Lastly, we add macroeconomic conditions $Economy_{jt}$ differing across countries j and time t by putting the GDP growth rate GDP_{jt} and the inflation rate π_{jt} to control for possible demand effects. We expect credit growth to respond positively to GDP growth and negatively to inflation. The details of construction of the all variables are provided in the Appendix A.

We estimate three versions of the model. For start, we run a classical OLS regression. We recognize however, that the estimates from the OLS might be biased due to the endogeneity problem. Firstly, our main variable of interest, the bank ownership, might not be exogenous to the credit policy of a bank. In theory, it is possible, that domestic-owned banks that exhibit faster growth of credit are more prone to be bought by a foreign owner. Secondly, bank-level control variables (size, capitalization, liquidity and profitability) might also be endogenous to the credit growth and macro controls.

Secondly, we apply differences-in-differences approach, where we control for bank and time fixed effects. Controlling for time fixed effects allows us to remove any possible trend or time-specific factors that may affect credit

[6] Out of the four most related studies to ours Wu et al. (2011) do not report estimates of bank controls, others find consistently that size does not matter for credit growth, Allen et al. (2013) find positive estimate of profitability, negative of liquidity and capitalization to be not significant, de Haas and van Lelyveld (2006) find positive estimate of profitability and capitalization and liquidity to be not significant, while Aydin (2008) finds mixed evidence for profitability and positive estimate for liquidity.

behavior of all banks in a given year[7].

Some studies related to ours (Wu et al. (2011), Adams-Kane et al. (2013), Claessens and Van Horen (2013), Gambacorta (2005) and Brzoza-Brzezina et al. (2010) deal with endogeneity problem by employing one period lag for bank control variables. We follow this approach augmented by the difference GMM estimation[8] developed by Arellano and Bond (1991). In this estimation we allow dependent variable (ΔL_{ijt}) to be potentially autocorrelated, contemporary bank controls ($Size_{it}$, Liq_{it}, Cap_{it} and $Prof_{it}$) to be endogenous[9] and ownership (FGN_{ijt}) to be predetermined but not strictly exogenous. Macro controls (GDP_{jt} and π_{jt}), lagged bank controls ($Size_{it-1}$, Liq_{it-1}, Cap_{it-1} and $Prof_{it-1}$) and independent variable (ΔMP_{jt}) are treated as strictly exogenous and therefore in the estimation process are potential instruments for the differenced endogenous variables. In each specification to avoid spurious inference, we cluster the errors on a country level.

2.3 Baseline Results

In Table 1 we present the results of the estimation of the benchmark model from the equation (1). First, the results confirm the existence of the bank lending channel. Banks contract their credit action after an increase in the monetary policy rate (and expand after a decrease in the MP rate). Second, foreign banks react differently than domestic banks to changes in the monetary policy rate. The reaction of their credit is more tamed (by more than a half). Interestingly, previous studies found that the very fact of banks being foreign-owned affects their credit granting behavior. In none of our estimations foreign dummy variable FGN is significant, but in all three methods its interaction with the monetary policy rate is significant, positive and less than the estimate of the change in monetary policy rate in absolute value. Our results show that the differences between foreign and domestic banks come exclusively from their reactions to the monetary policy rate, that is through the bank lending channel.

In the two models (OLS and D-in-D) the size of a bank, as expected, does not affect its credit granting behavior. However, a system GMM estimation shows that credit grows faster in bigger banks. More liquid banks and better capitalized banks extend less credit (as in Allen et al. (2013)). As expected, profitability increases the growth of credit at the bank-level in all three estimations. Macroeconomic controls that affect the demand for credit work as expected. The volume of credit at the bank-level increases in GDP growth and decreases in inflation. According to the results of the system GMM estimation the growth of credit is positively autocorrelated, albeit the coefficient is not high.

Once we bring domestic monetary policy in the picture, the significance of foreign ownership dummy, found in other studies, vanishes. The data suggest that it is the differential response to the domestic monetary policy that is differentiating foreign-owned banks from domestic banks.

[7] Formally we estimate bank and time-specific intercepts $\beta_0 = [\beta_i \quad \beta_t]$.
[8] We would like to thank the anonymous referee for suggesting this approach.
[9] For the sake of brevity we suppress coefficient estimates for the lagged bank controls in all regression results tables

Table 1: Determinants of bank lending 1998-2012

	OLS	D-in-D	GMM
FGN	-1.243	2.967	1.438
	(2.298)	(3.152)	(2.791)
MP	-1.582***	-1.734***	-1.332***
	(0.281)	(0.378)	(0.351)
FGN*MP	1.137***	0.930***	1.137**
	(0.342)	(0.228)	(0.499)
Size	-0.0416	-0.0160	2.292**
	(0.0630)	(0.277)	(1.008)
Liq	-0.0687	-0.353***	-0.713***
	(0.0479)	(0.0617)	(0.120)
Cap	-0.235**	-0.648**	-2.103***
	(0.0937)	(0.203)	(0.406)
Prof	1.581***	1.561***	1.756***
	(0.451)	(0.408)	(0.238)
GDP	2.204***	1.156***	0.825**
	(0.304)	(0.157)	(0.259)
Pi	-0.382	-1.099***	-1.027***
	(0.234)	(0.145)	(0.179)
L.Delta Net Loans			0.212***
			(0.0256)
Observations	2403	2403	2001

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

2.4 Results - Financial Crisis

Next we distinguish between reactions to monetary policy in normal times and during financial turmoil by estimating the following equation:

$$\begin{aligned}\Delta L_{it} = \beta_1 FGN_{it} + \beta_2 \Delta MP_{jt} + \beta_3 \Delta MP_{jt} * FGN_{ijt} + \beta_4 \text{Bank}_{it} + \beta_5 \text{Economy}_{jt} \\ + \beta_5 Crisis * \Delta MP_{jt} + \beta_6 Crisis * \Delta MP_{jt} * FGN_{it} + \beta_0\end{aligned} \tag{2}$$

where we include the interaction of the crisis dummy, that takes value one for the period 2008-2012 and zero otherwise, with the change in monetary policy rate $Crisis * \Delta MP_{jt}$ and the interaction of the crisis dummy with both change in monetary policy rate and the foreign dummy $Crisis * \Delta MP_{jt} * FGN_{it}$. We do not need to include crisis dummy itself, as we estimate the model with time fixed effects.

In Table 2 we present the results of the estimation of the benchmark model enriched with the Financial Crisis dummy and their interactions as in equation (2). We see that controlling for Financial Crisis does not change the baseline results. The bank lending channel is still significant and of the same magnitude and the difference between domestic and foreign banks reaction to changes in the monetary policy rate is still significant and of the same magnitude. Most importantly, we find that during financial turmoil of 2008-2012 in the CEE countries bank lending channel did not change neither for domestic banks nor for foreign-owned banks. This further confirms our benchmark results and shows that the differences in reactions to the monetary policy instrument between domestic

Table 2: Determinants of bank lending - including Financial Crisis

	OLS	D-in-D	GMM
FGN	-1.154	2.692	1.655
	(2.145)	(3.052)	(2.742)
MP	-1.628***	-1.904***	-1.307***
	(0.403)	(0.434)	(0.376)
FGN*MP	0.660**	0.735**	1.137*
	(0.273)	(0.241)	(0.571)
Crisis*MP	0.407	1.442	-0.131
	(1.162)	(0.810)	(0.555)
Crisis*MP*FGN	2.549***	0.987	0.0573
	(0.606)	(0.559)	(0.664)
Size	-0.0376	-0.0327	2.295**
	(0.0615)	(0.290)	(1.011)
Liq	-0.0725	-0.356***	-0.713***
	(0.0493)	(0.0627)	(0.120)
Cap	-0.236**	-0.651**	-2.105***
	(0.0918)	(0.206)	(0.406)
Prof	1.579***	1.561***	1.754***
	(0.453)	(0.413)	(0.235)
GDP	2.068***	1.144***	0.824**
	(0.244)	(0.161)	(0.258)
Pi	-0.456*	-1.079***	-1.038***
	(0.228)	(0.159)	(0.184)
L.Delta Net Loans			0.211***
			(0.0256)
Observations	2403	2403	2001

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$

and foreign banks cannot be attributed to the idiosyncrasy of the financial crisis episode.

