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MT-DP – 2015/28

Decomposing the Riskiness of Corporate Foreign Currency Lending: the Case of Hungary

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Abstract

I decompose the factors contributing to the riskiness of foreign currency borrowers. I compare counterfactual default probabilities of local and foreign currency borrowers estimated on disaggregated data. My results suggest that the currency mismatch with the depreciation of the local currency is the most important factor contributing to the riskiness of foreign currency borrowers, though boom-period excessive risk taking of banks is also concentrated in foreign currency lending.

Keywords: foreign currency debt, banking

JEL classification: G21, F31, F34

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A vállalati devizahitelezés kockázatának tényezői: Magyarország esete

Vonnák Dzsamila

Összefoglaló

A tanulmányban azt vizsgálom, hogy milyen tényezők járulnak hozzá a devizahiteles vállalatok válság alatti magas adósságszolgálati nemtelejesítési rátájához. A különböző devizában eladósodott vállalatok hipotetikus adósságszolgálati nemteljesítési rátáit hasonlítom össze mikroszintű adatok segítségével. A magyarországi devizahitelezésben használt két fő devizára, az euróra és a svájci frankra koncentrálok. Az eredményeim azt mutatják, hogy az euróhitelt felvevő vállalatokhoz képest a svájci frankban eladósodottakat jobban sújtotta a devizaárfolyam változása. Ugyanakkor a svájci frankban eladósodott vállalatok eleve kockázatosabbak is voltak és a válság is rosszabbul hatott rájuk.

Tárgyszavak: devizahitelezés, bankok

JEL kódok: G21, F31, F34

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Dzsamila Vonnák†

June 8, 2015

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1 Introduction

Excessive credit growth periods are potential threats to the financial stability. Credit booms followed by recession periods may turn into financial crises. In emerging market countries, due to the interest rate gap between the local and major currencies, credit boom periods are often accompanied by significant foreign currency indebtedness, which then aggravates the crisis. This was the case during the Latin American debt crises in 1980s, the Asian crisis in 1997-98 and the 2008 financial crisis in Central and Eastern Europe.

The question is that through which channels does foreign currency lending affect risk? The European Systematic Risk Board in one of its Macro-prudential Commentaries[1] points out that "Forex loans are associated with a variety of risks, starting with the increased probability of credit booms, elevated credit and funding risks, impediments to monetary policy and enhanced potential for cross-border spillovers". So which factors are in effect? And what part of risk is independent of foreign currency lending.

In this paper I decompose the riskiness of foreign currency borrower firms by using a micro-level data. The data allows me to dissect the effects influencing the loan performance of foreign currency borrowers. I assess to what extent is the excessive risk is owing to the boom-period shift in risk taking (and thus over-indebtedness), to the heterogeneous effect of the crisis and to the risk caused by the serious currency mismatch (which is then materialized by the huge depreciation of the local currency during the crisis).

I analyze firms in Hungary during the 2008 financial crisis. Hungary entered the crises with more that half of the total private sector loans denominated in foreign currency. Mainly two currencies - the Euro (EUR) and the Swiss franc (CHF) - were used for foreign currency lending. During the crisis Euro borrowers perform much better than firms with Swiss franc loan. In particular, the non-performing loan ratio for Swiss franc denominated loans in the corporate sector have become more than twice as big as the non-performing loan ratio for Hungarian forint (HUF) loans. Meanwhile, the loan performance of Euro and Hungarian forint borrowers have changed quite similarly. I investigate the difference between the performance of Euro and Swiss franc borrowers.

Disaggregated data is essential to properly dissect the factors contributing to the riskiness of borrowers. I use a unique dataset containing micro-level data on the universe of borrower firms

[1] Szpunar and Głogowski (2012)

in Hungary. It contains data on firms, banks and loan denomination.

I test three hypotheses to explain the gap between the performance of Euro and Swiss franc borrowers. First, there could have been more unfavorable changes in the conditions of Swiss franc loans. Indeed the Hungarian forint depreciated more to Swiss franc than to Euro and thus the debt service on Swiss franc loans increased more than on Euro loans. I refer to this hypothesis as the exchange rate effect.

Second, the crisis anyway may have hit harder the Swiss franc borrowers. This can be the case for example if firms belonging to sectors that were affected the most by the economic downturn had been more prone to borrow in Swiss franc. I call this hypothesis the crisis balance sheet effect.

Third, per se riskier firms may have got Swiss franc loan. One potential explanation for this is that the strong competition in the banking sector could lead to a shift in the credit supply and this excess credit might have concentrated at Swiss franc lending. I refer to this potential explanation as the ex-ante credit risk hypothesis.

I disentangle the aforementioned hypotheses in three steps. In each step I calculate counterfactual excessive default probabilities of foreign currency borrowers (separately for Swiss franc and Euro) to Forint borrowers, that is how much extra risk would foreign currency borrowers represent compared to local currency debtors in some hypothetical case.

In the first step I calculate default probabilities that would be without the crisis. Thus I can capture the part of the excessive risk which is due to the (observed part of) ex-ante credit risk. First, I estimate a default probability model on pre-crisis data using all firms with outstanding debt. Then, I project the model to the crisis years and I compare the predicted default ratios of Swiss franc and Euro borrowers to firms with Hungarian forint credit. I find that Swiss franc borrowers were ex-ante riskier then Euro or Forint borrowers.

In the second step I calculate the default probabilities of foreign currency borrowers that would be if they were Hungarian forint borrowers. I use a propensity score matching method where treatment is defined as having foreign currency loan and the propensity score is estimated on firms' pre-crisis characteristics. In this way I compare the crisis default probabilities of firms with foreign and with local currency credit but otherwise same pre-crisis observed characteristics. The difference between their crisis performance would capture the exchange rate effect in case of unconfoundedness, however there are unobservables affecting both currency choice and

riskiness[2]. Thus in fact the differences capture both the exchange rate effect and the unobserved part of ex-ante credit risk. The result show that among firms with apparently same pre-crisis characteristics but different loan denomination the one with Swiss franc became the most risky and the one with Hungarian forint become the less risky.

