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In lands of foreign currency credit, bank lending channels run through?

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Steven Ongena–Ibolya Schindele–Dzsamila Vonnák

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The views expressed are those of the authors' and do not necessarily reflect the official view of the central bank of Hungary (Magyar Nemzeti Bank).

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In Lands of Foreign Currency Credit, Bank Lending Channels Run Through?

(A monetáris politika banki hitelcsatornája devizahiteles országokban: Tanulmány magyar vállalati hiteladatokon)

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In Lands of Foreign Currency Credit, Bank Lending Channels Run Through?

Abstract

We study the impact of monetary policy on the supply of bank credit when bank lending is also denominated in foreign currencies. Accessing a comprehensive supervisory dataset from Hungary, we find that the supply of bank credit in a foreign currency is less sensitive to changes in domestic monetary conditions than the equivalent supply in the domestic currency. Changes in foreign monetary conditions similarly affect bank lending more in the foreign than in the domestic currency. Hence when banks lend in multiple currencies the domestic bank lending channel is weakened and international bank lending channels become operational.

Keywords: Bank balance-sheet channel, monetary policy, foreign currency lending.

JEL: E51, F3, G21.

I. Introduction

Bank lending in a foreign currency to local businesses and households has been a widely observed phenomenon in many "dollarized" (or "euroized") countries around the world, in South-America, East Asia, and more recently in Eastern Europe.[1] And in those countries with large credit exposures denominated in foreign currencies, policy makers never fail to point out the adverse effects of foreign currency lending on the transmission of domestic monetary policy.[2]

Yet, despite the prevalence of foreign currency lending and its widely noted effect on the monetary policy transmission mechanism, there is little or no empirical work with micro data identifying the impact of monetary conditions on the local supply of credit in the domestic versus the foreign currency, and equally important there is no work identifying the impact of the monetary policy set by the relevant central bank abroad (that issues the foreign currency) on the local supply of credit (in the different currencies). Given the increased calls for tighter international monetary co-operation in the aftermath of the financial crisis this is a particularly acute policy issue for emerging economies.[3]

To fill this gap in the literature, this paper investigates the impact of monetary policy on the supply of bank loans in the presence of widespread foreign currency lending.[4] First, we examine

[1] Even in the Euro area around ten percent of credit by resident financial institutions to the non-financial sector is granted in a foreign currency (European Central Bank and Brown, Peter and Wehrmüller (2009)).

[2] The 2005 Annual Report of the National Bank of Romania for example states that "[y]et another challenge to monetary policy implementation was to maintain the upward trend in financial intermediation by increasing the share of RON [Romanian New Leu] denominated loans in non-government credit, which would entail an improvement of the transmission mechanism [...]." For similar exhortations see also the Annual Reports of the National Bank of Romania in 2001, 2005, 2011, 2012, and 2013, the Minutes of the Monetary Policy Council Meetings at the National Bank of Poland, in January and February 2008, and the 2012 Report on Monetary Policy Implementation by the Monetary Policy Council of the National Bank of Poland.

[3] For example, *Financial Times*, January 30, 2014, "India's Raghuram Rajan hits out at uncoordinated global policy." Similarly Fischer (2014) argues that changes in US monetary conditions may create substantial international spillovers and that as European banks are global players European monetary policy may also play an important role.

[4] Besides lending in foreign currency, banks' access to currency funding can also mute the effects of domestic monetary policy when banks engage in carry-trade. Given our data on loan currency denomination, we analyze the

whether foreign currency lending *per se* is a relevant compositional dimension of the bank lending channel of domestic monetary policy by testing whether changes in domestic monetary conditions have a differential impact on the supply of bank loans in the domestic and foreign currencies. Second, we investigate whether foreign currency lending introduces international transmission channels through which foreign monetary policies also (differentially) affect the local supply of bank loans in the domestic and foreign currencies.[5] To the best of our knowledge, our paper is the first to show with micro data that foreign monetary policy may alter the currency composition of the local loan supply through an international bank-lending channel.[6]

In particular, we test two key hypotheses. First, we hypothesize that a monetary expansion by the domestic central bank decreases the local banks' cost of funding in the domestic currency but not (at least to the same extent) in the foreign currency, generating a differential impact on banks'

direct effects of monetary changes on the composition of loan supply. Our results do not, however, exclude the possibility that the domestic bank lending channel can be muted through banks' access to foreign funding.

[5] The question relates to the academic and policy debate on the spillover effects of monetary policy. It has been shown that the monetary policies set in large economies considerably impact the rest of the world, and that this impact mostly operates through asset prices and capital flows (Bank for International Settlements (2015), p. 83, and Chen, Mancini-Griffoli and Sahay (2014)). In our paper we analyze the cross-border impact through the bank-lending channel. This channel also consists of international capital flows, however the spillover effects through this particular channel have not been identified before.

[6] Ioannidou, Ongena and Peydró (2015) assess if changes in the US federal funds rate have compositional effects on the supply of US Dollar denominated credit granted in Bolivia, an almost entirely dollarized country, while Morais, Peydró and Ruiz (2015) assess the impact of foreign monetary policies on lending by foreign versus domestic banks in Mexico. However neither paper does assess – as we do – the differential potencies of the bank lending channels in both the domestic and foreign currencies. More similar in this respect is recent work by Acharya, Afonso and Kovner (2013) who examine the difference between US and foreign banks in their response to the freeze in the US asset-backed commercial paper market (for which US banks had immediate alternatives but foreign banks did not) when lending in US Dollars, Euros or Pounds to corporations through the syndicated loan market. Recent work also investigates the determinants and effects of global liquidity at the aggregate level. Cerutti, Claessens and Ratnovski (2014) for example use country-to-country level data on cross-border bank flows to study the non-price determinants of the cross-border supply of credit. They find that global liquidity is driven primarily by uncertainty (VIX), US monetary policy (term premia but not federal funds rate per se), and UK and Euro Area bank conditions (proxied by leverage and TED spreads). Dinger and te Kaat (2015) study the impact of country-level current account balances on individual bank risk-taking. See also He and McCauley (2013), Lo Duca, Nicoletti and Vidal Martinez (2014), McCauley, McGuire and Sushko (2015), and Temesvary, Ongena and Owen (2015).

loan supply decisions in the different currencies.[7] Second, we hypothesize that a monetary expansion by the foreign central bank lowers the domestic (but potentially foreign owned) banks' cost of funding in the foreign currency but not in the domestic currency and examine, again, the local banks' consequent lending decisions in the domestic and foreign currencies.

Hungary provides an almost ideal setting to identify this currency compositional effect. Although the Hungarian economy is not "dollarized" or "euroized",[8] many local loans are denominated in Euro or in Swiss Franc (in some sample years more than a third of the bank lending was). The comprehensive credit register at the Central Bank of Hungary (*Magyar Nemzeti Bank*) contains granular information on all loans extended by all credit institutions operating in Hungary, including and – essential for our purposes – their currency denomination. And with an economic system dominated by banks,[9] we can identify the causal impact of monetary policy on the supply of bank credit by exploiting theoretically-motivated interactions between changes in monetary conditions on the one hand and a key bank balance-sheet strength variable, i.e., the bank capital-to-total-assets ratio, on the other hand (Bernanke, Gertler and Gilchrist (1996), Kashyap and Stein (2000)). The definition of the bank capital-to-total-assets ratio we employ closely follows the theoretical literature that attributes a prominent role to net worth in determining the ability of banks

[7] Currencies are unlikely to be perfectly substitutable for most banks. Acharya, Afonso and Kovner (2013) show this to be the case even for global banks that lend in the US syndicate loan market. Hungarian banks are no exception. Hungarian banks did rely on foreign currency funding to finance lending in foreign currencies, but at times also used domestic currency funds while hedging some of the resultant on-balance sheet open positions with foreign exchange swap transactions (Mák and Páles (2009)). Analyzing information on the requested and granted loan currency for all loans granted by one Bulgarian bank, Brown, Kirschenmann and Ongena (2014) examine how bank funding affects the currency denomination of business loans. They document that foreign currency lending is at least partially driven by the bank's eagerness to match the currency structure of assets with that of its liabilities.

[8] The amount of foreign cash held in the form of dollars and euros has traditionally been very low in Hungary. Based on survey data from the Austrian National Bank, Feige (2003) for example estimates that the fraction of total currency held as foreign currency was only 6 percent in Hungary in 2001.

[9] Bank financing has traditionally been the most important source of funding for corporations in Hungary. In 2005-2011, the ratio of bank credit to non-financial firms to GDP varied between 25 and 31 percent, corporate bond issues were below 2 percent, and the value of IPOs was about 0.1 percent of the country's GDP (Bijlsma and Zwart (2013)).

to obtain financing from their own financiers (Holmstrom and Tirole (1997), Holmstrom and Tirole (1998), Bernanke, Gertler and Gilchrist (1999), Gertler and Kiyotaki (2011)).

In this way our identification strategy closely follows the most recent empirical literature assessing the effects of monetary policy on the provision of bank credit. Jiménez, Ongena, Peydró and Saurina (2012) and Jiménez, Ongena, Peydró and Saurina (2014) for example explore a dataset of firms' credit exposures to multiple banks and control for firm-level time-varying heterogeneity in credit demand by including borrower-time fixed effects as in Khwaja and Mian (2008).[10] Their identification of the impact of monetary policy on the volume and composition of credit supply, respectively, rests *à la* Kashyap and Stein (2000) on the differential responses (to changes in the monetary policy rate) by banks of different balance-sheet strengths. In this paper, we similarly account for all firm-level time-varying heterogeneity in credit demand by including borrower-time fixed effects and also identify supply effects from the differential responses to changes in monetary conditions by banks with different capitalization ratios. We differ, however, from the literature in that we identify the impact of monetary changes on the supply of loans in different currencies (rather than by different banks) while controlling for credit demand at the borrower-time level. Since a large number of firms in our sample borrow from one bank only (but in multiple currencies), for those firms we include in essence *bank*-borrower-time fixed effects that account then fully for each firm`s bank-specific credit demand.

In sum, we will focus on the *set of loans* in *various currencies* granted *in the same month* to *the same borrower* by one or more banks of varying balance-sheet strengths. Within this set of loans, for which the (observed and unobserved) quality of potential borrowers is constant, we study

[10] Using fixed effects is a standard way to control for demand side heterogeneity also in other strands of the literature. Paravisini, Rappoport, Schnabl and Wolfenzon (2014) for example analyze the effect of credit supply on trade and also include various sets of fixed effects to account for all non-credit determinants.

how monetary conditions affect the granting of loans in different currencies depending on bank capital. Consequently, what we require for the identification of supply effects is that the changes in the domestic (or foreign) interest rate do not affect firms' demand for domestic versus foreign currency loans in a way that is somehow correlated with banks' capitalization ratios.[11] In this way, our borrower-time fixed effects control for all features of firm-level loan demand, even those arising from non-random matching between firms and banks, as long as bank-firm relationships last long enough, i.e., longer than a month.[12] Nevertheless, we also account for the possibility that over time banks' specialization in different industries or export destination markets results in assortative matching between firms and banks (Paravisini, Rappoport and Schnabl (2014)), by using a subsample of non-exporting firms to identify our results.