2.5 Robustness - Monetary Policy Regimes

Our sample consists of countries with similar, albeit not identical monetary policy arrangements. While in the analyzed time-frame the majority of the countries followed an independent monetary policy interest rate setting rule, some countries had their exchange rate pegged to the euro and some did not enjoy an independent monetary policy at all, due to their presence in the common currency area. In this subsection we analyze how do different monetary policy regimes affect our findings from two previous sections. Our hypothesis is that banks, when deciding on their credit growth, take into account monetary policy rate regardless of what a monetary policy regime produced that interest rate. Our findings confirm this hypothesis.

In order to verify our hypothesis we run five additional regressions. In the regression presented in column (1) of the Table 11 (see Appendix) we include country fixed effects. This allows us to capture differences in the mean growth of credit at the bank level stemming from time invariant particular characteristics of the economy and institutions, like the monetary policy regime. Additionally, we also add time fixed effects to control for common, time-variant global shocks. Our main finding, that foreign banks reaction to monetary policy is more tamed

compared to domestic banks, is unaffected.

Secondly, we expand our baseline model to include the dummy variable $IndependentMP$. This variable takes value 1 for countries that in the given year enjoyed independent monetary policy regime and 0 otherwise. Results of this analysis are reported in column (2). The monetary policy independence does not affect the growth of credit at the bank-level. In column (3) of Table 11 we present the results of the more detailed exercise. Additionally, we employ time fixed effects and bank fixed effects. Including the latter allows us to capture the differences in mean credit growth stemming from the time invariant particular credit policies of each bank. Similarly to the previous analysis, the choice of a monetary policy regime does not affect credit policy at the bank level.

In column (4) we take a somewhat different approach. Instead of looking at the institutional arrangements regarding the monetary policy conduct directly, we take a look at possible symptoms. Different degrees of freedom in setting interest rate lead to different volatilities in local exchange rates, particularly versus the euro. Thus, we expand the set of independent variables to include the yearly relative change in the exchange rate of a local currency versus the euro. The variable turns out to be significant. Local currency depreciation of a 1% leads to a decrease in the average growth of a credit at the bank level by 0.39 p.p.. Extending the set of controls does not affect our key finding, however. In column (5) we expand the analysis from column (4) by adding country and time fixed effects. We observe that the significance of the exchange rate found in column (4) vanishes and again, our main finding is still unaffected.

2.6 Robustness - Further Evidence

To further confirm the robustness of our results we run two alternative specifications of our benchmark model. In the first we include government ownership dummy GOV_{it} and its interactions with the change in the monetary policy rate and with the crisis dummy (see Table 12 in Appendix). Contrary to previous studies[10] we find that public-owned banks neither differ in their credit granting behavior from private domestic banks, nor do they differ in their reaction to monetary policy rate changes. Controlling for public banks we confirm the robustness of our baseline results.

Next, we take a close look at takeovers of domestic banks by foreign owners. Table 13 show the results of estimations in which we address possible problem of the ownership endogeneity. We drop all observations of banks that became foreign owned. We also have to drop the variable FGN_{it} as it becomes co-linear with the sum of bank fixed-effects for foreign-owned banks. We find that our baseline results are robust both qualitatively and quantitatively.

[10] Micco and Panizza (2006) for worldwide study of banks' lending behavior between 1995-2002 and Allen et al. (2013) for study of CEE banks between 1994-2010.

3 Sketch of the DSGE model

Our theoretical analysis builds on Gerali et al. (2010) and Gambacorta and Signoretti (2014). The details of the derivations are explained in Appendix 5. Here we discuss the most important equations and building blocks of the model.

There are two groups of agents in the private sector: households and entrepreneurs. Both groups are risk averse, households care about consumption and leisure while entrepreneurs are only concerned with consumption. Because of different rate of time preferences, entrepreneurs borrow while households save. Entrepreneurs buy capital from capital producing firms and hire labor in the competitive market. There is a central bank that sets nominal interest rates.

There is a unit mass of banks, of which a fraction μ is foreign-owned. Each bank comprises of two branches: a wholesale branch that deals on the interbank market and collects deposits in a perfectly competitive market and a retail branch that grants loans. Foreign direct owners take decisions on the balance sheet structure of their subsidiaries by deciding on dividends. Adjusting the dividends implies costs on the owner bank.

There is a set of financial frictions at play. Both savings and borrowing can only be done via intermediaries. Borrowing is also subject to a borrowing constraint such that the amount borrowed is related to the valuation of entrepreneur's capital. We also postulate that due to product differentiation loans at different banks are imperfect substitutes.

3.1 Households and Entrepreneurs

Households discount future at a rate β_H. Each period each household decides how much to consume $c_t(i)$, how much labor to supply $l_t^H(i)$ and how much to save in bank deposits $d_t(i)$ given the wage rate W_t and last period savings $d_{t-1}(i)$ to maximize expected stream of utilities. Households own banks and retail good packers and receive their dividends and profits. Formally, household i solves:

$$\max_{c_t^H, l_t^H, d_t^H} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta_H^t \left(\log\left(c_t^H(i)\right) - \frac{l_t^H(i)^{1+\phi}}{1+\phi} \right) \tag{3}$$

$$\text{subject to: } c_t^H(i) + d_t^H(i) \leq w_t l_t^H(i) + \left(1 + r_{t-1}^d\right) d_{t-1}^H(i) + T_t^H. \tag{4}$$

with T_t^H is a transfer including dividends from retail firms and bank dividends, π_t inflation and r_t^d the nominal return on deposits.

We assume that entrepreneurs maximize the utility of consumption discounted at a rate $\beta_E < \beta_H$. Entrepreneur i solves:

$$\max_{c_t^E, l_t^E, k_t^E, b_t^E} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta_E^t \log\left(c_t^E(i)\right) \tag{5}$$

$$\text{subject to: } y_t^E(i) = a_t^E \left(k_t^E\right)^{\alpha} \left(l_t^E(i)\right)^{1-\alpha}, \tag{6}$$

$$\frac{y_t^E(i)}{x_t} + b_t^E(i) + q_t^k(1-\delta) k_{t-1}^E(i) = c_t^E(i) + w_t l_t^E(i) + \left(1 + r_{t-1}^{bE}\right) b_{t-1}^E(i) + q_t^k k_t^E(j), \tag{7}$$

$$\left(1 + r_t^{bE}\right) b_t^E(i) \leq m^E E_t\left(q_{t+1}^k(1-\delta) k_t^E(i)\right). \tag{8}$$

where 6 is the production function, 7 is the budget constraint and 8 the borrowing constraint, all denoted in real terms. l_t^E is demand for labor, k_t^E is the chosen stock of capital, a_t^E is a TFP random variable, y_t is the quantity of the intermediate good, q_t^k is the price of capital. Parameter m^E measures the severity of the collateral constraint.