In the third step I calculate the default probabilities of foreign currency borrowers that would be if they borrowed in the local currency. I isolate the exchange rate effect from the unobserved factors by applying an instrumental variable approach. I instrument foreign currency indebtedness of the the firm with their bank relationships. The instrument is motivated by the observation that banks had effect on firms' currency denomination choice. Thought currency lending also influenced the matching between banks and firms, thus instruments building on current bank-firm relationships would be invalid. Thus instead I use only bank-firm relationships established before the foreign currency lending boom. I find that the exchange rate changes had significant effect on the riskiness of Swiss franc borrowers but not on Euro debtors.

Literature [to be explicated] This paper is related to the literature which analyzes credit cycles and systematic risk. Aggregate studies show that episodes of excessive credit growth are good predictors of financial crises (Mendoza and Terrones (2012), Schularick and Taylor (2012)). Though there are both good and bad credit booms. In the former case the credit expansion is driven by a productivity-driven shift in the demand for the credit (for instance a positive technology shock). Thus the boom is caused by economic fundamental and the subsequent crisis is attributed to bad luck. In the latter case credit expansion is caused by a shift in the supply of credit driven by imperfections in the credit supply process. In order to properly disentangle the demand and the supply side one needs disaggregated data. For example Mian and Sufi in a series of articles[3] analyze with microeconomic data the mortgage credit expansion and the subsequent recession in the US. They find that a shift in the supply of credit combined with the accelerator effect of borrowing against increasing house values caused the huge growth in the leverage of US households between 2002 and 2006. Then the consequent reduction in aggregate demand drove Great Recession.

My paper also belongs to the literature on foreign currency lending[4]. Most of the papers use

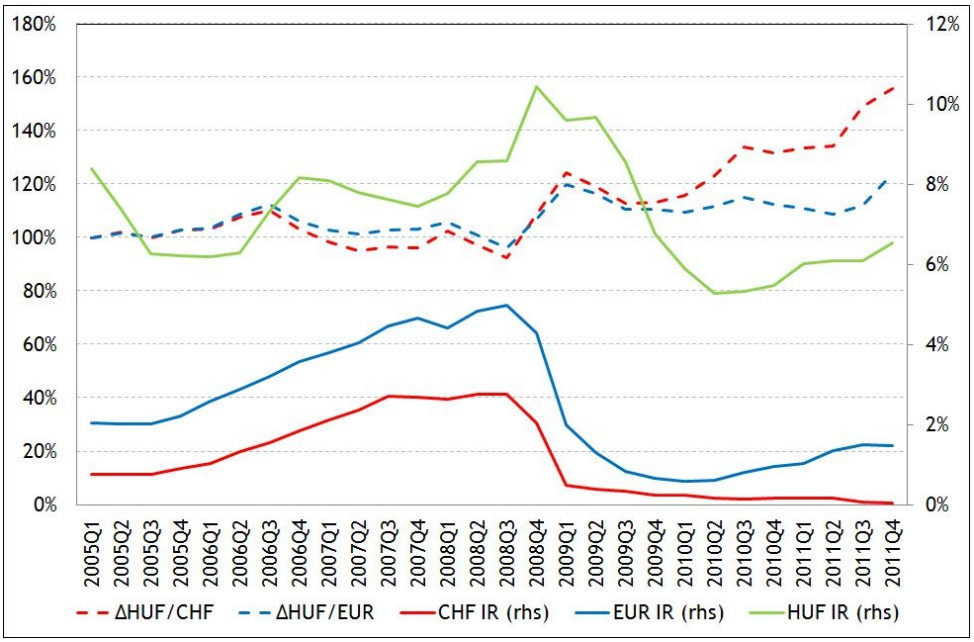
[2]See for example Beckmann and Stix (2015) who show relationship between financial literacy and the demand for foreign currency loans

[3]Mian and Sufi (2009, 2010a, 2010b, 2011) and Mian et al. (2010)

[4]For a detailed review of the related literature see Nagy et al. (2011).

shows the changes in exchange rate changes compared to 2005Q1 and the three-month Hungarian forint, Euro and Swiss franc money market interest rate levels. Euro and Swiss franc interest rates are lower then the Hungarian forint interest rate. Moreover Euro looks a natural choice in countries willing to join the euro-zone. But what about Swiss franc? Swiss franc lending has its roots in areas of Austria close to the Swiss border[6]. First the Swiss franc lending practice dispersed over Austria, then multinational banks transmitted across the borders what local banks quickly adopted. Figure 3 shows that Swiss franc and Euro interest rates moved quite similar during the period, however the level of Swiss franc interest rate was always lower. Besides, the EUR/HUF and the CHF/HUF exchange rate also changed quite similar until the end of 2009. The low interest rate together with the small EUR/CHF volatility made Swiss franc loans attractive. However, later on the Hungarian forint depreciated more relative to Swiss franc than to Euro. This partially explains the post-2008 trends in foreign currency lending.