As common in the literature, we account for the stance of monetary policy with changes in representative short-term interest rates. We further comprehensively account for changes in domestic GDP growth and inflation (Taylor (1993)), at all levels of interaction where the domestic interest rate is also featured. To identify the currency compositional effect, we focus on corporate rather than household bank loan supply. Focusing on corporate loans is likely to generate conservative estimates of the currency compositional effect, since the volume of foreign currency lending was larger in the household than in the corporate sector in Hungary. Furthermore, firms are naturally hedged and most do not actively seek to carry trade (Brown, Ongena and Yeşin

[11] This condition seems more readily satisfied than the one in Khwaja and Mian (2008). They estimate the impact of bank-specific liquidity shocks on bank lending for a sample of firms with multiple banking relationships. They include firm fixed effects and in their case identification requires that concurrent changes in firm credit demand are not bank-specific. Becker and Ivashina (2014) analyze business cycle fluctuations in bank lending using a sample of firms raising new debt financing, either by taking a bank loan or issuing public debt. In their context, demand explanations are properly ruled out by the use of firm-time fixed effects since their sample is conditioned on firms' issuing new debt. Finally, recall that Kashyap and Stein (2000) use bank-level data that does not allow controlling for heterogeneity in credit demand, making disentangling credit supply from demand a steep challenge.

[12] Since ample evidence shows that bank-firm relationships are stable over time (e.g., Ongena and Smith (2001); Degryse, Kim and Ongena (2009)), the condition is duly satisfied, especially in our single-bank firm subsample.

(2011)),[13] a risky activity that could be associated with borrowing from banks with low capital or liquidity ratios.

Given these ingredients we can identify the impact of the monetary conditions set by both domestic and foreign central banks on the supply of credit by local banks in both domestic and foreign currencies. We find that expansionary domestic monetary conditions substantially increase lending from banks with lower capital ratios in the domestic currency but not in the foreign currency. Expansionary foreign monetary conditions on the other hand spur lending in the foreign currency but less so in the domestic currency.[14] These estimated differences in potency of the bank lending channels in domestic and foreign currency are not only statistically significant but also economically relevant (as our detailed discussion in the paper demonstrates). So when credit is also granted in foreign currencies, domestic monetary policy drives only part of the local supply of credit, and foreign monetary policies will also matter. In that case "multiple bank lending channels of various strengths may run through a country."

Our paper fits in the recent literature that identifies the impact of banks' funding shocks on the provision of credit. Khwaja and Mian (2008) for example provide evidence that bank-specific liquidity shocks contract corporate loan supply in Pakistan. The impact of monetary policy shocks on the supply of credit has also been widely analyzed, by the early literature using credit aggregates (Bernanke and Blinder (1992), Kashyap and Stein (2000)) and by recent papers using micro-level data (Jiménez, Ongena, Peydró and Saurina (2012), Becker and Ivashina (2014)). Research on the

[13] Their paper analyzes firm level data and documents that foreign currency borrowing by small firms is related to (firm-level) foreign currency revenues suggesting that the macroeconomic and institutional environment may not be the only determinant of financial dollarization. Consequently their paper also suggests that firm-level controls are essential to identify the effects of monetary conditions on bank lending in various currencies.

[14] I.e., we find that the differences in the response of highly versus lowly capitalized banks to changes in the Euro and Swiss monetary rates are larger when banks lend in a foreign currency.

impact of the monetary policy rate on the *composition* of the supply of credit has so far focused on direct credit risk taken (Jiménez, Ongena, Peydró and Saurina (2014), Ioannidou, Ongena and Peydró (2015), Dell'Ariccia, Laeven and Suarez (2016), and references therein). In this paper we focus on monetary policy and analyze its impact on the supply of credit along currency denomination and we do so for both domestic and foreign monetary policies. But credit risk and currency denomination are intimately connected. For example an expansionary foreign monetary policy will lead to more foreign currency lending domestically, which exposes borrowers to foreign exchange risk that metastases in credit risk for the lenders when the domestic currency depreciates. The latter possibility may not have been fully recognized in bank capital regulation.[15]

Our paper fits in a specific literature assessing the potency of a domestic bank lending channel in Central and Eastern Europe. Matousek and Sarantis (2009) for example use bank-level data from eight countries in the region and find evidence for the channel's existence – though with varying strength – in each country. Beņkovskis (2008) and Kujundžić and Otašević (2012) use credit aggregates from Latvia and Serbia to show that interest rate changes may affect credit in the domestic currency but seem to have limited impact on credit granted in the foreign currency.[16] Although, in line with our approach, these papers focus on the effects of domestic monetary policy on the provision of credit, analyzing aggregate information they are unable to disentangle supply from demand effects. Our paper is the first to consider the differential effects of domestic (and

[15] According to Hungarian regulation, foreign currency lending does not require banks to maintain different bank capital levels as long as the position is hedged through foreign currency funding (on-balance) or through the foreign exchange swap market (off-balance sheet). Similarly, banks' reserve requirements do not differ for deposits in different currencies.

[16] In addition, few recent papers consider the effectiveness of macroeconomic policies in the presence of financial dollarization (e.g. Brown, De Haas and Sokolov (2015)). Using credit aggregates from four Central and Eastern European economies Brzoza-Brzezina, Chmielewski and Niedźwiedzińska (2010) find that restrictive monetary policy may lead to a substitution in the demand for domestic to foreign currency loans. Mora (2013) analyzes a sample of 56 banks in Mexico and documents that banks with a low amount of foreign currency deposits are more (less) sensitive to domestic (foreign) monetary policy shocks than banks with a substantial amount of foreign currency deposits.

foreign) monetary policy on the supply of credit by individual banks to individual firms in local and foreign currencies, directly accounting for time-varying firm-level loan demand (at a monthly frequency).

In addition, our paper relates to the large empirical literature on financial dollarization that studies the determinants of banks' domestic lending in foreign currency in Latin American and transition economies (Nagy, Jeffrey and Zettelmeyer (2011)). This literature finds that in general the lack of macroeconomic policy credibility, inflation volatility, low institutional quality, interest rate differentials, financial market development, and foreign funding of bank credit all contribute to a high level of foreign currency bank loans in these economies (e.g., Barajas and Méndez Morales (2003), De Nicolo, Honohan and Ize (2003), Rajan and Tokatlidis (2005), Rosenberg and Tirpák (2009), Basso, Calvo-Gonzalez and Jurgilas (2011), Neanidis and Savva (2015)). In contrast to this literature that focuses on macro-level money, credit and output aggregates, and often highlights carry-trade on the demand side, we employ micro-level data to identify the impact of changes in monetary conditions on the supply of bank credit across currencies.

The rest of the paper is organized as follows. Section II describes foreign currency lending in Hungary, the country's credit register, and the resultant sample. Section III discusses the identification strategy. Section IV introduces the methodology and the variables. Section V contains the results assessing the potency of the bank lending channels in both domestic and foreign currency. Section VI concludes.

II. Foreign Currency Lending in Hungary and Data Sources

A. Foreign Currency Lending in Hungary

Hungary's transition from a centrally planned to a market economy started at the end of the 1980s and was accompanied by a major inflow of foreign bank capital into the financial sector. By the end of the 1990s the majority of the banks in the country were foreign owned. Since capital markets were still underdeveloped, during the transition period, bank loans provided the major funding source for economic growth.

In early 2000s, a credit expansion started fueled by an intense competition in the banking sector. In parallel, the share of foreign currency denominated loans increased significantly both in the household and the corporate sector. While the most popular denominations were the Euro and the Swiss Franc (see Figures 1 and 2), other currencies like the US Dollar and even the Japanese Yen were also not uncommon for corporations.

The most cited reason for the expansion of foreign currency lending in Hungary was the large difference between domestic and foreign interest rates (see Figure 3)[17]. A high level of government debt, lenient fiscal policy, and high inflation, all played a role in generating the difference in nominal interest rates. At the same time, differential interest rates did not affect borrowers' expectations and awareness of exchange rate risk. In addition to demand side effects, intense credit market competition and banks' consequent willingness to provide loans to riskier clients also contributed to the currency lending boom. Finally, the lack of prudential regulation and appropriate

[17] For example, in the period between January 2005 and December 2011, the average annualized monthly interest rates on corporate loans in Hungarian Forint were on average 4.9 percentage points higher than the average rates on corporate loans in Euro (authors' own calculation based on data from the Central Bank of Hungary).

supervisory policies limiting banks' risk taking when lending in foreign currencies further contributed to the expansion of credit supply. [18]

From 2004 onwards, with the disappearance of state-subsidized domestic currency mortgages, foreign currency loans became a major product in both household and corporate lending. By the end of 2007, 56 percent of total outstanding loans to non-bank clients were denominated in foreign currency ({Brown, 2009 #2811}).[19]

[Insert Figures 1 and 2 here]

In particular, large corporations with revenues in Euro started to borrow in Euro to hedge their exchange rate exposures. The popularity of Swiss Franc loans is attributed to even lower interest rates and low Euro/Swiss Franc exchange rate volatility during the period.

[Insert Figure 3 here]

When the financial crisis hit Hungary in the Fall of 2008, the Hungarian Forint depreciated significantly against the major currencies. The unprecedented collapse of USD liquidity and the drying up of foreign exchange swap markets curbed Hungarian banks' possibilities to continue lending in Euro and Swiss Franc without foreign currency open positions on their balance sheets. In subsequent years, therefore, the share of foreign currency lending substantially decreased. Swiss

[18] The prospect of the introduction of the Euro as the national currency may also have been a contributing factor to the assessment of the foreign exchange risks involved ({Fidrmuc, 2013 #2835}).

[19] Note that while the lending boom can be characterized by the spread of foreign currency loans both in the household and corporate sectors, Figures 1 and 2 show the amount and number of loans given to non-financial corporations since the population of these corporations constitutes our sample.

Franc lending essentially vanished, but lending in Euro preserved its importance both in the household and corporate sectors.

B. The Hungarian Central Credit Information System (KHR)

The Hungarian Central Credit Information System (KHR) contains information on *all* outstanding loans extended by *all* credit institutions operating in Hungary. As such this credit register contains loans from commercial banks, branch offices of foreign banks, saving cooperatives, credit unions, specialized credit institutions and other financial enterprises. We restrict our sample to corporate loans granted by commercial banks and branch offices of foreign banks and we focus on commercial and industrial loans that represent 66 percent of total corporate loans registered in the credit register (Endrész, Gyöngyösi and Harasztosi (2012)).

We observe all outstanding loans denominated in the domestic as well as foreign currency, between 2005 and 2011, at a monthly frequency.[20] We aggregate the data to the firm-month-currency level that will be the focal unit of observation in our analysis. Our dataset includes credit lines but the results we present in subsequent sections are however robust to the exclusion of credit lines from the sample.