Investment decisions are taken by competitive capital producers. The relative price of capital q_t^k is a ratio of the nominal price of capital P_t^K and the aggregate price level P_t (for capital good producers problem solution see Appendix D).

3.2 Aggregate price level

The model features monopolistically competitive retail good packers that aggregate goods produced by each entrepreneur to the single final good and sell it at a markup. The optimization of retail good packers yields a Phillips curve featuring persistence with respect to inflation rate and its deviation from the steady state level (see Appendix D).

3.3 Banks

Each bank has two branches: a wholesale and a retail branch. The wholesale branch owns bank equity (also called bank capital) $K^b(o,j)$ and collects deposits $D_t(o,j)$ from households on which it pays the interest rate set by the central bank r_t^{ib}. It also issues wholesale loans to retail branch $B_t(o,j)$ commissioning the interest rate $R_t^b(o,j)$. Following GNSS we assume that there exists a target value of the ratio of bank capital to loans ν (leverage or capitalization ratio). This assumption is crucial to generate realistic interactions between real and financial sectors.

We differentiate banks by ownership $o \in \{dom, fgn\}$. Each bank has to obey the basic balance sheet identity:

$$B_t(o,j) = D_t(o,j) + K_t^b(o,j). \tag{9}$$

Bank capital of a domestic bank is financed from the retained earnings:

$$K_t^b\left(dom,j\right)=\left(1-\delta_b\right)K_{t-1}^b\left(dom,j\right)+\left(1-\omega_H\right)J_{t-1}^b\left(dom,j\right), \tag{10}$$

while a foreign bank's dividends stream is a choice variable of the parent bank:

$$K_t^b\left(fgn,j\right)=\left(1-\delta_b\right)K_{t-1}^b\left(fgn,j\right)+\left(1-\omega_t\left(fgn,j\right)\right)J_{t-1}^b\left(fgn,j\right), \tag{11}$$

with ω_H denoting the share of the earnings paid out to households by domestic banks. The market for deposits is competitive with the quantity of deposits pinned down exactly by the choice of the risk-free rate by the central bank. The key idea here is that the adjustment of the dividends stream acts implicitly as the internal market for bank capital. We assume that there are quadratic costs of adjusting the dividend parameter from the reference value (equal to ω_H):

$$Adj\left(\omega_t,\omega_H\right)=\frac{\kappa_\omega}{2}\left(\omega_t-\omega_H\right)^2. \tag{12}$$

The optimization problem of a foreign bank is identical with one exception. The foreign bank owner decides on the allocation of the dividends, taking into account how it affects future profits. If the dividends increase too much today, they will negatively affect the subsidiary's profits next period. Formally foreign bank owner solves:

$$Div_t^*=\max_{\omega_t(j)}\int_\mu\left(\omega_t\left(j\right)J\left(fgn,j\right)-\frac{\kappa_\omega}{2}\left(\omega_t\left(j\right)-\omega_H\right)^2\right)dj+\beta^{H*}\mathbb{E}Div_{t+1}^*. \tag{13}$$

There are two points to be made here. First, the foreign owner bank can potentially mitigate the costs stemming from changes in monetary policy in the Home country trading them against the costs of adjusting the dividends. Second, observe that setting $\kappa_\omega\mapsto\infty$ yields the foreign and domestic banks identical, as it forces $\omega_t=\omega_H$ and in this case these banks are homogeneous.

3.4 Wholesale branch

The wholesale branch solves:

$$\max_{D_t(o,j),B_t(o,j)}\{R_t^b\left(o,j\right)B_t\left(o,j\right)-r_t^{ib}D_t\left(o,j\right)-\frac{\kappa_b}{2}\left(\frac{K_t^b\left(o,j\right)}{B_t\left(o,j\right)}-\nu\right)^2K_t^b\left(o,j\right)\} \tag{14}$$

subject to the balance sheet identity for pre-determined bank capital. The last expression in 14 is a loans adjustment cost function. We follow the assumption that it is a quadratic function in adjustment from the target leverage ratio ν^b and is multiplicative in the level of bank capital $K_t^b(o,j)$. We plug the balance sheet constraint into the target

function and calculate the first order conditions to get:

$$R_t^b(o,j) = r_t^{ib} - \kappa_{Kb}\left(\frac{K_t^b(o,j)}{B_t(o,j)} - \nu^b\right)\left(\frac{K_t^b(o,j)}{B_t(o,j)}\right)^2. \tag{15}$$

Banks optimal policy collapses to choosing a time-varying markup over the central bank's rate.

Loan branch The loan branch collects the wholesale loans and differentiates them at no cost generating monopolistic power over its own loan type j of the total loan variety which gives rise to the standard demand equation:

$$b_t^E(o,j) = \left(\frac{r_t^{bE}(o,j)}{r_t^{bE}}\right)^{-\varepsilon^{bE}} b_t^E. \tag{16}$$

with pricing equation involving a markup on the wholesale rate $R_t^b(o,j)$ which is proportional to the elasticity of substitution between loans of different banks:

$$r_t^{bE}(o,j) = \frac{\varepsilon^{bE}}{\varepsilon^{bE}-1} R_t^b(o,j). \tag{17}$$

The law of motion for profits of bank j reads:

$$J_t^b(o,j) = r_t^{bE}(o,j)\, b_t^E(o,j) - \frac{\kappa_{Kb}}{2}\left(\frac{K_t^b(o,j)}{B_t(o,j)} - \nu^b\right)^2 K_t^b(o,j) - Adj_t^B(o,j) \tag{18}$$

with the last term being the cost of adjustment of bank capital structure. Equilibrium conditions and aggregation equations are relegated to the Appendix.

3.5 Central bank and monetary policy

The central bank follows a Taylor rule that features smoothing of rates in addition to tracking the deviations of inflation and product:

$$(1+r_t) = (1+r)^{1-\phi_R}(1+r_{t-1})^{\phi_R}\left(\frac{\pi_t}{\pi}\right)^{\phi_\pi(1-\phi_R)}\left(\frac{Y_t}{Y_{t-1}}\right)^{\phi_\pi(1-\phi_R)}\varepsilon_t^R. \tag{19}$$

4 Simulations

Before proceeding to simulation-based comparative exercises we go over the response of the homogeneous-banks version of the model to a monetary shock. In Figure 1 we plot the response of bank profits, bank capital, loans and deposits to a one standard deviation monetary shock. The decrease of loans is intuitive. In this model the