Figure 3: Exchange rates and interest rates



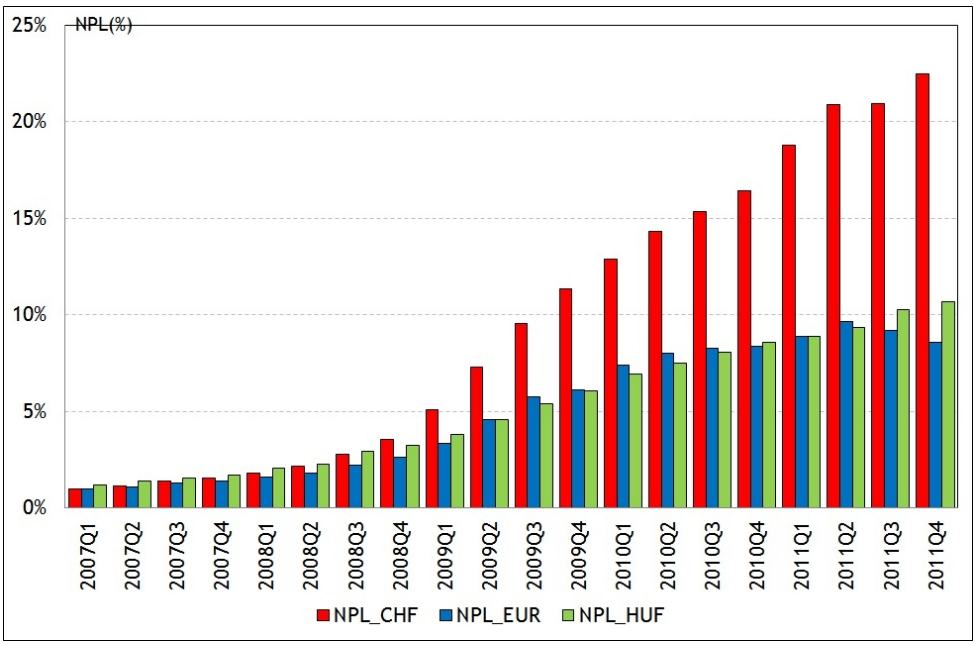
Note: The figure shows quarterly changes in CHF/HUF and EUR/HUF exchange rates compared to 2005Q1 (measured on the left-hand side axis)and 3-month money market HUF, CHF and EUR interest rate levels (measured on the right-hand side axis).

Meanwhile, the riskiness of Euro and Swiss franc borrowers changed quite differently. Figure 4 shows the non-performing loan ratios for loans denominated in different currencies between

[6]Beer Ongena and Peer (2010), Epstein and Tzanninis (2005), Waschiczek (2002))

2007 and 2011. All of them show an increasing pattern, however the non-performing loan ratio for Swiss franc borrowers rose much steeper than the for the other currencies. Euro loans changed quite similar to the performance of Hungarian forint denominated loans and at the end of the period even outperformed it.

Figure 4: Ratio of non-performing corporate loans by currency in Hungary



Note: The figure shows quarterly data between 2007 and 2011 on non-performing loan ratios (the share of number of loans with more than 90-day delinquencies in total loan portfolio) of banks in Hungary.

3 Data

3.1 Data sources

I use several data sources to compile my database. The first one is the database of the Hungarian National Tax and Customs Administration (NTCA) containing the financial report (balance sheet and income statement) of all Hungarian companies with double-entry bookkeeping[7]. Then, data on loans is available from the Hungarian credit registry, called Central Credit Information System (CCIS). It contains contract level data on all outstanding credit loans in the Hungarian banking sector. Basic data about the loan such as the type of agreement, outstanding amount

[7]According to the Hungarian accounting rules, businesses above a certain threshold have to use double-entry bookkeeping.

and currency denomination are available for all loans extended between 2005 and 2011. Data on late payments are available from 2007. Both CCIS and NTCA contain the tax number of the firms through which I match the two databases. However CCIS does not contain the identity of the lender. Instead, I exploit the firm-bank relationships available from the Complex firm register database. This database contains the bank account numbers of each company from which I can identify the banks in relationship with each firm in any time period[8]. Finally, I complete my database with bank variables available from bank regulatory reports. Figure 5 in the Appendix sums up how data is compiled.

3.2 Sample

My sample includes non-financial corporations with bank loan of which I have data on bank relationship and firm characteristics between 2004[9] and 2008. I exclude firms borrowing in foreign currency other than Euro or Swiss franc[10] in order to avoid capturing the effect of other foreign currencies. Table 1 shows the composition of borrowers broken down by currency denomination of their credit.

Table 1: Composition of borrowers broken down by currency denomination of their loan

	Group 1	Group 2		Group 3		Excluded		
year	HUF	EUR	EUR,HUF	CHF	CHF,HUF	CHF,EUR	CHF,EUR, HUF	Total
2004	35 260	2 243	3 020	1 713	2 473	100	330	45 139
2005	37 112	2 336	3 214	2 665	3 583	114	456	49 480
2006	38 664	2 321	3 179	3 732	4 912	151	521	53 480
2007	39 929	2 449	3 345	4 441	5 615	208	811	56 798
2008	37 651	2 736	3 406	4 163	3 998	374	863	53 191
Total	188 616	12 085	16 164	16 714	20 581	947	2 981	258 088

Source: Central Credit Information System

Only a minority of the firms have both Euro and Swiss franc (1-2% in each year), thus I

[8]The first three digits of the bank account number is the GIRO code. The GIRO code is initially a unique identifier for each bank. However in case of mergers and acquisitions the successor institution inherits the GIRO code, thus a bank might have more GIRO codes and a GIRO code might belong to different banks in different times. The Verification Table issued monthly by the Central Bank of Hungary contains the actual GIRO code-bank matches. Using the historical versions of the Verification Table I track the GIRO code-bank matches through time and thus identify in each period the bank associated with a bank account number.

[9]loan data is only available from 2005, since in the other case I use year-end data, for 2004 I can use instead beginning of 2005 data

[10]Only 0.6% of all borrower firms have loan denominated in other foreign currency. Results are robust to their inclusion.

exclude them from the estimation[11].

The final sample consists of 258 088 firm-year observations covering 74 495 individual firms and 37 banks[12]. The focal group of my analysis is firms with loan at the end of 2008. There are 53 191 firms and 32 banks in this subsample.

I categorize the borrowing firms into three groups according to the denomination of their loans. Firms with only Hungarian forint loans belong to the first group. The second group contains firms with any Swiss franc loan, that is those firms who have only Swiss franc loans or have both Swiss franc and Hungarian forint loans. The third category consists of Euro borrowers, that is firms with only Euro or with both Euro and Hungarian forint loans. I refer to the three groups as Hungarian forint, Swiss franc and Euro borrowers, respectively. I denote by $(it) \in J$ or $y_{it} = J$ if firm i in year t belongs to the J currency borrower group, where $J \in \{HUF, EUR, CHF\}$. Table 2 shows the summary statistics of borrowers in 2008 by currency group[13].