We match the thus-organized loan data to firm and bank characteristics. Firms' financial statement data are available from the Hungarian National Tax and Custom Administration (APEH) database that contains the balance sheet and income statement of all Hungarian firms with double-entry book-keeping. Banks' financial and ownership data are available from bank regulatory

[20] This time period looks favorable in length compared to those used in recent papers that analyze the effects on the provision of credit of monetary and financial shocks. Aforementioned papers by Jiménez, Ongena, Peydró and Saurina (2012) and Jiménez, Ongena, Peydró and Saurina (2014) cover 2002 to 2008, Ioannidou, Ongena and Peydró (2015) analyze data ranging from 1999 to 2003, while Khwaja and Mian (2008) study data from 1996 to 2000.

reports accessible at the Central Bank of Hungary. Because the credit register provides information only about the type of the lender (bank, branch office, savings cooperative, leasing company, or other type) but not the individual lender's identity, we obtain information on the extant bank-firm relationships from a firm register called Complex that contains each firm's bank account numbers. The first three digits of the bank account number (called GIRO code) uniquely identify the bank belonging to a particular account number. For the majority of firms, this information unambiguously identifies the lender since three quarters of the firms in our dataset borrow from one bank only. A quarter of the firms have multiple bank relationships (and 2.36 banks on average). For these firms, we are not able to uniquely identify the bank-firm relationship (and consequently have to take averages across the reported banks when constructing the relevant bank characteristics).

III. Identification Strategy

Do low monetary policy rates at home and/or abroad spur changes in the currency denomination of the credit that is supplied by banks? To address this question one needs to disentangle the impact of the changes in the interest rate on the currency denomination of the supply of credit from changes in the volume of the supply and changes in the quality and the volume of the demand − while accounting for the impact of other key macro variables. This bank supply channel involves compositional changes in the supply of credit at the *bank-firm-currency denomination* level.

Our identification strategy consists of two crucial ingredients: (1) Interacting the change in the interest rate with bank capital and currency denomination, while saturating with firm-time fixed effects; (2) horseracing the interest rate, in its interaction with bank capital and currency

denomination, with the corresponding triple interactions of other key macro variables, in particular GDP growth and inflation.

In essence, our identification scheme follows standard state-of-the-art methodology in the most recent literature (Jiménez, Ongena, Peydró and Saurina (2012), Jiménez, Ongena, Peydró and Saurina (2014)) that builds on, but goes well beyond, the path-setting methodology to identify the effect of monetary policy shocks on banks' loan supply decisions first employed by Kashyap and Stein (2000).

As we are assessing the within-firm credit composition (along currency), first-stage firm-level loan application information as in Puri, Rocholl and Steffen (2011), Jiménez, Ongena, Peydró and Saurina (2012), Berg and Kirschenmann (2014) and Jiménez, Ongena, Peydró and Saurina (2014), for example, would be potentially less informative for our purposes. Given that we focus on the currency denomination of credit granted to a firm in a certain month knowing the currency requested by the firm would be helpful. However, and as far as we are aware, no credit register in the world records this type of information (Miller (2003)) and only one study so far employs information on the currency requested from loan applications made to one bank (Brown, Kirschenmann and Ongena (2014)).

We now discuss the two aforementioned strategy components in more detail, along with our measures of credit granting.

A. Saturation with Fixed Effects and Triple Interactions

Our benchmark specification is a model that explains the extensive margin of the granting of loans in a currency given the firm had no precedent loan in the currency before. We also investigate the ending of lending across currencies and the increase in the amount of different currency lending.

1. Firm-Time Fixed Effects

Given the prominent role of net worth in determining the borrowing by banks from their financiers, and given that the majority of banks may have little capital at stake, expansionary monetary policy by the central bank managing one currency may spur banks into lending in this respective currency but − given imperfect hedging opportunities for either the bank and/or its financiers − not necessarily (or at least not to an equal degree) in other currencies.

However, this testable prediction can also be consistent with demand channels, in particular with the firm balance sheet and the interest rate channels of monetary policy (Bernanke and Gertler (1995)). Therefore, to suppress concurrent changes in the type (along balance sheet strength or export opportunities, for example) and volume of the firm demand for credit, we saturate our benchmark specifications with firm-time fixed effects. Observed and unobserved time-varying firm characteristics that are accounted for in this way include the net present value of firm projects, export and investment opportunities, agency problems, risk, pledgeable income and collateral. Our saturated specifications also account for the endogeneity of bank loan supply when changes in macroeconomic conditions affect banks' lending decisions indirectly, by altering the performance and profitability of borrowing firms. In our saturated specifications, identification comes from comparing changes in lending by one or more banks (that are different with respect to their capital-to-asset ratios) in the *same* month to the *same* firm in different currencies.[21] Only a quarter of the

[21] Note that our third panel dimension (that we need for the inclusion of firm-time fixed effects) is the currency dimension. Unlike recent research analyzing loan applications made by firms to different banks (Jiménez, Ongena, Peydró and Saurina (2012)), Jiménez, Ongena, Peydró and Saurina (2014)), we do not observe multiplicity in the firm-bank relationship dimension.

firms deal with multiple banks,[22] so in robustness we break out the single-bank firms for which we know the exact bank – firm exposure.

In our most robust specifications, firm-time fixed effects also account for the possibility that assortative matching between firms and banks generates bank-specific currency loan demand. Firms exporting to specific destination markets may borrow from banks that specialize in those markets (Paravisini, Rappoport and Schnabl (2014)), therefore currency-specific loan demand may be correlated with bank characteristics. Firm-time fixed effects in estimations on a subsample of single-bank firms will control for such demand characteristics as long as bank-firm relationships are stable over time, i.e., do not change within a period of few months. Nevertheless, we account for the possibility that over time banks' specialization in different industries or export destination markets results in assortative matching by using a subsample of non-exporting firms to identify our results.

2. Triple Interaction of Interest Rate, Bank Capital Ratio, and Currency Denomination

Given the set of fixed effects, identification of a bank lending channel comes from exploiting the testable prediction that when the monetary policy rate decreases for one particular currency, banks with lower net worth will react more by lending more in this currency than banks with higher net worth. Therefore, it is essential to have a sharp measure for the intensity of the agency conflict that besets banks' own borrowing from their financiers. The bank capital-to-assets ratio is such a

[22] Hence multiple firm-bank relationships are much less commonly observed in Hungary than in Spain and Italy for example. In Ongena and Smith (2000) the mean number of relationships for (large) firms in Hungary equals 4, while in Spain and Italy it equals 10 and 15, respectively.

measure (Holmstrom and Tirole (1997)). The ratio is also particularly meaningful in Hungary because off-balance sheet activity by banks has been almost non-existent.[23]

To identify the "currency composition channel" of monetary policy we interact the change in the interest rate with the lagged bank capital ratio (in the spirit of Kashyap and Stein (2000)) and a dummy variable indicating the currency of the bank-firm exposure. When explaining new credit granted or credit growth we expect a negative sign for the estimated coefficient on this triple interaction term: When the domestic interest rate decreases, banks with a lower capital ratio are less likely to grant more credit in the foreign currency. However if the different currencies are substitutable for banks (through e.g. hedging), this estimated coefficient should be close to zero, while if lending in a foreign currency is perceived to facilitate extra risk taking the estimated coefficient may even be positive (or at least less negative).[24]

Our identification strategy relies on the assumption that the distribution of firms with respect to capitalization is similar in the two groups of borrowers granted loans by highly versus lowly capitalized banks. Table I presents foreign currency lending patterns by firms and bank characteristics. It reveals that local banks tend to lend more in foreign currency relative to foreign banks, however highly and lowly capitalized banks have similar loan portfolios in our sample.

[23] Banks in Hungary did not develop conduits or Structured Investment Vehicles (SIVs). Total bank assets therefore cover most of the banks' business. Securitization is also not practiced and therefore cannot be a significant motive for lending in the foreign currency.

[24] In this case the bank's lower net worth (or "skin in the game") could lead to more foreign currency lending. Indeed, analyzing banks' lending patterns in Hungary, Vonnák (2014) finds that domestic, lowly capitalized, less liquid and less profitable banks lend with higher relative probability in foreign currencies, especially Swiss Franc. Relatedly, Ongena, Popov and Udell (2013) provide evidence that foreign banks may engage in risky lending in domestic markets, especially when entry barriers and restrictions on non-core bank activities in domestic markets are low. Notice that banks' engagement in risky foreign currency lending may coincide with more risky lending in the domestic currency and that lending in a foreign currency not necessarily involves more risk-taking (Dell'Ariccia, Laeven and Marquez (2011)).

[Insert Table I here]

In accordance with the focus of our analysis, we cluster standard errors at the firm level.[25] Clustering at the firm and time level at a frequency lower than year-month maintains our main findings, while likely due to the high frequency of most variables' series clustering at the firm and year-month level robs *all* the estimated coefficients of their statistical significance.[26]

B. Horseracing Triple Interactions

1. Interest Rate

Banks are mostly funded by short-term debt, the interest rates of which will likely respond to changes in the monetary policy rate. As in Angeloni, Kashyap and Mojon (2003), we employ the yearly change in a three-month interest rate, for Hungarian Forint exposures on a Hungarian government bond, and for euro lending on a generic government bond. For Swiss Franc lending we use the annual change in the Swiss 3-month LIBOR interest rate.[27] For all three interest rates our sample period spans a full yet (across-interest-rates) distinct cycle and corresponding changes in the foreign exchange rate (see Figure 4).

[Insert Figure 4]

[25] Banks may prefer to lend in a currency in which the firm has revenues for example (even though revenue currency denomination may not always be fully observable, potentially leading to more foreign currency credit as in Brown, Ongena and Yeşin (2014)).
[26] Clustering at the main bank level (as in e.g. Jiménez, Mian, Peydró and Saurina (2014)) throughout the analysis is impossible as we do not know the respective bank shares of the credit exposures.
[27] We use a three-month interbank rate because there is no three-month Swiss Treasury bill or government bond. We rerun all key exercises with the relevant three-month interbank rate from the three currency areas but results are unaffected.

2. Other Key Macro Variables

Despite the predominance of banks' short-term funding, their lending could also be affected by other key macro variables. Hence, the third crucial component in our identification strategy is to concurrently account for the effects of changes in GDP growth and prices as the main determinants of the monetary policy rate (but which may also capture firm investment opportunities and pledgeable income) and other aggregate variables including changes in exchange rate and foreign direct investment. We therefore horserace the triple interaction of changes in GDP growth, prices and other macro variables, with bank capital and currency denomination, with the equivalent triple interactions with the monetary policy rate.[28]

Given their correlation with the interest rate, these macro variables in triples also feature as controls, to the extent that the firm-time fixed effects did not already soak up relevant macroeconomic variation.