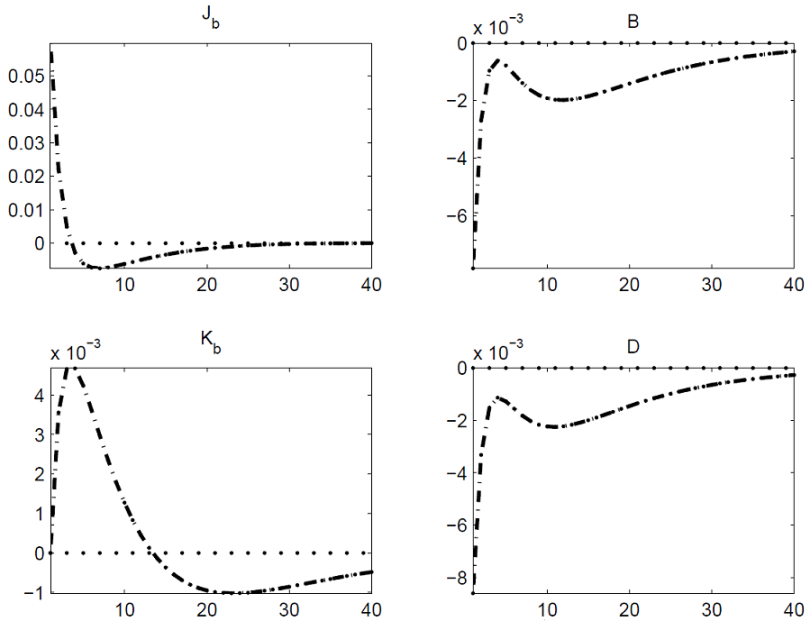

Figure 1: Response of banking variables to a one standard deviation monetary shock, homogeneous banks model

deposits also fell because of entrepreneurs reducing their labor demand and capital stock due to the tightening of the borrowing constraint. Despite the higher rate of return the households consume part of their deposits to smooth the negative income shock triggered by firms cutting production inputs. Because the drop in deposits is stronger than the drop in the loans, the initial bank profits rise to then fall sharply. The response of profits determines the path of bank capital - there is initial accumulation in the initial period and de-accumulation on the convergence to the steady state.

The increase in bank profits is driven by the preference parameters of the households and the entrepreneurs, especially how the hours worked changes are weighted in the utility function. The second component that contributes to our results is the tightness of the borrowing constraint. With more relaxed constraint the immediate effect of the change in interest rates on the loans would be weakened. Note, however, that due to parameter heterogeneity the results we present here are not directly comparable to the results of the next section.

We do two thought experiments, using a calibration borrowing from the literature to investigate the response of bank lending conditional on the composition of the banking sector (how many banks are foreign banks), and adjust some parameters of the model to mimic the *internal market* and industry competition hypotheses. We vary the parameters governing the bank balance sheet dynamics of the foreign-owned banks.

First, we decrease the punishment for deviations of the target dividend ratio κ_ω which is to model the possibility

of transfer liquidity from and to the bank owner in order to avoid excessive deviations from the target leverage ratio. We also decrease the target ratio of bank capital to bank loans for foreign-owned banks, allowing them to fund more loans with a given level of bank capital. This exercise corresponds to *internal market hypothesis*.

Second, we shut the dividend smoothing channel and introduce two sub-markets in the market for loans, each with different elasticity of substitution $\varepsilon_{bE}^{l} < \varepsilon_{bE} < \varepsilon_{be}^{h}$ picking the values of ε_{bE}^{l} and ε_{bE}^{h} such that under the assumption that the two sub-markets are penetrated proportionately by foreign-owned and domestic banks the dynamics of the model remain as in the homogeneous case corresponding to one elasticity ε_{bE} to facilitate comparison. This exercise corresponds to *market segmentation hypothesis*.

For each of the parameters combinations we hit the economy with a one standard deviation monetary shock. We are interested in how the total volume of loans reacts to this shock and how foreign banks loans responses differ from domestic banks loans responses within a one year horizon (one period in our model). We also want to know how the two objects vary with the level of banking sector penetration μ. This exercise is aimed at answering two questions. First, any dependence of the response of total loans on μ would constitute an indirect measure of the strength of the bank balance sheet transmission channel. Second, the differential response of foreign and domestic banks would be a validation test for the model to replicate qualitatively our empirical findings.

The internal market mechanism operates through the wholesale interest rate setting equation. Upon a monetary shock, the foreign owner adjusts the stream of dividends which reduces the response of the wholesale branch rate that pins down the loan rate. The market segmentation mechanism operates primarily through the demand for loans.

4.1 Internal market hypothesis

In Figure 2 we plot the response of total loans to a monetary shock under low, $\mu = 0.05$ and high $\mu = 0.95$ penetration of a domestic banking system by foreign banks. What we find is that the response of aggregate loans is tamed when foreign-owned banks dominate the domestic banking system. Thus, the balance sheet transmission channel is weakened due to the more flexible adjustment of bank capital in the foreign owned banks. The model can also replicate a weaker response of the foreign banks, as expected. Under the parametrization that corresponds to the results presented in this sub-section we managed to get the first-period response of foreign-owned banks loans to be weaker by about one-third than the reaction of domestic banks loans.

The deterioration of the bank lending transmission channel implies that the real effects of monetary shocks are diminished. Thus, the response of prices to monetary policy is also mitigated, in a somewhat similar fashion to the monetary policy trilemma mechanism in a small open economy. The response of the interest rate set by the bank is tamed thanks to a more flexible adjustment of bank capital which leads to a smaller change in the deposits and hence, consumption.

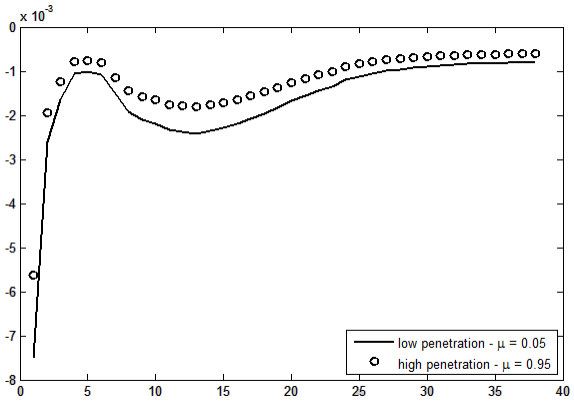

Figure 2: Response of total bank lending to a 1% standard deviation monetary shock.

4.2 Market segmentation hypothesis

Now, we assume that the banks' balance sheet parameters are the same among the two types of banks. We postulate, however, that they manage to introduce some form of market segmentation, where foreign owned banks access more profitable segments of the market for loans. We assume that there are two markets for loans and each entrepreneur is confined to pick from a portfolio of loans in one of the sub-markets. The size of each market is fixed: γ_l for low-elasticity market and $\gamma_h = 1 - \gamma_l$ for the high elasticity market.

Then, we assume that a fraction $\mu^{\varepsilon_l} > 0.5$ of foreign banks operate in the low-elasticity market. In this way we introduce a skew in the composition of the foreign-owned banks loans portfolio such that out of the total measure of 1 of all banks $\mu\mu^{\varepsilon_l}$ are foreign-owned banks in the low elasticity market and $(1-\mu)\,\mu^{\varepsilon_l}$ is the measure of the domestic banks operating in the low-elasticity market etc. We keep γ_l fixed in our experiments as changing it would change the steady state of the model.

What we find is that switching from low to high penetration scenario makes almost no difference in the dynamics of the total loans after a monetary shock. We do observe, however, an increasing differential in the response of loans across two types of banks. In this scenario the level of profits (in the steady state with $\mu = 0.5$ and $\mu^{\varepsilon_l} = 0.8$) differs across banks. We find that foreign banks have steady-state profits roughly equal to 1.5 times the profits of domestic banks. We document the response of total loans in Figure 3. Under the parametrization that corresponds to the results presented in this sub-section we got the first-period response of foreign banks loans to be weaker by about 15% than the reaction of domestic banks loans.