Table 2: Summary statistics

	Group 1 (HUF)			Group 2 (CHF)			Group 3 (EUR)		
Variable	Mean	Std.	Median	Mean	Std.	Median	Mean	Std.	Median
Export sales ratios	0.04	0.16	0.00	0.02	0.11	0.00	0.20	0.32	0.00
Foreign ownership	0.05	0.23	0.00	0.03	0.17	0.00	0.27	0.44	0.00
Capital ratio	0.40	0.29	0.37	0.29	0.24	0.25	0.32	0.25	0.29
Liquidity ratio	0.63	0.30	0.69	0.50	0.30	0.49	0.49	0.30	0.48
Log total assets	10.53	1.91	10.48	11.19	1.65	11.20	12.70	1.69	12.83
ROA	-0.04	0.69	0.02	-0.02	0.41	0.02	-0.01	0.47	0.01
Log num.of employees	1.52	1.25	1.39	1.69	1.24	1.61	2.54	1.58	2.64
Log age	2.02	0.60	2.08	2.05	0.58	2.08	2.22	0.59	2.40
Switcher	1.32	0.60	1.00	1.36	0.58	1.00	1.84	0.91	2.00
Number of banks	1.64	0.89	1.00	1.85	0.99	2.00	2.03	1.22	2.00

Firms with Euro loan export more on average, are owned by foreigners with higher probability, bigger then their peers both in terms of total assets and number of employees, more

[11]Neither duplicating the observations then assigning them both to the group of Euro borrowers and to the group of Swiss franc borrowers, nor randomly assigning them to either the Euro or the Swiss franc borrowers alter my findings.

[12]I use the label bank both for commercial banks and branch offices of foreign banks. Although these two groups have different legal status, they operate alike in terms of lending. Note, however, that my sample does not cover saving cooperatives since they differ in many relevant aspects. Saving cooperatives are typically rural institutions with special clientele and more limited range of services. They give only 3-4% of corporate lending and less than 1% of foreign currency corporate lending.

[13]The definitions on the variables are found in Table 7 in the Appendix

profitable, elder, less liquid and has more bank relationships than the their peers. Swiss franc borrowers export less, are owned by foreigner with smaller probability and less capitalized then other firms. Hungarian forint borrowers are more capitalized, more liquid, less profitable, smaller younger and has less bank relationships then their peers.

So my focus group is the firms with loan in 2008[14]. In particular, I analyze how riskiness of these firms changes during the succeeding 3 years. My indicator of risk is the default on bank loans. A firm is defined to be in default if it has loan with more than 90-day delinquency. I concentrate on cumulative defaults, in particular the s-year default at year t for firm i is denoted by the dummy variable $def_{i,t,s}$, which is equal to one if firm i defaults during the subsequent s years (i.e. in years $[t+1, t+s]$) and equals zero otherwise. The s-year default ratio (or non-performing loan ratio) at year t is the ratio of firms who are defaulted within s-year: $def_{t,s} \equiv \frac{\sum_i \Pr(def_{i,t,s})}{N_t}$, where N_t denotes the total number of firms in year t. Similarly the s-year default ratio for the J currency group at year t is $def^J_{t,s} \equiv \frac{\sum_{i,t\in J} \Pr(def_{i,t,s})}{N^J_t}$, where N^J_t stands for the number of firms belonging to group J in year t. Table 3 shows for each currency group the s-year default ratios for 2008 borrowers.

Table 3: The s-year default ratios of 2008 borrowers

	HUF	CHF	EUR
1-year	4.49%	9.16%	5.90%
2-year	7.22%	13.73%	9.09%
3-year	9.39%	17.02%	11.06%

Source: Central Credit Information System

4 Empirical strategy

I proceed in three steps. In each step I calculate excessive default probabilities of foreign currency borrowers (separately for Swiss franc and Euro) to Forint borrowers based on some counterfactual default probabilities. In the first step I calculate the excess default probabilities that would be if there were no crisis. In the second step I model what would be if the foreign currency borrowers were local currency borrowers. Then in the third step I estimate the default probabilities that would be if foreign currency debtors would instead borrow in Hungarian forint.

[14]I choose 2008 since in Hungary the crisis started to escalate in fall of 2008, thus the effects mainly appeared from 2009.

4.1 Ex-ante riskiness

In this section I estimate the ex-ante riskiness of firms indebted in different currencies. The estimates are ex-ante in the sense that they show what would be without the outbreak of the crisis. I estimate a pre-crisis default model which then I project to crisis years. I compare the ex-ante default probabilities across group of borrowers with different currency denomination.

Consider a general specification for the probability of default over $[t, t+s]$ which looks as follows:

$$def_{i,t,s} = \beta_s F_{i,t} + \alpha_{t,s} + \nu_{i,t,s} \tag{1}$$

where $def_{i,t,s}$ is a dummy for default event over $[t, t+s]$, which takes value one if firm i defaults from year $t+1$ to year $t+s$, equals zero otherwise. $F_{i,t}$ is a set of firm-specific variables for firm i at the end of year t (in particular sector dummies, firm export sales ratio, foreign ownership, size, capital ratio, liquidity, profitability, age, indicator for new bank relationship) and $\alpha_{t,s}$ is time fixed effect representing average macro effects for the period.

I use only pre-crisis data (that is $\forall t : t+s \leq 2008$[15]) to estimate the model. Thus the parameter vector β_s represents the averages pre-crisis coefficients.

The estimated coefficients are shown in Table 8 in the Appendix. Exporters are less likely to default in one and two years. Foreign owned, more capitalized and more profitable firms are less risky in all time horizon. Surprisingly liquidity does not matter in short run, though in long run more liquid firms are riskier. Firms bigger in terms of balance sheet are more likely to default, while firms with more number of employee are less risky. New clients are riskier in all time horizon. Older firms are less risky in two and three-year horizon.