IV. Methodology and Variables

A. Model Line-Up

This Section presents and discusses our estimates. We estimate models with as dependent variables new credit granted (extensive margin), ending credit (extensive margin) and increase in

[28] We also run specifications dropping GDP growth and inflation as well as the corresponding double and triple interaction terms of these variables from the regression. Coefficients of the interest rate variable and its interaction terms remain both statistically and economically significant.

the credit amount granted (intensive margin). To stepwise saturate with fixed effects and make robust inferences, we employ linear probability models.[29]

The sample period goes from January 2005 to December 2011. The total number of observations (i.e., total firm – credit in currency – year:month) equals 36,661,233, but given computing constraints the regressions in Tables III to VIII employ a 10 percent random sample of firms.[30] Table II presents the summary statistics. Summary statistics for banks (firms) are based on the average values of the bank (firm) characteristics over the sample period. The number of banks in our sample is 39.[31] The number of firms in our sample is 318,411.

B. Specification and Dependent Variables

The complete model before saturation with firm-time fixed effects, which is e.g., Model (5) in Table III, equals (in abridged form):

$$(1) \qquad \text{CREDIT}_{ikt} = \alpha_i + \alpha_t + \beta IN\ FX_{ikt} + \delta \Delta INTEREST\ RATE_{t-1} * IN\ FX_{ikt} + \gamma\ \Delta INTEREST\ RATE_{t-1} * BANK\ CAPITAL_{it-1} * IN\ FX_{ikt} + Controls + \varepsilon_{ikt}$$

[29] Given the extensive sets of fixed effects we include and as we are primarily interested in the estimated coefficients on the triple interactions (as the next sections explain), we employ linear probability models (Ai and Norton (2003); Norton, Wang and Ai (2004)). In further unreported robustness exercises we also run probit models at the quarterly level that only include time (i.e., year:quarter) fixed effects. The higher level of aggregation and the exclusion of firm fixed effects is necessary for estimations to be technically feasible. Results are similar however.

[30] Our 10 percent random sample does not suffer from the problem of overrepresentation of short-lived firms. The mean life span of firms in the population and our random sample, in any given month, is approximately the same.

[31] With one exception, all banks offered both Hungarian forint and foreign currency loans during the sample period.

The dependent variable is a measure of the $CREDIT_{ikt}$ granted to firm *i* in currency *k* in month *t*.[32] For each firm for each year we know the set of banks the firm is having an account with but do not know the individual bank-firm credit exposure, except when the firm maintains only one bank which ("fortunately" in a sense) happens in 74 percent of the cases.

We first focus on the extensive margin of new credit, i.e., *New Granting of Credit*, which equals one if firm *i* receives credit in currency *k* in month *t*, conditional on having no debt in currency *k* in month *t-1*, and equals zero otherwise. Later we assess the ending of credit and growth in amount with two additional dependent variables: *Ending Credit* which equals one if firm *i* receives no more credit in currency *k* in month *t*, conditional on having received some credit in currency *k* in month *t-1*, and equals zero otherwise;[33] and *Increasing the Amount of Credit* which equals one if the nominal amount of credit firm *i* holds in currency *k* in month *t* exceeds the nominal amount of credit in currency *k* in month *t-1*, and equals zero otherwise.

Analyzing the extensive margin of new credit in a binary manner has several advantages. Such an analysis is comprehensive, comparable and directly interpretable across all loan types and conditions, it avoids having to adjust for exchange rate changes (which could create spurious correlations in our estimations), and it is least affected by the continuous decrease in firm-bank exposures, according to their contracted repayment schedules. We will therefore also investigate in robustness the extensive margin of ending credit and the intensive margin of increasing credit.

[32] We also run specifications on a quarterly sample and find that the effect of the interest rate change on the likelihood of credit granting per quarter is four times the monthly effect, confirming the results we obtain from the analysis of monthly data.

[33] For most firms, the variable is equal to one when the firm repays all of its debt and does not take a new loan.

The main independent variables are IN FX_{ikt},[34] the abridged label for *Credit Is Granted in Foreign Currency*, which equals one if the credit to firm *i* in month *t* is in currency *k* which is a foreign currency, and equals zero otherwise, ΔINTEREST $RATE_{t-1}$ is the annual change in the relevant three month interest rate at *t-1*,[35] and BANK $CAPITAL_{it-1}$ is the capital ratio at time *t-1* defined as the ratio of bank equity and retained earnings over total assets of the set of banks granting the credit to firm *i*.[36] These latter two variables are discussed more at length in the next section.

We are interested in the three coefficients, i.e., β, δ and γ, the coefficients on currency denomination and its double and triple interactions with the interest rate, and the interest rate and bank capital. The specification further loads in firm- and time fixed effects (represented by α_i and α_t), and as controls include the following sets of variables: (1) the triple interactions of the change in GDP and inflation, respectively, with bank capital, and currency denomination; (2) bank capital ratio, size, liquidity, profitability and non-performing loans; (3) firm capital ratio, size, liquidity, profitability and export sales ratio and (4) in specifications with no time fixed effects the changes in the exchange rate, foreign direct investment, sovereign credit default swap spread and yield curve.

[34] An alternative notation would be to use α_k instead of β IN FX_k and interpret it as a currency dummy or currency fixed effect.

[35] We also run specifications replacing the one-month lag of the interest rate with its two-, three-, four-, five-, or six-month lags. Results are similar. Furthermore, we run specifications including up to four lags of the interest rate variable as well as interactions between each lag, bank capitalization, and currency denomination of the loan. We find that the sum of the coefficients on the double and triple interaction terms are both statistically and economically significant, and their sum similar in magnitude to those we report on the first lag.

[36] BANK CAPITAL denotes the average capitalization of the set of banks the firm has an account with. Consequently, the variable is firm-specific and we use the subscript *i* in notation. Since 74 percent of the firms in our sample maintain only one bank relationship, for most observations the variable is both firm- and bank-specific.

C. Main Independent Variables

1. Short-Term Interest Rate

The main variable of interest in our analysis is the yearly change in the three-month Forint interest rate that we measure by the yield on the three-month Hungarian government bond rate. The average change in the three-month interest rate during the sample period is -0.73 percentage points and it varies between -5.29 percentage points and 4.25 percentage points. To proxy for monetary policies from the other central banks that issue the currencies that are employed often, we also use the yearly change in three-month interest rates from the Eurozone and Switzerland. The Euro interest rate is based on the average yield on the three-month Euro benchmark government bonds while the Swiss interest rate is the three-month Swiss interbank rate. The average Euro and Swiss three-month interest rates in the sample period are -0.19 percentage points and -0.05 percentage points, respectively. The former varies between -3.91 percentage points and 1.25 percentage points, the latter between -2.73 percentage points and 1.19 percentage points. Definitions and summary statistics of all variables are in Table II.

[Insert Table II here]

To comprehensively account for changes in domestic GDP growth and inflation (Taylor (1993)), we include both variables at all levels of interaction where the domestic interest rate is also featured.[37] The average GDP growth rate in Hungary during the sample period was 0.80

[37] Alternatively, we run the interest rate first on GDP growth and inflation and employ the residuals of this regression rather than the interest rate itself. Results are very similar (and obviously independent of whether we then also feature in the second step GDP growth and inflation as independent variables). These results hold for both three-month government bond and interbank interest rates.

percent ranging between -8.00 percent and 4.70 percent, while average inflation was -0.40 percent, ranging between -1.05 and 6.73 percent. Additional macro controls are the annual change in the nominal effective exchange rate index of the Forint, foreign direct investment captured by the annual change in the amount of currency reserves at the Central Bank of Hungary, the annual change in the CDS rate on 5-year Hungarian sovereign bonds, and the annual change in the difference between 10-year and 1-year government bond yields.[38] The macro variables are available monthly, except for GDP growth and currency reserves, which are measured quarterly. For interim months, we use the end-of-quarter GDP growth rate and currency reserve values.

2. Bank Capital Ratio

Our key bank balance-sheet variable is the *Bank Capital Ratio* defined as the ratio of bank equity over total assets.[39] This ratio is a proxy for the bank's ability to obtain funding from its own financiers (Holmstrom and Tirole (1997)) and lend in the currency of the interest rate change ("bank balance sheet channel") but at the same time also for bank moral hazard (i.e., more "skin in the game" may deter 'other' currency lending if that is riskier). The average bank capital ratio during the sample period is 12.76 percent.[40]

We include as control variables a number of bank characteristics that capture the time-variation in banks' loan supply.[41] In particular, we use the natural logarithm of total assets (*Bank*

[38] In unreported regressions, we also include the annual change in the one-year forward exchange rate as a control variable. Results are robust to controlling for the EUR/HUF and/or CHF/HUF forward exchange rates.

[39] Consistent with the literature, for bank subsidiaries we use local subsidiary rather than bank-group-level capital ratios (see, for example, Kashyap and Stein (2000)). Nevertheless, we test the robustness of our findings to a redefinition of the bank-capital variable and estimate our main specifications using group-level capital ratios. Results do not change.

[40] For a few branch offices of foreign banks, the bank capital ratio takes negative values. In our final sample, observations with negative bank-capital ratio represent less than 0.03 percent of the total number of observations, and removing these few observations does not alter our main findings.

[41] As noted before our data does not allow us to identify the individual bank-firm exposures when firms maintain multiple banks. Multiplicity occurs in around a quarter of the observations. We then simply average bank characteristics across the firms' banks.

Total Assets) to proxy for bank size and the ratio of liquid to total assets (*Bank Liquidity Ratio*) to measure bank liquidity. We also include the *Bank Return on Assets* to measure profitability,[42] and the *Bank Doubtful Loan Ratio* to proxy for the current non-performance and riskiness of the bank's portfolio. We note that the firm fixed effects we include also control for the average time-invariant characteristics of the banks the firms maintain.

All bank balance-sheet and income statement variables are available at the monthly frequency. Balance-sheet variables for month *t* are proxied by their values at the end of month *t-1*, while bank performance variables for month *t* are the annualized values of their values measured over month *t-1*.

D. Control Variables Including Fixed Effects

To control for the variation in the amount and quality of loan demand faced by the banks, we also include a set of firm characteristics, as well as firm and firm-time fixed effects in our specifications (with time equal to year:month).[43] In particular, in all regressions without firm-time fixed effects, we include the *Firm Capital Ratio* measured by the ratio of the firm's equity capital to total assets, the natural logarithm of the firm's total assets (*Firm Total Assets*), the *Firm Liquidity Ratio* measured by the ratio of current to total assets, the *Firm Return On Assets* that equals to the firm's net income over total assets, as control variables. To capture foreign linkages, we also use the *Firm Export Sales Ratio* calculated as the ratio of export sales to total sales.

[42] Table II shows that the average bank in our sample has zero return-on-assets. Indeed, banks operate with large balance sheets compared to pretax profits that turn out to be negative in some years during the sample period.

[43] When the sample includes only single-bank firms, the firm-time fixed effects also account for all observed and unobserved heterogeneity at the bank-time level, e.g., changes over time in technology and business model in each individual bank.

Firm characteristics are available at yearly frequency. For each month in a given year, our firm-level balance-sheet variables are proxied by their values taken at the end of the preceding year, while income statement variables are proxied by their values measured over year *t-1*.