Notice that the market segmentation hypothesis implies that the distinction between "foreign" and "domestic" banks boils down to recovering underlying demand heterogeneity. With all the banks being "foreign" or "domestic" no observable difference between the banks would show up in the panel estimation assuming uniform access to both sub-markets. This is why the aggregate response functions don't differ, although on a micro level the differences in

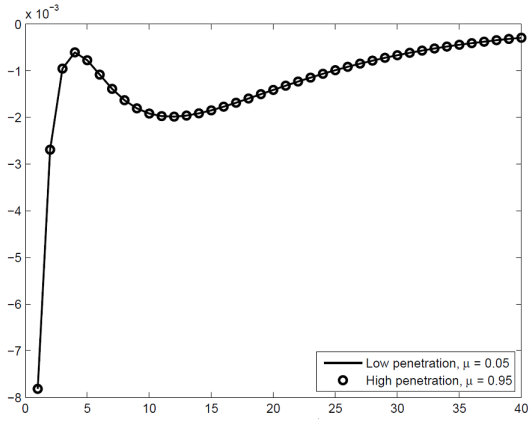

Figure 3: Response of bank lending to a 1% standard deviation monetary shock, market segmentation hypothesis, $\mu = 0.95$

the elasticity of the demand for loans introduce differentiated lending patterns.

4.3 Discussion

Our simulations show that the two different types of bank heterogeneity lead to qualitatively similar results when it comes to differences in banks' lending response to a monetary shock. Lending by foreign-owned banks is less responsive to monetary policy either because of low demand elasticity, or because the bank capital adjustment is smoother. There are several caveats to our results, however. First, the stability of the steady-state of the model hinges on the size of the penalty parameters measuring deviations from target dividend rates and leverage which comes from the deposits and bank capital being perfect substitutes in the balance sheet identity. Second, the mechanism of competition between banks is to a large extent shut down because of absence of entry and exit. Relaxing those assumptions is left for future research.

The implications for the behavior of the total loans of the two mechanisms are different, though. If the main outcome of ownership heterogeneity is flexibility in adjusting the bank capital, then an increased presence of foreign-owned banks weakens monetary policy transmission channel and is prone to instability abroad, as foreign bank import foreign shocks through the internal capital market. On the other hand, due to low dependence on host country conditions foreign banks are less prone to variations not only in the monetary policy rate, but also in host country's GDP. If, however, different ownership leads to bank customer heterogeneity then, what we see is a different partition of the banking sector profits, with no impact on total loans dynamics.

The data used or the empirical part of this paper do not allow us to detect internal capital market directly. However, we can test which of the two hypotheses is more relevant indirectly, by testing assumption and implications.

Table 3: Testing Assumptions Behind Two Hypotheses

Hypothesis	Assumption	Data Test	Result	Verification
Internal market	$\nu^{fgn} < \nu^{dom}$	$Cap^{dom} - Cap^{fgn}$	= 2.087***	YES
	$\kappa_b^{fgn} > \kappa_b^{dom}$	$\sigma(Cap^{dom}) - \sigma(Cap^{fgn})$	= 0.951***	YES
	$\kappa_\omega^{fgn} > \kappa_\omega^{dom}$	$\sigma(Div^{dom}) - \sigma(Div^{fgn})$	= 4.005	NO
Market segmentation	$\epsilon_{bE}^{fgn} < \epsilon_{bE}^{fgn}$	$Prof^{dom} - Prof^{fgn}$	= -0.133	NO

* p<0.10, ** p<0.05, *** p<0.010

Testing Assumptions. In this section we have simulated the DSGE model under two different parametrizations to reflect the two different hypotheses regarding the foreign banks credit granting behavior. First, to mimic the *internal market hypothesis* we made three assumptions: i) the target leverage ratio is lower in foreign banks, ii) the penalty multiplier on deviations from the target leverage is higher in foreign banks, iii) the penalty multiplier on deviations from the target dividends ratio is higher in foreign banks. Those assumption yield following consequences, that should be observed at the bank-level data: i) capitalization in domestic banks is significantly higher than in foreign banks, ii) standard deviation of capitalization in domestic banks is significantly higher than in foreign banks, iii) standard deviation of dividend ratio in domestic banks is significantly higher than in foreign banks.

Second, to mimic the *market segmentation hypothesis* we made only one assumption: more foreign banks operate in the segment where the elasticity of substitution is lower. The consequence of this assumption that we should be able to observe in the data, is that domestic banks are on average less profitable than foreign banks. We collect assumption, testable consequences and data test results in Table 3.

As indicated in the Table 3 the data slightly favour assumptions behind the *internal market hypothesis*: mean capitalization is lower in foreign banks and capitalization is less volatile in foreign banks. However, the assumption about different volatility of dividends ratio in foreign banks is not confirmed by the data. Regarding the assumption behind the *market segmentation hypothesis*, the data shows that foreign banks are on average more profitable, but the difference is not significantly different from zero.

Testing Implications. Next, we test implications of each hypothesis. The *internal market hypothesis* implies that foreign banks should react to innovations abroad, namely to the changes in the interest rate and GDP in the country of the parent bank. Also, foreign banks, because of the facilitated access to funds from abroad, should react less to the changes in the host country GDP. The second hypothesis on the other hand implies that foreign banks do not react to the innovations abroad and that their reaction to the changes in the host country GDP are the same as domestic banks. To test these assumptions we expand our regression equation in 1 to include additional terms:

Table 4: Determinants of bank lending - testing implications

	OLS	D-in-D	GMM
FGN	-1.022	1.895	0.797
	(1.622)	(3.164)	(2.246)
MP	-1.542***	-1.648***	-1.302***
	(0.320)	(0.407)	(0.441)
FGN*MP	1.018**	0.811***	1.099**
	(0.340)	(0.201)	(0.533)
GDP	2.554***	1.210***	0.957**
	(0.464)	(0.309)	(0.386)
Pi	-0.388	-1.103***	-1.032***
	(0.232)	(0.142)	(0.140)
Eurozone GDP	-1.089	1.725**	0.253
	(0.921)	(0.670)	(0.822)
EurozoneGDP*FGN	1.112	0.743	0.877
	(0.991)	(0.803)	(0.926)
MPinFGN	1.618	0.292	-0.239
	(1.148)	(0.638)	(1.027)
FGN*GDP	-0.525	-0.0445	-0.190
	(0.338)	(0.391)	(0.491)
Observations	2403	2403	2001

Standard errors in parentheses
* p¡0.10, ** p¡0.05, *** p¡0.010

monetary policy in the country of the parent bank $MPinFGN$, change in the GDP in the Eurozone $EzoneGDP$ and its interaction term with the foreign ownership dummy $FGN * EzoneGDP$ and an interaction term of the foreign ownership dummy with changes in the host country's GDP $FGN * GDP$. The results of the augmented regression are presented in Table 4. Again, we run three different models: pooled OLS, differenced-in-differences and system GMM.

The results of this regression show, that none of the three implications of the *internal market hypothesis* are to be found in the data. Foreign banks neither react to the monetary policy nor to changes in the GDP in their home country. Also, foreign banks do not react differently to the changes in the host country GDP, as the existence of the internal capital market would suggest. This, on the other hand, points towards the direction of the alternative hypothesis, the *market segmentation*. To conclude, we show that the data do not unambiguously favor one hypothesis other the other. Although the assumptions of the *internal market hypothesis* are valid, the implications are not. Conversely, although the assumption of the *market segmentation* hypothesis are not validated in the data, the implications find much more support.

5 Lessons for policy and directions for future research

We have documented that foreign-owned banks presence may pose additional challenges for policy makers not only during the times of financial turmoil. Using a variant of a DSGE model featuring monopolistic competition between banks we have demonstrated that the differential response to monetary policy stemming from different ownership

Table 5: Testing Implications of Two Hypotheses

Hypothesis	Implication	Verification
Internal market	Foreign banks react to changes in foreign monetary policy	NO
	Foreign banks react to changes in foreign GDP	NO
	Foreign banks react less to changes in domestic GDP	NO

does not have to be driven by flows between the subsidiary and the owner. If that was the case, then an increased presence of foreign owned banks would decrease the strength of the bank balance sheet transmission channel.