Fitting the model to 2008 firm characteristics I can estimate the default probabilities that would have been if there were no crisis. That is the no-crisis counterfactual default probability for firm i is

$$\widehat{def}_{i,2008,s} = \widehat{\beta}_s F_{i,2008} + \widehat{\alpha}_{2008,s} \tag{2}$$

[15] In particular I use $t \in [min\{2005, 2007-s\}, 2008-s]$. On the one hand the crisis gives the upper limit. Thus default data from 2008 is the latest year which I can use. For s-year prediction it means the (2008-s)-year balance sheet data. On the other hand data is available on loans from 2005, on default from 2007. The lower limit is thus $min\{2005, 2007-s\}$.

Similarly for the $J \in \{HUF, EUR, CHF\}$ currency borrower group the counterfactual default probabilities can be calculated as follows:

$$\widehat{def}^{J}_{2008,s} = \widehat{\beta}_s F^{J}_{2008} + \widehat{\alpha}_{2008,s} \tag{3}$$

where F^J_t represents average characteristics of firms belonging to the J currency borrower group ($F^J_t \equiv \frac{\sum_{it \in J}(F_{it})}{N^J_t}$).

The problem is that the year fixed effects for 2008 ($\widehat{\alpha}_{2008,s}$) are unknown. Fortunately we still can calculate the excess default probabilities of foreign currency over Forint borrowers:

$$\widehat{Edef}^{J,HUF}_{2008,s} \equiv \widehat{def}^{J}_{2008,s} - \widehat{def}^{HUF}_{2008,s} = \widehat{\beta}_s (F^{J}_{2008} - F^{HUF}_{2008}) \tag{4}$$

Table 4 shows the estimated excess default probabilities. These captures the (observed part of) ex-ante credit risk. The results show that companies indebted in Swiss franc are ex-ante riskier on average than their peers on all analyzed time horizons.

Table 4: Step 1 estimated excess default probabilities

	CHF	EUR
1-year default probability	0.59pp	0.15pp
2-year default probability	0.41pp	0.04pp
3-year default probability	0.18pp	0.17pp

The table reports predicted excess default probabilities that would be if there were no crisis.

4.2 Propensity Score Matching

In this section I compare foreign currency borrowers to Hungarian forint borrowers with similar pre-crisis characteristics. Thus I can get the default probabilities of foreign currency borrowers that would be if they were forint borrowers.

I apply a propensity score matching approach. I perform the analysis separately for Swiss franc borrowers and for Euro borrowers. In both case the treated group is the group of firms with loan denominated in the given foreign currency in 2008, while the control group is firms with only Hungarian forint loan in 2008. First, I estimate the probability to be treated (the propensity score) based on the firms' 2008 characteristics:

$$e^J(F_{i,2008}) \equiv \Pr(y_{i,2008} = J \,|F_{i,2008}\,) = \beta F_{i,2008} + \nu_{i,2008} \tag{5}$$

where $y_{i,2008}$ is the denomination of the loan of firm i in 2008 such that $J \in \{EUR, CHF\}$ and $F_{i,2008}$ are firm specific variable for firm i at the end of 2008 (in particular sector dummies, firm export sales ratio, foreign ownership, size, capital ratio, liquidity, profitability, age, indicator for new bank relationship).

Then, by comparing the default probabilities of local and foreign currency borrowers with the same propensity score I get the so called treatment effects. In particular, I calculate the average treatment effects for the treated:

$$ATET = E(def^J_{i,2008,s} - def^{HUF}_{i,2008,s} \,|y_{i,2008} = J\,) \tag{6}$$

where $def^J_{i,2008,s}$ is the s-year default in 2008 of firm i who belongs to the J currency borrower group ($y_{i,2008} = J$) and $def^{HUF}_{i,2008,s}$ is the default for a firm with the same propensity score as firm i but with Hungarian forint loan.

The average treatment effects on treated are in fact the access counterfactual default probabilities. In case of unconfoundedness it would captures the exchange rate effect. But there are unobservables affecting both currency choice and riskiness (for example firms with financially less qualified management are expected to borrow moreSee for example Beckmann and Stix (2015). in FX and also to be per se riskier). Thus these treatment effects incorporate both the exchange rate effect and the unobserved part of ex-ante credit risk. Table 5 shows the results.

Table 5: Step 2 ATET

	CHF	EUR
1-year default probability	3.81pp	1.33pp
2-year default probability	5.34pp	2.43pp
3-year default probability	6.34pp	2.58pp

The table reports predicted excess default probabilities that would be if foreign currency borrowers were forint borrowers.

4.3 Exchange rate effect

In this section I analyze the effect of the change in the exchange rate on the credit risk of foreign currency borrowers. I estimate what would be the default probability of firms with foreign currency credit they borrowed instead in the local currency.

I estimate the following model:

$$def_{i,2008,s} = \beta_s F_{i,2008} + \gamma_s^{CHF} firmCHF_{i,2008} + \gamma_s^{EUR} firmEUR_{i,2008} + \epsilon_{i,2008,s} \tag{7}$$

where $def_{i,2008,s}$ is a dummy for default event over $[2008, 2008 + s]$. $F_{i,2008}$ is a set of firm variables for firm i at the end of year 2008 (in particular firm sector dummies, export sales ratio, foreign ownership, size, capital ratio, liquidity, profitability, age, indicator for new bank relationship). Then $firmCHF_{i,2008}$ and $firmEUR_{i,2008}$ are dummies denoting if the firm i has loan denominated in Swiss franc borrower or in Euro borrower, respectively. After estimating the model the counterfactal default probabilities of foreign currency borrowers that would be if they borrowed in Forint (that is when $firmCHF_{i,2008} = 0$ and $firmEUR_{i,2008} = 0$) can be calculated as follows:

$$\widehat{def}_{i,2008,s} = \widehat{\theta}_s F_{i,2008} \tag{8}$$

However, as I have already pointed out earlier, there are unobserved factors affecting both the riskiness of firms and their currency choice. Thus I apply an instrumental variable approach to address this endogeneity problem. In particular, I instrument the currency borrower dummies ($firmCHF_{i,2008}$ and $firmEUR_{i,2008}$) with bank fixed effects. The motivation of the instrument is based on the observation that the currency denomination of loans are affected by the supply side as shown in Subsection 4.3.2. However, currency lending also affects the bank-firm matching process as shown in Subsection 4.3.1. Because of that, instrument building on the current bank-firm relationships might be correlated to the unobserved factors affecting the denomination preference of firms. Hence, I restrict the sample to firms who already have been with their banks before the foreign currency lending boom, in particular I include only firms that have not established new bank relationships since 2004. In the following two subsections I motivate the choice of the instruments. First, I demonstrate that bank-firm matching are influenced by foreign currency lending. Second, I show evidence that the currency choice of firms are also

affected by the banks. Finally, I present the result of the IV estimation.