V. Results

A. Effect of Domestic Monetary Policy on the Composition of Loan Supply

1. Domestic versus Foreign Currency Credit

We start analysing the effect of domestic monetary policy on banks' loan supply decisions focusing on domestic vis-à-vis foreign currency loans, without distinguishing between firms' exposures in Euro and Swiss Franc. We focus on the extensive margin of lending by examining the effect of monetary policy on changes in the likelihood of banks' first-time credit granting in a certain currency (i.e., the extensive margin of new credit, henceforth abridged as "credit initiation").

Table III presents our first results. Models 1 to 4 provide a step-by-step development towards the base specification which is Model 4 and which includes all relevant interaction terms for the interest rate, GDP growth, and inflation. The estimated coefficients of the domestic interest rate variable are highly significant in all models and have the expected negative sign suggesting that an interest rate decrease expands credit. In addition, Model 2 shows that the coefficient of the interaction of the interest rate with the bank capital ratio is statistically significant and takes a positive sign implying that a lower interest rate boosts credit granting especially by banks with low capital-to-asset ratios. This estimate is consistent with the existence of a bank-lending channel in Hungary, similar to the U.S. (e.g. Kashyap and Stein (2000)) and Spain (Jiménez, Ongena, Peydró and Saurina (2012)).

The bottom panel in Table III presents the economic relevance of the estimated coefficients. A 25 basis point decrease in the domestic interest rate increases the likelihood of initiating credit by a lowly capitalized bank 0.019 percentage point more than by a highly capitalized bank (if we take the difference between low and high capitalization to be equal to two standard deviations of the sample capitalization ratio). The estimated effect is thus economically significant, taking into account that the sample probability of new credit for any firm is 0.23 percent implying a semi-elasticity of the difference in loan granting between lowly and highly capitalized banks of 8 percent.[44] Notice that this estimated elasticity is more than five times larger than the roughly one percent differential effect of a 25 basis point change in the interest rate on the likelihood of loan granting between lowly and highly capitalized banks documented by Jiménez, Ongena, Peydró and Saurina (2012).[45] This difference in estimated elasticity suggests that, when banks grant loans in different currencies, the supply of credit in each currency (so defined) reacts most vigorously to changes in monetary conditions.

[Insert Table III here]

We next study the compositional effect of monetary policy on banks' loan supply decisions in Models 4 to 7. The estimates in Model 4 show that the differential impact of an interest rate change between lowly and highly capitalized banks is magnified when lending occurs in the

[44] In robustness we will assess if the low probabilities involved make inference problematic (*à la* King and Zeng (2001) and King and Zeng (2006)).

[45] Jiménez, Ongena, Peydró and Saurina (2012) find that a 100-basis point decrease in the interest rate increases loan granting by lowly capitalized banks by 3.9 percent more than by highly capitalized banks, where the difference in bank capitalization is defined as the difference between the tenth and ninetieth percentiles of the distribution. Other differences between their and our setup include the sample (i.e., they study loan applications) and method of identification (i.e., they rely on loan fixed effects).

domestic currency and minimized when lending occurs in a foreign currency. The same result is obtained in Model 5, which includes time – i.e., year:month – fixed effects, in addition to the firm fixed effects that were present in Models 1 to 4. Model 4 shows that a 25 basis point decrease in the domestic interest rate generates a 0.029 percentage point higher likelihood of credit initiation by a lowly- than by a highly capitalized bank when credit is granted in the domestic currency (Hungarian Forint). This differential impact represents 13 percent of the probability of credit initiation in the sample and is thus economically relevant. Model 5 indicates that the estimated economic effect is even higher – 14 percent of the sample probability of granting first-time credit – when, besides firm fixed effects, we also include time fixed effects in the regression. Coefficients on triple interaction terms including the interest rate variable in Models 4 and 5 show, however, that when lending takes place in a foreign currency, the economic impact of bank capitalization on the likelihood of first-time credit granting is almost insignificant. According to Model 4 (Model 5), a 25 basis point decrease in the domestic interest rate generates a differential impact between low and high capitalization banks that equals only 4 percent (5 percent) of the unconditional probability of initiating credit in the sample.

Models 6 and 7 saturate the empirical specification with firm-time fixed effects that account for all time-varying firm-specific heterogeneity in loan demand (volume and quality). The estimated coefficients on the triple interactions of the interest rate, bank capitalization, and currency denomination, indicate that the differential impact of interest rate changes along capitalization on credit initiation in domestic and foreign currency is robust to accounting for all time-varying firm heterogeneity in loan demand. The bottom panel in Table III shows that the size of the difference in the economic impact between the domestic and foreign currencies equals 8 and 4 percent, respectively. The two models differ in the sample employed: Model 7 restricts the

sample to firms with only one bank relationship (making the bank singularly identifiable), which represent 74 percent of all firms in our sample. Model 7 reveals that our results on the currency compositional effect of monetary policy are robust to the restriction of our analysis to one-bank firms.

Concerning the effects of other key macro variables, Table III confirms the economic relevance of GDP growth and CPI inflation in banks' loan supply decisions. Model 1 shows that both GDP growth and inflation have negligible aggregate effect on credit granting. Model 2, however, indicates that there is heterogeneity in how banks respond to changes in these macroeconomic variables. High GDP growth and low inflation boost credit granting by lowly capitalized banks, while reduce lending by highly capitalized banks. This finding corresponds to results in Jiménez, Ongena, Peydró and Saurina (2012) suggesting that GDP growth increases the probability of loan granting by Spanish banks. Estimates on the triple interactions of the GDP growth or inflation variables, bank capital, and the foreign currency dummy in Model 4 suggest that the differential impacts of changes in GDP growth and inflation between lowly and highly capitalized banks are magnified when lending occurs in the domestic currency and minimized when lending occurs in a foreign currency. Models 5 to 7 show that these results are robust to the inclusion of time fixed effects or firm-time fixed effects.

Overall, the results of Models 4 to 7 suggest that there is also a compositional effect in banks' loan supply decisions when responding to a change in the domestic interest rate: Expansionary monetary policy increases the likelihood of credit initiation in the domestic currency but banks' foreign currency lending is essentially unaffected. Put differently, the bank lending channel of the domestic monetary policy loses its potency when it comes to the supply of credit in the foreign currency.

2. Robustness: Other Macroeconomic Conditions, Asymmetric and Non-linear Effects, Bank Characteristics and Sample Splits

In this robustness section we first examine whether, besides GDP growth and inflation, banks' loan supply decisions are sensitive to shocks in other macroeconomic variables. In particular, we horserace triple interactions of bank capital, currency denomination, and various macroeconomic variables, including, besides GDP growth and inflation, the nominal effective exchange rate, the amount of foreign direct investment, and the credit default swap spread in the country.

The estimates in Models 1 and 2 in Table IV suggest that neither changes in the exchange rate nor changes in foreign direct investment affect the currency composition of credit granting.[46] Inclusion of triple interactions of the three macro variables with bank capital and currency denomination does not alter our findings regarding the differential supply effects of monetary policy. The difference in the economic impact between the domestic and foreign currencies is 13 and 5 percent, similar in magnitude to the differential impact obtained in our baseline specifications (see Models 6 and 7 in Table III).

To test the sensitivity of our results to changes in the macroeconomic shock variable, in unreported regressions we also include either one of two regulatory dummies. The first dummy equals one after 2008:01, the introduction of Basle II, and equals zero before. The second dummy equals one after 2008:09, when Swiss Francs lending by banks to households was no longer allowed, and equals zero before. These dummies are introduced at all levels, including the triple interactions with bank capital and the currency of exposure. But results on the triple interactions with the interest rate are unaffected in both cases.

[46] To conserve space in Table IV we focus on firms' aggregate foreign currency exposures without distinguishing between Euro and Swiss Franc loans (as we will do in the next section) and we present only the most saturated specification that includes firm-time fixed effects. Results are unaffected when splitting up by currency as the next section will show. To conserve space we henceforth also only report the estimated semi-elasticities.

[Insert Table IV here]

To test for the asymmetric impact of the interest rate, we replace the change in the interest rate with relevant interactive terms,[47] i.e., the interactions of the change of interest rate with (1) a dummy variable that equals one if the change in the interest rate during the previous month was larger than or equal to zero (and equals zero otherwise) and (2) a dummy variable that equals one if the change in the interest rate during the previous month was smaller than zero (and equals zero otherwise). The estimated coefficients on the resultant quadruples remain qualitatively similar, but it is especially the lowering of the domestic interest rate that has the most pronounced differential impact on domestic versus foreign currency lending. We also include squared terms (of the changes in the interest rate in all relevant interactions) but find no significant second order terms. To conserve space we choose not to report these specifications (that load in these extra terms and become somewhat unwieldy to present).

To control for the macroeconomic environment more completely, in unreported regressions we include changes in the Euro area and Swiss GDP growth rates and inflation as well as their full set of double and triple interactions with bank capitalization and currency denomination, to control for effects of other foreign macroeconomic aggregates. In other regressions we also include squared and cubed terms of the interest rate change, GDP growth and inflation and their interactions with bank capitalization and currency denomination in order to control for non-linear

[47] Our methodology is standard and similar to e.g. Thoma (1994) and Weise (1999). They find no asymmetric effects of monetary shocks on prices or output.

co-movements of these macro variable with the interest rate change. Our results remain robust in all cases.

So far we have focused on bank equity to total bank assets as the only bank balance-sheet characteristic that may affect changes in banks' lending decisions following monetary shocks (Holmstrom and Tirole (1997)). We now alter the measurement of bank capital and also follow the previous literature by examining whether bank size (the natural logarithm of bank assets) and bank liquidity (the ratio of liquid to total bank assets) also affect the impact of interest rate changes on banks' loan supply. Furthermore, we examine whether bank foreign ownership matters.

In Models 3 and 4 we employ as an alternative to the Bank Capital Ratio the (one-month lagged) Bank Regulatory Capital Ratio which is defined as regulatory capital over risk-weighted assets. The reasons for this replacement are twofold. First, bank capital is the outcome of strategic choices made by the bank, and even when pre-determined in time endogeneity concerns may linger. Regulatory capital suffers (somewhat less) on this account. Second, Popov and Udell (2012) for example document that especially regulatory capital constraints determine bank lending. Our results remain robust however to the choice of bank capital measure. Alternatively in further unreported regressions we also instrument the Bank Capital Ratio with for example one and two-quarter lags of the Bank Regulatory Capital Ratio (and/or lags of the bank capital ratio itself). Again results are very similar.

In Models 5 and 6 we follow Kashyap and Stein (1995) and focus on the impact of monetary shocks on the supply of loans by banks of different size, measuring bank size by total assets. The estimated coefficients of triple interactions of the interest rate change, bank size, and currency denomination are all insignificant suggesting that following monetary shocks there is no currency compositional effect in the supply of loans identifiable from the adjustment of banks of different

size. In Models 7 and 8 we add the Bank Capital Ratio and its interactions and observe that the estimated coefficient on the triple interaction term that includes the bank capital ratio is statistically significant and economically large, while the triple term that includes Bank Total Assets is at best marginally significant and is always economically very small.