We argue that industry competition dynamics in the banking sector may also be driving the empirical patterns. If that is indeed the case then an increased presence of foreign-owned banks in the economy *does not* weaken the bank balance sheet transmission channel but may skew the impact of monetary policy within the banking sector negatively towards domestic owned banks. That is, an increasing penetration by foreign banks may up to some point yield competition concerns for the policy makers. If the weakest, least productive banks are not taken over by foreign banks then monetary policy may affect their profitability and sector concentration.

Our empirical results confirm that the bank ownership can be a worry for monetary policy makers in times of financial distress. Monitoring of bank-owner financial health can prove vital for assessing the risks present in the domestic banking sector.

We think it is worthwhile to approach the issue of foreign banks penetration and monetary policy in a dynamic industry competition model which we leave for future research. It would be interesting to analyze individual country data complementing the cross-country patterns. Possibly different individual experiences can be explained in greater detail by country-specific banking competition factors.

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Appendix A. Data construction and definitions

Table 6: Definitions of variables

Dependent Variable	
ΔL_{ijt}	Growth rate of Net Loans in bank i in country j in year t less Inflation rate in country j in year t multiplied by 100. To neutralize the impact of outliers this variable is winsorized at 5^{th} and 95^{th} percentile. Net Loans reported in local currency. Source of Net Loans: Bankscope. Source of Inflation: Eurostat.
Monetary Policy	
MP_{jt}	Monetary policy tool; yearly average of Repo Rate of the central bank in country j in year t less yearly average in year $t-1$. To neutralize the impact of outliers this variable has been cleaned from values lower than -10 (no observations were higher than +10). Source: ECB and central bank's websites.
$MPinFGN_{ijt}$	Foreign monetary policy tool; defined only for observations with $FGN = 1$; yearly average of Repo Rate of the central bank in a residence country of major foreign owner in year t less yearly average in year $t-1$. Source: ECB and central bank's websites.
$IndependentMP$	Independent Monetary Policy dummy; takes value 0 if a country is withing a Eurozone or in a currency peg and 1 otherwise.
Ownership	
FGN_{ijt}	Foreign ownership dummy. Takes value 1 if more than 50% of the shares of bank i in country j in year t are owned by a party located in country different than j. Source: Bankscope and individual banks' websites.
GOV_{ijt}	Government ownership dummy. Takes value 1 if more than 50% of the shares of bank i in country j in year t are owned by a government of country j. Source: Bankscope and individual banks' websites.
Bank Controls	
$Size_{ijt}$	Bank's size; Total Assets in bank i in country j in year t divided by the sum of Total Assets in all banks in country j in time t times 100; winsorized at 99^{th} percentile. Total Assets reported in local currency. Source: Bankscope.
Liq_{ijt}	Bank's liquidity; Liquid Assets divided by Total Assets in bank i in country j in year t times 100; winsorized at 99^{th} percentile and cleared from negative values. Total Assets and Liquid Assets reported in local currency. Source: Bankscope.
Cap_{ijt}	Bank's capitalization; Total Equity divided by Total Assets in bank i in country j in year t times 100; winsorized at 99^{th} percentile and cleared from negative values. Total Assets and Total Equity reported in local currency. Source: Bankscope.
$Prof_{ijt}$	Bank's profitability; Operating Profit divided by Total Assets in bank i in country j in year t times 100; winsorized at 1^{st} and 99^{th} percentile. Total Assets and Operating Profit reported in local currency. Source: Bankscope.
Macro Controls	
GDP_{jt}	Growth rate of real GDP per capita in country j in year t. Source: Eurostat.
$EzoneGDP$	Growth rate of real GDP per capita in Eurozone in year t. Source: Eurostat.
Pi_{jt}	Inflation in country j in year t. Source: Eurostat.
$Crisis$	Financial Crisis dummy, takes value 1 for years 2008-2012.
Exchange Rates	
EUR x-rate	Relative change of a yearly average local currency to Euro exchange rate in country j in year t. Source: Eurostat.

Table 7: Comparison of bank controls across countries and ownership

	Size DOM	Size FGN	Liquidity DOM	Liquidity FGN	Capitalization DOM	Capitalization FGN	Profitability DOM	Profitability FGN
BG	4.28	6.22	40.05	28.58	17.74	13.02	1.13	1.34
CZ	3.30	3.89	33.12	24.71	10.55	10.19	0.42	1.04
EE	2.12	8.22	35.42	26.96	16.62	15.70	0.61	0.24
HR	1.39	5.82	30.06	28.64	15.76	13.40	0.55	0.78
HU	6.73	2.89	35.05	29.35	9.90	11.68	0.91	0.91
LT	4.42	13.19	29.88	22.59	12.91	9.58	0.07	-0.07
LV	4.97	7.30	42.56	30.16	13.47	10.60	0.83	-0.13
PL	3.94	2.87	16.05	20.10	11.82	13.12	1.41	1.44
RO	4.70	4.24	34.98	30.73	18.21	13.01	0.96	0.74
SI	5.76	3.51	21.19	16.95	9.35	7.79	0.74	0.31
SK	5.31	6.42	39.55	30.13	21.12	10.15	0.39	0.85
Total	4.04	4.79	31.17	26.29	14.05	11.93	0.79	0.90

Table 8: Comparison of bank controls across years and ownership

	Size DOM	Size FGN	Liquidity DOM	Liquidity FGN	Capitalization DOM	Capitalization FGN	Profitability DOM	Profitability FGN
1998	5.89	4.78	38.09	42.69	16.88	12.05	0.14	0.93
1999	5.87	4.59	37.43	42.02	16.75	14.32	1.09	0.83
2000	5.83	4.62	41.97	40.54	17.73	13.27	1.22	1.12
2001	5.67	5.42	46.40	40.42	16.36	12.74	0.98	1.07
2002	5.18	5.75	42.12	38.20	15.45	13.05	1.48	1.65
2003	3.88	5.76	38.18	34.25	14.38	12.59	1.13	1.47
2004	3.50	5.30	33.59	31.66	13.26	12.74	1.60	1.46
2005	3.26	4.69	32.71	30.27	13.50	11.20	1.63	1.39
2006	3.09	4.82	30.27	28.23	13.03	11.48	1.41	1.20
2007	3.08	4.83	26.19	24.93	13.11	10.95	1.54	1.30
2008	2.84	4.50	21.46	19.42	13.81	11.11	0.53	0.89
2009	2.98	4.28	20.96	17.68	12.72	10.99	0.16	-0.16
2010	2.91	4.33	22.49	17.13	11.37	11.63	-0.23	0.24
2011	3.08	4.48	22.31	17.15	10.62	11.77	-0.81	0.40
2012	3.37	5.27	22.03	16.38	11.11	12.13	0.02	0.36
Total	4.16	4.88	32.35	27.87	14.21	12.02	0.79	0.92

Appendix B. Data coverage

Table 9: Data coverage by country

	Number of bank-years		Sample coverage (in %)	
	ownership	net loans	in # of bank-years	in volume of net loans
BG	353	288	95.83	99.31
CZ	430	381	88.19	91.00
EE	114	97	91.75	99.25
HR	527	476	98.32	99.69
HU	448	455	84.40	98.50
LT	145	130	99.23	99.31
LV	310	229	98.69	98.76
PL	683	478	92.68	98.56
RO	437	344	92.44	99.57
SI	282	256	92.58	97.66
SK	279	246	93.09	95.49
Total	4008	3380	92.75	97.25