4.3.1 Bank-firm relationship

In this subsection I investigate whether foreign currency lending had effected on the bank-affiliation of firms. If firms go to banks where they can borrower easier in foreign currency then we should see that those who would like to borrow foreign currency changes bank with higher probability and thus the currency demand of new and old clients should be different. However banks handle new clients differently (e.g. due to information asymmetry) which would confound the comparison of new and old clients. Thus, instead I compare voluntarily and involuntarily new clients of a foreign currency lender bank.

I study a bank acquisition taken place at the end of 2007. In 2007 the acquirer bank lent more both in Swiss franc and in Euro (16.3% and 36.7% of its extended credit was denominated in Swiss franc and in Euro, respectively) then an average bank (10.6% Swiss franc and 29.8% Euro share) or the acquired bank (5.1% Swiss franc and 30.4% Euro share). This suggests easier access to foreign currency for the clients of the acquirer bank. I analyze the currency choice[16] of the clients of the acquirer bank in 2008, the year right after the acquisition. I differentiate old clients, voluntarily new clients and involuntarily new clients. I apply a multinominal logit estimator to model their denomination choice. The potential outcomes are the three denomination based categories, that is $J \in \{HUF, EUR, CHF\}$. The probability that firm i borrows in currency structure J is given by the following multinominal logit regression:

$$\Pr(y_i = J) = \frac{\exp(\theta_1^J SelfNewcomer_i + \theta_2^J Acquired_i + \beta^J F_i)}{\sum_{K \in \{HUF,EUR,CHF\}} \exp(\theta_1^K SelfNewcomer_i + \theta_2^K Acquired_i + \beta^K F_i)} \tag{9}$$

where y_i is the currency group where firm i belongs to based on the currency structure of its 2008-year new loans. The $SelfNewcomer$ dummy indicates voluntarily new clients, that is companies deciding to go to the bank of their own accord in 2008. While the *Acquired* dummy represents the clients inherited from the acquired bank, that is to say involuntarily new clients. F_i is a set of firms characteristics corresponding to firm i at the end of 2007, in particular firm sector dummies, export sales ratio, foreign ownership, size, capital ratio, liquidity, profitability

[16] I separate the choice of borrowing from the chice of currency denomination. Therefore I concentrate companies taking loan in 2008 and thus exclude from the sample firms not borrowing in that year.

and age.

Table 9 in the Appendix presents the results. I report marginal effects of each covariate evaluated at the mean of the explanatory variables. The marginal effects show the change in the probability of observing a given outcome resulted from a small change in a covariate (a change from 0 to 1 for dummy variables), holding all other explanatory variables constant, in this case at their mean. Self-newcomers compared to old clients borrow in Swiss franc with higher relative probability, while acquired clients are not borrowing significantly more in Swiss franc. That is firms are choosing to go to the bank especially to borrow in Swiss franc. This shows that the bank-firm matching is in fact affected by foreign currency lending.

4.3.2 Supply effect

In this subsection I test whether the lending practice of the banks influence the denomination choice of their client. I compare two anyway identical firms who are related to different banks. I show that the currency lending practice of the affiliated bank predict the currency choice of the firm.

I apply a multinominal logit estimator to model the possible denomination outcomes. The potential outcomes are the three denomination based categories, that is $J \in \{HUF, EUR, CHF\}$. The probability that the currency structure of the outstanding loans of firm i in year t falls into category J is given by the multinominal logit regression as follows:

$$\Pr(y_{i,t} = J) = \frac{\exp(\theta^J_{CHF} bankCHF_{i,t-1} + \theta^J_{EUR} bankEUR_{i,t-1} + \beta^J F_{i,t-1})}{\sum_{K \in \{HUF,EUR,CHF\}} \exp(\theta^K_{CHF} bankCHF_{i,t-1} + \theta^K_{EUR} bankEUR_{i,t-1} + \beta^K F_{i,t-1})} \tag{10}$$

where $y_{i,t}$ is the currency group where firm i belongs to in year t based on the currency structure of its outstanding loans. The $bankCHF_{i,t}$ and the $bankEUR_{i,t}$ variables are the share of Swiss franc and the share of Euro in the credit portfolio of the bank of firm i in year t[17]. Then $F_{i,t}$ include a set of firms characteristics corresponding to firm i at the end of year t, in particular, I include the following firm specific variables[18]: sector dummies, firm export sales ratio, foreign ownership, size, capital ratio, liquidity, profitability and age. I also include year fixed effects.

[17] If a firm has multiple bank relationships than I use the average characteristic of the related banks.

[18] Definitions of the variables are found in Table 7 in the Appendix

If bank-firm relationships were exogenous then the coefficient of $bankCHF$ and $bankEUR$ would purely capture supply side effects. However Subsection 4.3.1 showed that foreign currency lending affect the evolution of bank-firm relationships. A company who is more willing to lend in foreign currency is more willing to choose a bank who lends more in foreign currency. If there are unobserved factors affecting both the currency and the bank choice of firms, the parameter estimates will be biased. In order to get around this problem, instead of the current relationships, I use the bank-firm connections established not later than 2003[19]. The variables are thus the share of currency in the credit portfolio of the bank that had already been related to the firm before 2003.