In Models 9 and 10, inspired by Kashyap and Stein (2000)) or Jiménez, Ongena, Peydró and Saurina (2012), we examine the impact of monetary shocks on the supply of credit by banks with different liquidity ratios. The estimates suggest a differential impact of interest rate changes along the bank liquidity characteristic. Estimates of Model 9, for example, indicate that when credit is granted in the domestic currency a 25 basis point decrease in the domestic interest rate generates a 5 percent larger difference (measured by the semi-elasticity of the coefficient) in the impact on the likelihood of credit granting between banks with low and high liquidity ratios, than when credit is granted in the foreign currency. In Models 11 and 12 we horserace the bank capital ratio with liquidity. The estimates indicate it is especially the bank capital ratio that drives adjustments in banks' loan supply decisions following monetary changes.

Because foreign ownership may affect banks' own funding across currencies differentially we horse race the bank capital ratio with foreign ownership in Models 13 and 14.[48] The estimated

[48] Global banks manage liquidity on a global scale actively using cross-border internal funding in response to local shocks (Cetorelli and Goldberg (2012)). Having global operations therefore insulates banks from changes in local monetary policy, while banks without global operations are more affected by monetary policy. Another issue may arise if foreign owned banks have more foreign currency-denominated liabilities on their balance sheets. A decrease in the Forint interest rate may then affect their capital-to-assets ratio through its effect on the exchange rate with the Forint. The Forint depreciation will increase the Forint equivalent of the value of foreign currency denominated liabilities on the banks' balance sheets and may concurrently decrease the capital-to-assets ratios of these banks. However all our specifications employ a one-month lagged capital ratio and in previous models this ratio was replaced or instrumented with one- and two- quarter lags of the regulatory capital ratio. In general foreign banks may follow a different business model (e.g., Giannetti and Ongena (2009), Gormley (2010), Beck, Ioannidou and Schäfer (2012), Giannetti and Ongena (2012)) than domestic banks which may change their sensitivity to changes in monetary conditions (see similarly Zaheer, Ongena and van Wijnbergen (2013) on Islamic banks and Morck, Yavuz and Yeung (2013) on state-owned banks).

coefficients on foreign ownership are not statistically significant while the estimated coefficients on the triple interaction term with bank capital ratio again imply that when credit is granted in the domestic currency, a 25 basis point decrease in the domestic interest rate generates a 7 and 5 percent larger difference (again, measured by the semi-elasticity of the coefficients), respectively, in the impact on the likelihood of credit granting between banks with low and high capital ratios, than when credit is granted in a foreign currency.[49] In Model 1 in Table V we further split the sample by foreign ownership of banks and find similar estimated coefficients on these triple interactions of interest.

[Insert Table V here]

Next we study the period before and after the filing for bankruptcy by Lehman Brothers in 2008:09, which is now commonly considered as the start of the most acute phase of the global financial crisis that eventually also spread to Hungary. Models 3 and 4 contain the estimated coefficients from the period before Lehman. The difference in potency between the lending channels in domestic and foreign currency is larger than for the entire period. For the short period after Lehman none of the estimated coefficients are statistically significant (further unreported).[50]

[49] The estimated coefficients on foreign ownership are also not statistically significant when the bank capital ratio is not included. As an alternative for foreign ownership we also impute from the Swiss Franc Lending Monitor dataset (also used in e.g. Krogstrup and Tille (2014)) and from Hungarian bank regulatory reports the quarterly varying currency composition of the balance sheet of the average bank from Austria, Germany, France, Italy, or Hungary, and assign these values to the banks in our dataset that are headquartered in these countries. But we find no statistical significance on the terms of interest, which may be due to the likely substantial measurement error involved.

[50] There are a number of potential explanations for this lack of statistical significance: (1) Banks may have substantially changed their lending policies if not voluntarily (e.g., Cetorelli and Goldberg (2011), de Haas and van Lelyveld (2014)) then various regulatory limits may have become binding (Rosenberg and Tirpák (2009)); (2) due to unconventional monetary policies changes in short-term interest rates may have become less representative of changes in monetary conditions; and/or (3) the subsample period may be simply too short to yield statistically significant estimates.

One explanation for this lack of significance is that from 2009 lending in CHF essentially disappears in Hungary. This makes the identification of the effect of policy changes on the currency composition of loan supply a challenging task simply because the number of observations where lending takes place in a foreign currency becomes substantially lower.

In Models 5 and 6 we focus our analysis on the 50 percent largest firms by total assets (the 50 largest percent by number of employees yields similar results). We are interested if the economic relevancy of the difference in potency between the two channels also pertains to these large firms.[51] It does, making the observed phenomenon also relevant in an aggregate sense. Indeed, our results hold in the subsamples of both large and small firms.[52]

Finally, in Models 7 and 8 in Table V we analyse a subsample of non-exporting firms to assess whether our results are driven by non-random matching between firms and banks. Banks' specialization in different industries or export destination markets may result in assortative matching between firms and banks (Paravisini, Rappoport and Schnabl (2014)) and this may generate differential supply effects for banks with low and high capitalization ratios. Our results, however, hold in the subsample of non-exporting firms, suggesting that the currency compositional supply effect we identify is not driven by the selection of exporting firms to specific types of banks.

[51] We also assess results across EU and various other firm-size categorization schemes. Results are similar except for some largest-size classes. However, given the continuous financing needs of the largest firms, changes on their extensive margins of borrowing are also less frequent (potentially leading to less statistical significance). Notice that some small business owners in Hungary are thought to have personal bank accounts in Switzerland or the Euro area, making their (for us un-observable) personal financial situation potentially an omitted variable. We expect this effect to play less of a role for large firms.

[52] The results for the subsample of small firms are available from the authors upon request.

3. Domestic versus Euro and Swiss Franc Credit

We continue analysing the effect of domestic monetary policy on banks' loan supply decisions now distinguishing between Euro and Swiss Franc loans. Again, we focus on the extensive margin of lending and analyse banks' first-time credit granting decisions.

Table VI presents our estimates. Models 1 to 7 in Table VI are equivalent to the similarly numbered models in Table III, except that in the specifications of Table VI, the dummy variable *"Credit is Granted in Foreign Currency"* is decomposed into two distinctive dummy variables, *"Credit is granted in Euro"* and *"Credit is granted in Swiss Franc"*. This decomposition allows us to investigate whether the impact of monetary policy on the supply of credit depends on a specific foreign currency denomination or not.

[Insert Table VI here]

The results confirm the evidence presented in Table III. The estimates of Model 2 in Table VI for example again imply that a 25 basis point decrease in the domestic interest rate generates a statistically significant and an economically relevant difference (of 8 percent) between lowly and highly capitalized banks in the likelihood of initiating credit, confirming our earlier evidence of the existence of a domestic bank-lending channel.

Furthermore, the coefficients of Models 4 to 7 again indicate that an interest rate decrease affects credit initiation by banks to a greater extent when credit is granted in the domestic currency than when lending occurs in Euro or Swiss Franc. According to Model 5 that incorporates both firm and time fixed effects, a 25 basis point decrease in the domestic interest rate results in a 0.03 percentage points higher likelihood of credit initiation by lowly than by highly capitalized banks

when credit is granted in the domestic currency. The economic impact accounts for 19 percent of unconditional probability of credit initiation in the sample. When credit is granted in Euro or Swiss Franc, the equivalent differential effects are 4 and 5 percent, respectively, again suggesting a difference in the impact of domestic monetary policy on bank lending in the domestic and foreign currencies, but not between the two foreign currencies considered. The magnitudes of the estimated differential effects implied by the coefficients of Models 6 and 7, presented in the bottom panel of Table VI, confirm this conjecture. Overall, Models 4 to 7 in Table VI confirm our evidence of a currency compositional effect of domestic monetary policy on bank loan supply for this extensive margin of lending.

4. Further Robustness: Other Margins of Lending

So far we have focused on the positive extensive margin of lending by analysing banks' first-time credit granting decisions. To check our results concerning the compositional effects of monetary policy on banks' loan supply decisions, in this section, we consider other margins of lending. In particular, we consider the likelihood of banks' ending credit (negative extensive margin) and the likelihood of banks' increasing credit (intensive margin) in the domestic and foreign currencies.

[Insert Table VII here]

The regressions of Models 1 to 4 in Table VII focus on the impact of monetary policy on banks' decisions to end credit to borrowing firms. In Model 1, we include firm fixed effects in the regressions to control for firm heterogeneity in loan demand. Model 2 incorporates both firm and time fixed effects, while Models 3 and 4 represent our most saturated specification which includes

firm-time (year:month) fixed effects. The sign of the triple interactions of the variables *Interest Rate Change, Bank Capital Ratio,* and *Credit is Granted in Euro* (or *Credit is Granted in Swiss Franc*) shows that the currency compositional supply effect is present along the negative extensive margin as well. A domestic monetary expansion decreases the likelihood of banks' ending credit, but only when credit is granted in the local currency (Hungarian Forint). The economic significance of the impact of monetary expansion on ending credit in Euro or Swiss Franc is negligible, as shown by the numbers at the bottom of Table VII. These estimates overall provide evidence for the presence of a compositional effect along this particular extensive margin although the effect is statistically weaker (maybe because banks dither to cut firms off credit).

Models 5 to 8 in Table VII examine the impact of monetary conditions on the likelihood of banks' increasing the amount of credit to their borrowers. We find a strong compositional effect of monetary policy on bank loan supply along this intensive margin of lending as well. According to Model 6, when credit is granted in Hungarian Forint following a 25 basis point decrease in the domestic interest rate the difference in the response between banks with low and high capital ratios is 9 percent of the unconditional probability of increasing credit amount. In contrast, when credit is granted in Euro or Swiss Franc this differential impact does not exceed 2 or 1 percent, respectively, of the unconditional probability of increasing credit amount in the sample. The strong significance of the triple interaction terms in Models 7 and 8 indicates that this compositional effect is robust to saturation with firm-time fixed effects.

Finally, we address the concern that the low probability of credit granting and growth makes inference problematic (*à la* King and Zeng (2001) and King and Zeng (2006)). We therefore revisit the entire population of bank-firm exposures and select those firms that were granted a minimum of five loans during the sample period. This set of firms accounts for roughly four percent of the

population. We re-estimate the last two models for this new sample and display the estimates in Columns 9 and 10. If anything the estimated differential impact of interest rate changes are even larger.[53]

Overall, our evidence suggests that, besides affecting banks' first-time credit granting decisions, monetary policy has an impact on the currency composition of loan supply along the negative extensive margin and the (positive) intensive margin as well.