Table 10: Data coverage by year

	Number of bank-years		Sample coverage (in %)	
	ownership	net loans	in # of bank-years	in volume of net loans
1998	242	163	93.87	88.34
1999	242	168	91.67	89.22
2000	252	183	88.52	89.78
2001	244	176	86.93	87.29
2002	251	179	90.50	90.40
2003	266	188	94.68	93.31
2004	271	223	94.62	96.95
2005	282	251	95.22	96.70
2006	268	249	95.18	96.75
2007	266	253	93.28	96.95
2008	289	267	95.13	99.73
2009	282	283	91.52	98.43
2010	284	286	91.61	99.03
2011	284	272	93.75	97.65
2012	285	239	92.05	98.43
Total	4008	3380	92.75	97.25

Appendix C. Estimation results: robustness checks

Table 11: Determinants of bank lending, accounting for different monetary policy regimes

	(1)	(2)	(3)	(4)	(5)
FGN	-0.557	-1.280	3.059	-1.650	3.647
	(2.131)	(2.301)	(3.124)	(2.143)	(3.671)
MP	-1.816***	-1.578***	-1.677***	-1.688***	-1.629***
	(0.323)	(0.276)	(0.401)	(0.204)	(0.404)
FGN*MP	1.166***	1.138***	0.921***	1.103***	0.850***
	(0.326)	(0.344)	(0.228)	(0.264)	(0.237)
Size	-0.0734	-0.0374	-0.00511	-0.0462	0.0339
	(0.0503)	(0.0608)	(0.292)	(0.0577)	(0.251)
Liq	-0.147**	-0.0697	-0.349***	-0.0749	-0.360***
	(0.0558)	(0.0471)	(0.0621)	(0.0495)	(0.0650)
Cap	-0.253*	-0.236**	-0.665***	-0.265**	-0.649**
	(0.124)	(0.0923)	(0.201)	(0.0972)	(0.225)
Prof	1.315**	1.566***	1.590***	1.603***	1.539***
	(0.429)	(0.457)	(0.428)	(0.473)	(0.394)
GDP	1.310***	2.204***	1.147***	2.126***	1.412***
	(0.160)	(0.305)	(0.151)	(0.259)	(0.313)
Pi	-0.981***	-0.385	-1.112***	-0.125	-0.914***
	(0.139)	(0.239)	(0.145)	(0.206)	(0.196)
Independent MP		0.478	-3.636		
		(1.562)	(2.362)		
Change in EUR x-rate				-0.388**	-0.267
				(0.140)	(0.146)
Time Fixed Effects	Yes	No	Yes	No	Yes
Country Fixed Effects	Yes	No	No	No	No
Bank Fixed Effects	Yes	No	Yes	No	Yes
Observations	2403	2403	2403	2361	2361
R^2	0.244	0.165	0.305	0.172	0.308

Standard errors in parentheses
* p¡0.10, ** p¡0.05, *** p¡0.010

Table 12: Determinants of bank lending- government banks

	OLS	D-in-D	GMM
FGN	-1.809	0.345	0.0313
	(2.303)	(4.687)	(4.056)
GOV	-2.188	-7.680	-5.464
	(1.610)	(7.237)	(3.457)
MP	-1.777***	-1.676**	-1.474**
	(0.525)	(0.577)	(0.523)
FGN*MP	1.340***	0.879**	1.313*
	(0.284)	(0.272)	(0.668)
GOV*MP	0.588	-0.303	0.0828
	(0.860)	(0.943)	(0.777)
Size	-0.0288	0.0113	2.296**
	(0.0579)	(0.320)	(1.006)
Liq	-0.0639	-0.353***	-0.705***
	(0.0484)	(0.0609)	(0.118)
Cap	-0.226**	-0.655**	-2.084***
	(0.0968)	(0.208)	(0.424)
Prof	1.558***	1.539***	1.702***
	(0.456)	(0.415)	(0.249)
GDP	2.201***	1.143***	0.864***
	(0.301)	(0.166)	(0.258)
Pi	-0.384	-1.118***	-1.014***
	(0.236)	(0.156)	(0.173)
L.Delta Net Loans			0.212***
			(0.0270)
Observations	2403	2403	2001

Standard errors in parentheses
* p¡0.10, ** p¡0.05, *** p¡0.010

Table 13: Determinants of bank lending - without ownership change banks

	OLS	D-in-D	GMM
MP	-1.827***	-1.909***	-1.502**
	(0.249)	(0.535)	(0.562)
FGN*MP	1.567***	1.105**	1.399***
	(0.417)	(0.421)	(0.423)
Size	0.0994	-0.156	1.976
	(0.0782)	(0.533)	(1.236)
Liq	-0.0630	-0.271***	-0.673***
	(0.0577)	(0.0816)	(0.152)
Cap	-0.246**	-0.591**	-2.113***
	(0.102)	(0.243)	(0.454)
Prof	1.348**	1.444***	2.096***
	(0.502)	(0.418)	(0.347)
GDP	2.285***	1.145***	0.997***
	(0.281)	(0.211)	(0.303)
Pi	-0.364	-1.099***	-0.994***
	(0.214)	(0.170)	(0.235)
L.Delta Net Loans			0.210***
			(0.0357)
Observations	1825	1825	1502

Standard errors in parentheses
* p¡0.10, ** p¡0.05, *** p¡0.010

Appendix D. DSGE model

Households Standard intra-temporal condition for labor supply:

$$\frac{1}{c_t^H(i)} = \frac{l_t^H(i)^{\phi}}{w_t}, \tag{20}$$

and an inter-temporal condition for consumption choice:

$$\frac{1}{c_t^H(i)} = \beta_H\left(1+r_t^d\right)\mathbb{E}_t\left[\frac{1}{c_{t+1}^H(i)}\right]. \tag{21}$$

Given those two conditions, deposits are determined via budget constraint that holds with equality:

$$c_t^H(i) + d_t^H(i) = W_t l_t^H(i) + \left(1+r_{t-1}^d\right) d_{t-1}^H(i) + T_t^H. \tag{22}$$

Entrepreneurs

$$\frac{1}{c_t^E(i)} - \zeta_t^E(i) = \beta_E \mathbb{E}\frac{1+r_t^b}{c_{t+1}^E(i)} \tag{23}$$

$$\mathbb{E}\Big[\frac{\zeta_t^E(i)\, m^E q_{t+1}^k\left(1-\delta^k\right)}{1+r_t^b} + \frac{\beta_E}{c_{t+1}^E(i)}\left(q_{t+1}^k\left(1-\delta^k\right)+r_{t+1}^k\right)\Big] = \frac{q_t^k}{c_t^E(i)} \tag{24}$$

$$\frac{(1-\alpha)\, y_t^E(i)}{l_t^d(i)\, x_t} = w_t \tag{25}$$

$$r_t^k \equiv \frac{\frac{\partial y_t^E(i)}{\partial k_t(i)}}{x_t} \tag{26}$$

Banks - aggregation of loans The problem of entrepreneur i choosing his total loans $b_E(i)$ facing a continuum of banks indexed with j to allocate these loans among the continuum of banks is a standard cost-minimization problem:

$$\min_{b_E(i,j)} \int_0^1 r_b(j)\, b_E(i,j)\, dj \tag{27}$$

$$\text{subject to: } \left[\int_0^1 b_E(i,j)^{\frac{\varepsilon-1}{\varepsilon}} dj\right]^{\frac{\varepsilon}{\varepsilon-1}} = b_E(i) \tag{28}$$