Table 10 in the Appendix presents the results. I report marginal effect evaluated at the mean of the explanatory variables. Higher share of a foreign currency in the credit portfolio of a bank makes the client of the bank more likely to borrow in that currency. This suggests a supply side push of foreign currency loans, hence the currency choice decomposition of banks differ not only because banks have different clientele but also because banks provide foreign currency denominated loans with different intensity. Interesting observation is that when a firm is related to a bank which is lending more in Swiss franc, then the firm borrows in Euro with huigher probability, while the reverse is not true.

4.3.3 Results

Table 6 reports the estimated effects from the IV estimations, while 11 in the Appendix shows the coefficients from both the OLS and IV estimations.

Estimated exchange rate effects: $\widehat{\gamma}_s^{CHF}$ and $\widehat{\gamma}_s^{EUR}$

The results show that the effects of the exchange rate are large for Swiss franc borrowers on all analyzed time horizons, for Euro borrowers the effects are rather important for longer time horizons.

[19]The results are robust to using earlier years. However, there is a trade-off: using earlier bank-firm connections on the one hand reduces the likelihood of endogenous bank-firm relationships, but on the other hand increases the probability of selection bias by eliminating firms younger than the chosen time lag.

Table 6: Step 3 Estimated exchange rate effects

	CHF	EUR
1-year default probability	3.90pp	0.83pp
2-year default probability	6.24pp	2.73pp
3-year default probability	5.65pp	4.05pp

The table reports predicted excess default probabilities that would be if foreign currency borrowers have borrowed in forint.

5 Conclusions

I decompose the factors contributing to the riskiness of foreign currency borrowers. I compare counterfactual default probabilities of local and foreign currency borrowers estimated on disaggregated data. My results suggest that the currency mismatch with the depreciation of the local currency is the most important factor contributing to the riskiness of foreign currency borrowers, though boom-period excessive risk taking of banks is also concentrated in foreign currency lending.

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6 Appendix

Table 7: Variable definitions

variable	**definition**
Default	equals 1 if the firms has loan with more than 90-day delinquency, 0 otherwise
Export sales ratios	the export sales over the total sales of the firm
Foreign ownership	equals 1 if ratio of foreign ownership of the firm is higher than 50%, 0 otherwise
Total assets	the log of the total assets of the firm
Number of employees	the log of number of employees of the firm
Age	the log of one plus the age of the firm
Newcomer	equals 1 if the firm established a new bank relationship in the given year, 0 otherwise
Self-newcomer	equals 1 if the firm established a new bank relationship not due to acquisition in the given year, 0 otherwise
Acquired	equals 1 if the firm was a client of the acquired bank, 0 otherwise
Capital ratio	the ratio of own funds over total assets of the firm
Liquidity ratio	the ratio of current assets over total assets of the firm
ROA	the return on assets of the firm
Bank foreign ownership	equals 1 if ratio of foreign ownership of the bank is higher than 50%, 0 otherwise
Bank total assets	the log of the total assets of the bank
Bank doubtful loans	the ratio of doubtful loans over the total loan portfolio of the bank
Bank capital ratio	the ratio of own funds over total assets of the bank
Bank liquidity ratio	the ratio of bank liquid assets over total assets of the bank
Bank ROA	the total net income of the bank over the total asset of the bank
Bank CHF share	the share of CHF in the credit portfolio of the bank
Bank EUR share	the share of EUR in the credit portfolio of the bank

Stock variables are measured at the end of the year, flow variables are measured over year.

Table 8: Ex-ante default probability models

Dependent Variable	1-year default probability	2-year default probability	3-year default probability
Export sales ratio	-0.007***	-0.005**	-0.003
	(-3.35)	(-2.01)	(-1.44)
Foreign ownership	-0.012***	-0.012***	-0.009***
	(-7.95)	(-7.00)	(-5.28)
Capital ratio	-0.043***	-0.036***	-0.025***
	(-27.09)	(-22.26)	(-14.57)
Liquidity ratio	-0.002	0.003	0.007***
	(-0.94)	(1.52)	(3.99)
Total assets	0.003***	0.003***	0.001***
	(8.75)	(6.36)	(3.15)
ROA	-0.012***	-0.005***	-0.004***
	(-8.67)	(-4.08)	(-2.61)
Number of employee	-0.005***	-0.003***	-0.002***
	(-9.79)	(-6.11)	(-4.01)
Age	0.001	-0.003***	-0.004***
	(1.20)	(-3.64)	(-5.63)
Newcomer	0.003***	0.017***	0.022***
	(3.42)	(15.26)	(19.68)
Sector dummies	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	126769	124125	117870
R-squared	0.016	0.015	0.015

The table reports estimates from linear probability regressions of firm characteristics on default. The dependent variable is a dummy indicating whether the firm becomes non-performing on any of its loan within 1, 2 or 3 years. The definition of the variables can be found in Table 7. T-statistics based on heteroskedasticity-robust standard errors are reported in parentheses. *, **, *** represent that the coefficient is significantly different from 0 at the 10%, 5%, and 1% levels, respectively.

Table 9: Multinominal logit for the clients of the acquirer bank

Dependent Variable	New loan denomination		
	HUF	CHF	EUR
Export sales ratio	-0.005	-0.032**	0.036***
	(-0.52)	(-3.14)	(12.50)
Foreign ownership	-0.046	-0.041	0.087***
	(-1.51)	(-1.40)	(6.95)
Capital ratio	0.043***	-0.029**	-0.014*
	(4.07)	(-3.16)	(-2.11)
Liquidity ratio	0.063***	-0.043***	-0.020***
	(8.39)	(-6.68)	(-3.92)
Total assets	-0.074***	-0.022	0.096***
	(-5.37)	(-1.86)	(10.40)
ROA	-0.022	0.035	-0.012
	(-0.56)	(1.40)	(-0.31)
Number of employee	0.019*	-0.006	-0.013*
	(2.17)	(-0.81)	(-2.37)
Age	-0.023*	0.007	0.016**
	(-2.55)	(0.92)	(2.62)
Self-newcomer	-0.079***	0.030*	0.049***
	(-5.63)	(2.51)	(5.14)
Acquired	-0.064***	-0.014	0.078***
	(-3.58)	(-0.88)	(6.74)
Sector dummies	Yes		
Observations	5365		
Pseudo R-squared	0.134		

The table reports estimates from multinominal logit regression of firm and bank characteristics on the choice of the currency denomination of the loan for the clients of the acquirer bank in the year subsequent to the acquisition. The table presents marginal effects evaluated at the mean of all explanatory variables showing the change in the probability of observing each outcome resulted from a small change in a covariate (a change from 0 to 1 for dummy variables), holding all other explanatory variables constant at their mean. The definition of the variables can be found in Table 1. Z-statistics based on heteroskedasticity-robust standard errors are reported in parentheses. *, **, *** represent that the coefficient is significantly different from 1 at the 10%, 5%, and 1% levels, respectively.