B. Compositional Effect of Domestic versus Foreign Monetary Policy

Besides analysing the effect of domestic monetary policy on banks' local lending decisions in the domestic and foreign currencies, we also consider the effects of monetary policy set by the central banks abroad issuing the foreign currency. Hence, in Table VIII we extend our basic specification by including the annual change in the Euro and Swiss Franc interest rates,[54] as well as the corresponding interactions between interest rates, bank capitalization, and currency denomination. Among the macroeconomic variables the change in the nominal effective exchange rate, i.e., *Δ Exchange Rate*, is replaced by two exchange rates, i.e., *Δ Exchange Rate Hungarian Forint to Euro* and *Δ Exchange Rate Hungarian Forint to CHF*.

Models 1 and 2 in Table VIII present our results concerning the impact of changes in the Euro interest rate while Models 3 and 4 show our results on the impact of the Swiss Franc interest rate on banks' loan supply decisions. Models 5 and 6 include changes in both Euro and Swiss Franc

[53] The larger impact on Swiss Franc lending may be due to differential selection. Estimating a first-stage model selecting for firms with minimum five loans and including the resultant firm-level inverse Mills ratio in various specifications (that therefore do not include firm-time fixed effects) yields smaller (in absolute value) estimates of the triple coefficient of interest.

[54] In unreported regressions, instead of the changes in the three interest rates we include changes in the Hungarian - Euro area and the Hungarian - Swiss interest rate spreads. Results of the currency compositional effects of domestic and foreign monetary policies are unchanged.

interest rates in the specification. Every model in Table VIII includes firm-month fixed effects to control for time-varying heterogeneity in credit demand and thus builds on our (earlier used) most saturated specification.

[Insert Table VIII here]

We present several results concerning the impact of monetary policy on bank loan supply along the extensive margin of lending. First, our earlier findings concerning the effect of *domestic* monetary policy on the composition of domestic loan supply are confirmed by all models.[55] Following a 25 basis point decrease in the domestic interest rate, the estimated semi-elasticities of the differences, between lowly and highly capitalized banks, in credit initiation in Euro and Swiss Franc are 9 to 15 percent lower than the estimated semi-elasticities of the differences in credit initiation in Hungarian Forint. Therefore the results confirm the existence of differential supply effects across the three currencies: Domestic monetary expansion positively affects credit supply in Hungarian Forint, but has a negligible effect on the supply of credit in Euro and Swiss Franc.

Second, we present evidence that monetary changes in the Euro area and Switzerland influence the currency composition of the local supply of credit in Hungary. In Models 1 to 2 of Table VIII, the significance of the coefficients on the triple interaction of the variables *Interest Rate Change in Euro Area*, *Bank Capital Ratio*, and *Credit is Granted in Euro* (or *Credit is*

[55] The mandate of the Central Bank of Hungary is to target domestic inflation and its policy could have reacted to interest rates set by other relevant central banks. By including changes in Euro and Swiss interest rates we in effect also account for these additional elements that may be present in an open economy monetary policy rule. However our findings suggest that at least with respect to the transmission through bank lending, foreign interest rates do not play a significant role in the observed policy reaction function. We think it is also rather unlikely that the European Central Bank or the Swiss National Bank would react directly to policy rate changes in Hungary.

Granted in Swiss Franc) indicate that changes in the Euro area interest rate have differential effects on the local supply of credit in the domestic and foreign currencies. According to Model 1, following a 25 basis point decrease in the Euro interest rate, the differential likelihood of credit initiation, between lowly and highly capitalized banks, is 0.058 (0.042) percentage points higher when credit is granted in Euro (Swiss Franc) than the differential likelihood when credit is granted in Hungarian Forint. This differential effect between the domestic currency and the Euro (Swiss Franc) amounts to 36 (26) percent of the unconditional likelihood of first-time credit granting in the sample.

Furthermore, Models 3 and 4 indicate that changes in the Swiss interest rate also have a significant impact on the currency composition of domestic credit supply. According to Model 3, following a 25 basis point decrease in the Swiss Franc interest rate, the estimated differences in the likelihood of credit initiation between lowly and highly capitalized banks are 0.129 (0.109) percentage point higher when credit is granted in Euro (Swiss Franc) than when credit is granted in Hungarian Forint. The differential effects of changes in the Swiss interest rate on credit granting in the different currencies are also economically significant.

Finally, results in Models 5 and 6 indicate that the significant impact of changes in the Euro area interest rate disappear once we include both foreign interest rates as well as the relevant double and triple interaction terms in the regressions. This is a straightforward consequence of the multicollinearity problem arising from the high correlation between the two foreign interest rates.

Overall, our results in Table VIII show that the differential responses of highly and lowly capitalized banks, to changes in the Euro and Swiss interest rates, differ across the domestic and foreign currencies. Since the economic effects – of a monetary expansion in the Euro area and

Switzerland – are negative and more so for the domestic currency,[56] the results indicate that monetary expansions in the Euro area and Switzerland cause a relative contraction in credit supply in Forint and a relative expansion in the supply of Euro and especially Swiss Franc credit. Therefore, for the local supply of credit not only the domestic monetary policy matters, but also the monetary policy set by the central bank abroad issuing the foreign currency. This indicates the existence of an international (or global) bank lending channel that transmits the impact of foreign monetary policy to the local economy through changing the currency composition of banks' loan supply.

VI. Conclusion

We analyze the differential impact of domestic and foreign monetary policy on the local supply of bank credit in domestic and foreign currencies. We analyze a novel, supervisory dataset from Hungary that records all bank lending to firms including its currency denomination. This paper therefore takes the next obvious step in the empirical literature that identifies – with micro-data – the impact of monetary policy on the provision of credit.

Accounting for time-varying firm-specific heterogeneity in loan demand, we find that a lower domestic interest rate expands the supply of credit in the domestic but not in the foreign currency. A lower foreign interest rate on the other hand expands lending by lowly versus highly capitalized banks relatively more in the foreign than in the domestic currency.

The implications of our findings for monetary policy making are straightforward but salient. Local bank lending in foreign currencies limits the flow of the transmission of domestic monetary

[56] In unreported regressions we find that changes in the Euro and Swiss interest rates result in significantly lower likelihood of credit granting by lowly capitalized banks than by highly capitalized banks and that this differential negative effect is higher when credit is granted in the domestic currency.

policy through a bank lending channel in the domestic currency only. Lending in foreign currencies is seemingly mostly unaffected by domestic monetary policy. On the other hand, monetary policies pursued by central banks abroad may affect local bank lending in these foreign currencies. Changes in foreign monetary policy, therefore, also seems to transmit to local lending, through an international bank-lending channel that changes the currency composition of the local bank loan supply. Overall, these findings suggest that calls for global monetary policy coordination even during normal times are well-founded (though difficult and unlikely given current institutional mandates).

References

Acharya, Viral V.; Gara Afonso and Anna Kovner. 2013. "How Do Global Banks Scramble for Liquidity? Evidence from the Asset-Backed Commercial Paper Freeze of 2007." New York NY: Federal Reserve Bank of New York, Staff Report.

Ai, Chunrong and Edward C. Norton. 2003. "Interaction Terms in Logit and Probit Models." *Economics Letters*, 80(1), 123-29.

Angeloni, Ignazio; Anil K. Kashyap and Benoît Mojon. 2003. *Monetary Policy Transmission in the Euro Area*. Cambridge: Cambridge University Press.

Bank for International Settlements. 2015. "85th Annual Report." Basel: Bank for International Settlements,

Barajas, Adolfo and Armando Méndez Morales. 2003. "Dollarization of Liabilities: Beyond the Usual Suspects." Washington DC: International Monetary Fund, Working Paper.

Basso, Henrique S.; Oscar Calvo-Gonzalez and Marius Jurgilas. 2011. "Financial Dollarization: The Role of Foreign-Owned Banks and Interest Rates." *Journal of Banking and Finance*, 35(4), 794-806.

Beck, Thorsten; Vasso Ioannidou and Larissa Schäfer. 2012. "Foreigners Versus Natives: Bank Lending Technologies and Loan Pricing." Tilburg: European Banking Center, Discussion Paper.

Becker, Bo and Victoria Ivashina. 2014. "Cyclicality of Credit Supply: Firm Level Evidence." *Journal of Monetary Economics*, 62(March), 76-93.

Beņkovskis, Konstantins. 2008. "Is There a Bank Lending Channel of Monetary Policy in Latvia? Evidence from Bank Level Data." Riga: Latvijas Banka, Working Paper.

Berg, Gunhild and Karolin Kirschenmann. 2014. "Funding Vs. Real Economy Shock: The Impact of the 2007-2009 Crisis on Small Firms' Credit Availability." *Review of Finance*, Forthcoming.

Bernanke, Ben S. and Alan S. Blinder. 1992. "The Federal Funds Rate and the Channels of Monetary Transmission." *American Economic Review*, 82(4), 901-21.

Bernanke, Ben S. and Mark Gertler. 1995. "Inside the Black Box: The Credit Channel of Monetary Policy Transmission." *Journal of Economic Perspectives*, 9(4), 27-48.

Bernanke, Ben S.; Mark Gertler and Simon Gilchrist. 1996. "The Financial Accelerator and the Flight to Quality." *Review of Economics and Statistics*, 78(1), 1-15.

____. 1999. "The Financial Accelerator in a Quantitative Business Cycle Framework," J. Taylor and M. Woodford, *Handbook of Macroeconomics.* Amsterdam: Elsevier, 1341-93.

Bijlsma, Michiel J. and Gijsbert T. J. Zwart. 2013. "The Changing Landscape of Financial Markets in Europe, the United States and Japan." Den Haag: CPB Netherlands Bureau for Economic Policy Analysis, Discussion Paper.

Brown, Martin; Ralph De Haas and Vladimir Sokolov. 2015. "Regional Inflation, Financial Integration and Dollarization." Tilburg: European Banking Center Tilburg University, Discussion Paper.

Brown, Martin; Karolin Kirschenmann and Steven Ongena. 2014. "Foreign Currency Loans - Demand or Supply Driven?" *Journal of Money, Credit and Banking*, 46(7), 1313-554.

Brown, Martin; Steven Ongena and Pinar Yeşin. 2011. "Foreign Currency Borrowing by Small Firms in the Transition Economies." *Journal of Financial Intermediation*, 20(3), 285-302.

____. 2014. "Information Asymmetry and Foreign Currency Borrowing by Small Firms." *Comparative Economic Studies*, 56, 110-31.

Brown, Martin; Marcel Peter and Simon Wehrmüller. 2009. "Swiss Franc Lending in Europe." Zurich: Swiss National Bank, Mimeo.

Brzoza-Brzezina, Michał; Tomasz Chmielewski and Joanna Niedźwiedzińska. 2010. "Substitution between Domestic and Foreign Currency Loans in Central Europe: Do Central Banks Matter?" Frankfurt: European Central Bank, Working Paper.

Cerutti, Eugenio; Stijn Claessens and Lev Ratnovski. 2014. "Global Liquidity and Drivers of Cross-Border Bank Flows." Washington DC: International Monetary Fund, Mimeo.

Cetorelli, Nicola and Linda S. Goldberg. 2012. "Banking Globalization and Monetary Transmission." *Journal of Finance*, 67(5), 1811-43.