For a given aggregate price r_b the entrepreneur optimally chooses the total amount of loans and its partition among monopolistically competitive banks. Note, we can write:

$$\left[\int_0^1 b_E(i,j)^{\frac{\varepsilon-1}{\varepsilon}} dj\right] = b_E(i)^{\frac{\varepsilon-1}{\varepsilon}}. \tag{29}$$

The first order condition of retail branch j gives the demand for loans at bank j charging $r_{bE}(j)$, given aggregate price for loans r_{bE}:

$$b_E(i,j) = \left(\frac{r_{bE}(j)}{r_{bE}}\right)^{-\varepsilon} b_E(i) \tag{30}$$

which we integrate on the both sides wrt to i to get:

$$b_E(j) = \left(\frac{r_{bE}(j)}{r_{bE}}\right)^{-\varepsilon} b_E. \tag{31}$$

With $r_{bE} = \left[\int_0^1 r_{bE}(j)^{1-\varepsilon} dj\right]^{\frac{1}{1-\varepsilon}}$ being the price index. Now, we have the two following equations (the first one is postulated to reflect the monopolistic competition assumption, the other follows):

$$b_E(i) = \left[\int_0^1 b_E(i,j)^{\frac{\varepsilon-1}{\varepsilon}} dj\right]^{\frac{\varepsilon}{\varepsilon-1}}, \tag{32}$$

$$r = \left[\int_0^1 r(j)^{1-\varepsilon} dj\right]^{\frac{1}{1-\varepsilon}}. \tag{33}$$

Let us assume a within-ownership symmetric equilibrium such that a measure of foreign banks μ chooses $r_{f,bE}$ and a measure of domestic banks $1-\mu$ chooses $r_{h,bE}$. Without loss of generality we say the banks with $j \in [0,\mu)$ set $r_{f,bE}$. We than have that:

$$r_{bE} = \left[\int_0^1 r_{bE}(j)^{1-\varepsilon} dj\right]^{\frac{1}{1-\varepsilon}} = \left[\mu r_{f,bE}^{1-\varepsilon} + (1-\mu) r_{h,bE}^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}}. \tag{34}$$

Now, we use the demand equations to derive the index of quantities, by differentiating equation (31) with respect to j which yields:

$$b_E = \left(\mu b_{f,E}^{\frac{\varepsilon-1}{\varepsilon}} + (1-\mu) b_{h,E}^{\frac{\varepsilon-1}{\varepsilon}}\right)^{\frac{\varepsilon}{\varepsilon-1}}. \tag{35}$$

The last two equations are used in aggregation of individual demands and prices to aggregate demands and prices in the loans market.

Retailers Retail good producers buy the good produced by entrepreneurs, aggregate them to the final good and sell it with a markup subject to Rotemberg type of adjustment costs. The first equation is the definition of retailer profits, κ_p is the parameter governing the inertia of the aggregate price level. The second equation is the first order condition of the optimal pricing problem, can be thought of as a Philips curve.

$$J_t^R = y_t \left(1 - \frac{1}{x_t} - \frac{\kappa_p}{2}\left(\pi_t - \left(\pi_{t-1}^{\zeta_p}\bar{\pi}^{1-\zeta_p}\right)\right)^2\right) \tag{36}$$

$$1 = \varepsilon_t^y + \frac{\varepsilon_t^y}{x_t} - \kappa_p\left(\pi_t - \left(\pi_{t-1}^{\zeta_p}\bar{\pi}^{1-\zeta_p}\right)\right)\pi_t + \tag{37}$$
$$\beta^P \mathbb{E}_t\left[\frac{\lambda_{t+1}^P}{\lambda_t^P}\kappa_p\left(\pi_{t+1} - \left(\pi_t^{\zeta_p}\bar{\pi}^{1-\zeta_p}\right)\pi_{t+1}\right)\frac{y_{t+1}}{y_t}\right]$$

Capital good producers The role the capital good producers play in the model is twofold. First, their presence encapsulates the economy-wide investment equation and capital accumulation. Without loss of generality, this decision could be placed at the firm level as well. Next, and more importantly, it is a way of introducing the price of capital to the model hence facilitating the use of the collateral constraint on capital in a meaningful way.

$$k_t = (1-\delta_k)\,k_{t-1} + i_t\left(1 - \frac{\kappa_i}{2}\left(\frac{i_t}{i_{t-1}} - 1\right)^2\right) \tag{38}$$

$$1 = q_k\left(1 - \frac{\kappa_i}{2}\left(\frac{i_t}{i_{t-1}} - 1\right)^2\right) + \beta^E \mathbb{E}_t\left[\frac{\zeta_{t+1}^E q_{t+1}^k}{\zeta_t^E}\kappa_i\left(\frac{i_{t+1}}{i_t} - 1\right)\left(\frac{i_{t+1}}{i_t}\right)^2\right]. \tag{39}$$

Aggregation The aggregation conditions read:

$$Y_t = C_t + q_t^k\left(K_t - \left(1-\delta^k\right)K_{t-1}\right) + \frac{\delta^b K_{t-1}^b}{\pi_t} \tag{40}$$

$$B_t = D_t + K_t^b \tag{41}$$

$$C_t = \int c_t^H(i) + c_t^E(i)\,di \tag{42}$$

$$B_t = b_{E,t} \tag{43}$$

$$D_t = d_t \tag{44}$$

$$K_t = k_t^e \tag{45}$$

$$Y_t = y_t^e \tag{46}$$

$$l_t^d = l_t^p. \tag{47}$$

Appendix E. Calibration

In this section we discuss calibration of the model parameters. We calibrate the model using standard values for yearly data as this is the frequency micro data is reported in Bankscope. Let us start with the discussion of our calibration targets.

First, observe that the central bank rate pins down the rate of return on bonds. Thus, we wish to replicate a 6% p.a. value here, higher than the standard US value of 4% by two percentage points. This assumption determines the household discount factor β^H. We pick entrepreneurs patience to be captured by $\beta^E =$. We pick the inverse of the Frisch elasticity to be equal to 1. The capital share in the production function is set at $\alpha = 0.3$. The depreciation rate of physical capital is $\delta_k = 0.02$. The LTV ratio m^E is postulated to be equal to 0.35. We assume a markup in the goods market at 15% and the markup on the interbank rate to be about 40%. The monetary policy inertia we set at 0.8. The cost for managing bank capital is determined in the equilibrium to assure that the banks achieve their target balance structure. The multiplier on the quadratic cost of deviations from the optimal balance sheet structure κ_b is put at 10.The price stickiness parameter is set κ_p to 30. The elasticity of loans is equal to 4.

For the internal market hypothesis we increased the penalty multiplier κ_b in foreign banks to 100, we also postulate the target leverage to be $\nu_{fgn} = 0.045$ in foreign-owned banks while the domestic banks have it on $\nu_{dom} = 0.09$. The segmentation market hypothesis has $\varepsilon_l^H = 7$ and ε_l^L follows to map the steady state banking variables for the homogeneous elasticities baseline case. We set the country size parameter η to match the ratio of GDP of the Eurozone and Poland. Other parameters we keep symmetric apart from the markup on the interbank market to be half of the one used for the Home country. We pick the penalty parameter κ_ω to allow for up to 10% deviations in the stream of the dividends in the policy simulations experiments.