____. 2011. "Global Banks and International Shock Transmission: Evidence from the Crisis." *IMF Economic Review*, 59(1), 41-76.

Chen, Jiaqian; Tommaso Mancini-Griffoli and Ratna Sahay. 2014. "Spillovers from United States Monetary Policy on Emerging Markets: Different This Time?" Washington DC: International Monetary Fund, Working Paper.

de Haas, Ralph and Iman van Lelyveld. 2014. "Multinational Banks and the Global Financial Crisis: Weathering the Perfect Storm?" *Journal of Money, Credit and Banking*, 46(1), 333-64.

De Nicolo, Gianni; Patrick Honohan and Alain Ize. 2003. "Dollarization of the Banking System: Good or Bad?" Washington DC: Worldbank, Policy Research Working Paper.

Degryse, Hans; Moshe Kim and Steven Ongena. 2009. *Microeconometrics of Banking: Methods, Applications and Results*. Oxford University Press.

Dell'Ariccia, Giovanni; Luc Laeven and Gustavo A. Suarez. 2016. "Bank Leverage and Monetary Policy's Risk-Taking Channel: Evidence from the United States." *Journal of Finance*, Forthcoming.

Dell'Ariccia, Giovanni; Luc Laeven and Robert Marquez. 2011. "Financial Frictions, Foreign Currency Borrowing, and Systemic Risk." Washington DC: International Monetary Fund, Mimeo.

Dinger, Valeriya and Daniel Marcel te Kaat. 2015. "Global Imbalances and Bank Risk-Taking." Osnabrück: University of Osnabrück, Mimeo.

Endrész, Mariann; Győző Gyöngyösi and Péter Harasztosi. 2012. "Currency Mismatch and the Sub-Prime Crisis: Firm-Level Stylised Facts from Hungary." Budapest: Magyar Nemzeti Bank, Working Paper.

Feige, Edgar L. 2003. "The Dynamics of Currency Substitution, Asset Substitution and De Facto Dollarization and Euroization in Transition Countries." *Comparative Economic Studies*, 45(3), 358-83.

Fidrmuc, Jarko; Mariya Hake and Helmut Stix. 2013. "Households' Foreign Currency Borrowing in Central and Eastern Europe." *Journal of Banking and Finance*, 37(6), 1880-97.

Fischer, Stanley. 2014. "The Federal Reserve and the Global Economy." Washington DC: Per Jacobsson Foundation, Lecture.

Gertler, Mark and Nobuhiro Kiyotaki. 2011. "Financial Intermediation and Credit Policy in Business Cycle Analysis," B. M. Friedman and M. Woodford, *Handbook of Monetary Economics 3a.* New York NY: Elsevier, 547-99.

Giannetti, Mariassunta and Steven Ongena. 2009. "Financial Integration and Firm Performance: Evidence from Foreign Bank Entry in Emerging Markets." *Review of Finance*, 13, 181-223.

____. 2012. "'Lending by Example': Direct and Indirect Effects of Foreign Bank Presence in Emerging Markets." *Journal of International Economics*, 86(1), 167-80.

Gormley, Todd A. 2010. "The Impact of Foreign Bank Entry in Emerging Markets: Evidence from India." *Journal of Financial Intermediation*, 19(1), 26-51.

He, Dong and Robert N. McCauley. 2013. "Transmitting Global Liquidity to East Asia: Policy Rates, Bond Yields, Currencies and Dollar Credit." Basle: Bank for International Settlements, Working Paper.

Holmstrom, Bengt and Jean Tirole. 1997. "Financial Intermediation, Loanable Funds, and the Real Sector." *Quarterly Journal of Economics*, 112, 663-91.

____. 1998. "Private and Public Supply of Liquidity." *Journal of Political Economy*, 106(1), 1-40.

Ioannidou, Vasso P.; Steven Ongena and José-Luis Peydró. 2015. "Monetary Policy, Risk-Taking and Pricing: Evidence from a Quasi-Natural Experiment." *Review of Finance*, 19(1), 95-144.

Jiménez, Gabriel; Atif Mian; José-Luis Peydró and Jesús Saurina. 2014. "The Real Effects of the Bank Lending Channel." Madrid: Banco de España, Mimeo.

Jiménez, Gabriel; Steven Ongena; José-Luis Peydró and Jesús Saurina. 2012. "Credit Supply and Monetary Policy: Identifying the Bank Balance-Sheet Channel with Loan Applications." *American Economic Review*, 102(5), 2301-26.

____. 2014. "Hazardous Times for Monetary Policy: What Do Twenty-Three Million Bank Loans Say About the Effects of Monetary Policy on Credit Risk-Taking?" *Econometrica*, 82 (2), 463-505.

Kashyap, Anil K. and Jeremy C. Stein. 1995. "The Impact of Monetary Policy on Bank Balance Sheets." *Carnegie-Rochester Conference Series on Public Policy*, 42, 197-202.

____. 2000. "What Do a Million Observations on Banks Say About the Transmission of Monetary Policy?" *American Economic Review*, 90(3), 407-28.

Khwaja, Asim Ijaz and Atif Mian. 2008. "Tracing the Impact of Bank Liquidity Shocks: Evidence from an Emerging Market." *American Economic Review*, 98(4), 1413-42.

King, Gary and Langche Zeng. 2006. "The Dangers of Extreme Counterfactuals." *Political Analysis*, 14, 131-59.

____. 2001. "Logistic Regression in Rare Events Data." *Political Analysis*, 9(2), 137-63.

Krogstrup, Signe and Cedric Tille. 2014. "The Impact of Swiss Monetary Developments on the International Role of the Swiss Franc." Zurich: Swiss National Bank, Presentation SNB Workshop on Foreign Currency Lending.

Kujundžić, Srđan and Dragiša Otašević. 2012. "The Bank Lending Channel in an Euroised Economy: Tthe Case of Serbia." Belgrade: National Bank of Serbia, Working Paper.

Lo Duca, Marco; Giulio Nicoletti and Ariadna Vidal Martinez. 2014. "Global Corporate Bond Issuance: What Role for Us Quantitative Easing?" Frankfurt: European Central Bank, Working Paper.

Mák, István and Judit Páles. 2009. "The Role of the Fx Swap Market in the Hungarian Financial System." *MNB Bulletin*, 3(May), 24-34.

Matousek, Roman and Nicholas Sarantis. 2009. "The Bank Lending Channel and Monetary Transmission in Central and Eastern European Countries." *Journal of Comparative Economics*, 37(2), 321-34.

McCauley, Robert N.; Patrick McGuire and Vladyslav Sushko. 2015. "Global Dollar Credit: Links to Us Monetary Policy and Leverage." *Economic Policy*, Forthcoming.

Miller, Margaret J. 2003. *Credit Reporting Systems and the International Economy*. Cambridge MA: MIT Press.

Mora, Nada. 2013. "The Bank Lending Channel in a Partially Dollarized Economy." *Journal of Applied Economics*, 16(1), 121-51.

Morais, Bernardo; José-Luis Peydró and Claudia Ruiz. 2015. "The International Bank Lending Channel of Monetary Policy Rates and Quantitative Easing: Credit Supply, Reach-for-Yield, and Real Effects." Washington DC: World Bank, Working Paper.

Morck, Randall; M. Deniz Yavuz and Bernard Yeung. 2013. "State-Controlled Banks and the Effectiveness of Monetary Policy." Edmonton: University of Alberta, Mimeo.

Nagy, Piroska M.; Stephen Jeffrey and Jeromin Zettelmeyer. 2011. "Addressing Private Sector Currency Mismatches in Emerging Europe," E. Prasad and M. Kawai, *Financial Market Regulation and Reforms in Emerging Markets.* Washington DC: Brookings Institution Press, 365-405.

Neanidis, Kyriakos C. and Christos S. Savva. 2015. "Is Loan Dollarization Contagious across Countries? Evidence from Transition Economies." Manchester: University of Manchester, Mimeo.

Norton, Edward C.; Hua Wang and Chunrong Ai. 2004. "Computing Interaction Effects and Standard Errors in Logit and Probit Models." *Stata Journal*, 4(2), 154-67.

Ongena, Steven; Alexander A. Popov and Gregory F. Udell. 2013. ""When the Cat's Away the Mice Will Play": Does Regulation at Home Affect Bank Risk-Taking Abroad?" *Journal of Financial Economics*, 108, 727-50.

Ongena, Steven and David C. Smith. 2001. "The Duration of Bank Relationships." *Journal of Financial Economics*, 61(3), 449-75.

____. 2000. "What Determines the Number of Bank Relationships? Cross-Country Evidence." *Journal of Financial Intermediation*, 9(1), 26-56.

Paravisini, Daniel; Veronica Rappoport and Philipp Schnabl. 2014. "Comparative Advantage and Specialization in Bank Lending." London: London School of Economics, Mimeo.

Paravisini, Daniel; Veronica Rappoport; Philipp Schnabl and Daniel Wolfenzon. 2014. "Dissecting the Effect of Credit Supply on Trade: Evidence from Matched Credit-Export Data." *Review of Economic Studies*, 82(1), 333-59.

Popov, Alexander and Gregory F. Udell. 2012. "Cross-Border Banking, Credit Access, and the Financial Crisis." *Journal of International Economics*, 87(1), 147–61.

Puri, Manju; Jörg Rocholl and Sascha Steffen. 2011. "Global Retail Lending in the Aftermath of the Us Financial Crisis: Distinguishing between Supply and Demand Effects." *Journal of Financial Economics*, 100, 556-78.

Rajan, Raghuram G. and Ioannis Tokatlidis. 2005. "Dollar Shortages and Crises." *International Journal of Central Banking*, 2, 177-219.

Rosenberg, Christoph B. and Marcel Tirpák. 2009. "Determinants of Foreign Currency Borrowing in the New Member States of the Eu." *Czech Journal of Economics and Finance*, 59(3), 216-28.

Taylor, John B. 1993. "Discretion Versus Policy Rules in Practice." *Carnegie-Rochester Conference Series on Public Policy*, 39, 195-214.

Temesvary, Judit; Steven Ongena and Ann L. Owen. 2015. "A Global Lending Channel Unplugged? Does U.S. Monetary Policy Affect Cross‐Border and Affiliate Lending by Global U.S. Banks?" Clinton NY: Hamilton College, Mimeo.

Thoma, Mark A. 1994. "Subsample Instability and Asymmetries in Money-Income Causality." *Journal of Econometrics*, 64, 279-306.

Vonnák, Dzsamila. 2014. "Determinants and Riskiness of Corporate Foreign Currency Lending: The Case of Hungary." Budapest: Central European University, Mimeo.

Weise, Charles L. 1999. "The Asymmetric Effects of Monetary Policy: A Nonlinear Vector Autoregression Approach." *Journal of Money, Credit and Banking*, 31(1), 85-108.

Zaheer, Sajjad; Steven Ongena and Sweder J.G. van Wijnbergen. 2013. "The Transmission of Monetary Policy through Conventional and Islamic Banks." *International Journal of Central Banking*, 8(5), 175-224.

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