Table 10: Multinominal logit for currency choice

Dependent Variable	Outstanding loan denomination		
	HUF	CHF	EUR
Bank CHF share	-0.324***	0.178***	0.146***
	(0.04)	(0.03)	(0.03)
Bank EUR share	-0.145***	-0.057***	0.202***
	(0.02)	(0.02)	(0.02)
Export sales ratio	-0.008***	-0.026***	0.034***
	(0.00)	(0.00)	(0.00)
Foreign ownership	0.080***	-0.124***	0.045***
	(0.01)	(0.01)	(0.01)
Capital ratio	0.069***	-0.041***	-0.027***
	(0.00)	(0.00)	(0.00)
Liquidity ratio	0.059***	-0.033***	-0.026***
	(0.00)	(0.00)	(0.00)
Total assets	-0.160***	0.039***	0.121***
	(0.00)	(0.00)	(0.00)
ROA	-0.044***	0.055***	-0.011
	(0.01)	(0.01)	(0.01)
Number of employee	0.022***	-0.004	-0.018***
	(0.00)	(0.00)	(0.00)
Age	-0.013***	0.005	0.008**
	(0.00)	(0.00)	(0.00)
Newcommer	-0.041***	0.030***	0.012***
	(0.00)	(0.00)	(0.00)
Sector dummies	Yes		
Year FE	Yes		
Observations	119 511		
Pseudo R-squared	0.157		

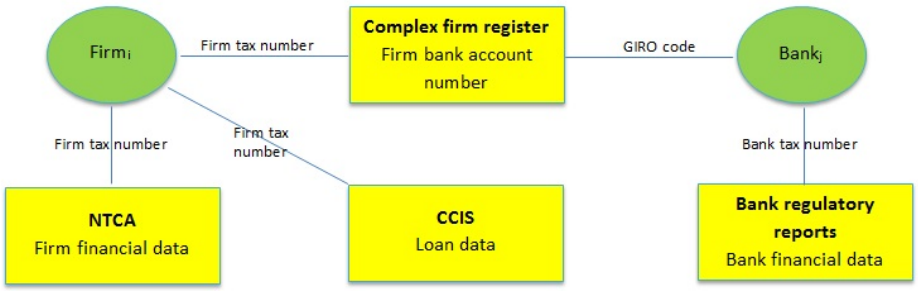
The table reports estimates from multinominal logit regression of firm and bank characteristics on the choice of the currency denomination of the loan for the clients of the acquirer bank in the year subsequent to the acquisition. The table presents marginal effects evaluated at the mean of all explanatory variables showing the change in the probability of observing each outcome resulted from a small change in a covariate (a change from 0 to 1 for dummy variables), holding all other explanatory variables constant at their mean. The definition of the variables can be found in Table 1. Z-statistics based on heteroskedasticity-robust standard errors are reported in parentheses. *, **, *** represent that the coefficient is significantly different from 1 at the 10%, 5%, and 1% levels, respectively.

Table 11: Effect of FX rate change

Dependent Variable	1-year default probability		2-year default probability		3-year default probability	
	OLS	IV	OLS	IV	OLS	IV
firmCHF	0.0175***	0.0390**	0.0281***	0.0624**	0.0347***	0.0565*
	(5.79)	(2.99)	(6.85)	(3.15)	(7.29)	(2.16)
firmEUR	0.0097**	0.0083	0.0164***	0.0273	0.0168**	0.0405*
	(2.77)	(0.93)	(3.43)	(1.81)	(3.03)	(2.07)
Export sales ratio	-0.0053	0.0027	-0.0078	0.0007	-0.0125	-0.0131
	(-1.08)	(0.57)	(-1.16)	(0.1)	(-1.61)	(-1.36)
Foreign ownership	-0.0057	-0.0003	-0.0067	-0.0058	-0.0101	-0.0202**
	(-1.60)	(-0.09)	(-1.39)	(-1.13)	(-1.80)	(-2.98)
Capital ratio	-0.0317***	-0.0145***	-0.0526***	-0.0293***	-0.0675***	-0.0511***
	(-10.19)	(-4.61)	(-12.49)	(-6.38)	(-13.79)	(-8.69)
Liquidity ratio	-0.0013	-0.0012	0.0023	0.0076	0.0076	0.0047
	(-0.43)	(-0.34)	-0.54	(1.55)	-1.56	(0.77)
Total assets	0.0002	0.0002	0.0012	0.0004	0.0019	0.0009
	(0.25)	(0.34)	(1.17)	(0.38)	(1.56)	(0.77)
ROA	-0.0054***	-0.0033	-0.0034	-0.0027	-0.0026	-0.0025
	(-4.04)	(-1.57)	(-1.91)	(-1.20)	(-1.24)	(-1.06)
Number of employee	-0.0031***	-0.0023**	-0.0037**	-0.0022	-0.0042**	-0.0026
	(-3.30)	(-2.71)	(-2.93)	(-1.93)	(-2.81)	(-1.90)
Age	-0.0024	-0.0016	-0.0054	-0.003	-0.0077*	-0.0081*
	(-1.09)	(-0.86)	(-1.79)	(-1.09)	(-2.21)	(-2.51)
Observations	20073	20073	20073	20073	20073	20073
R-squared	0.013		0.016		0.019	

The table presents the effect of FX rate change on default probabilities. Column (1) and (2) present the first stage regressions. The CHF and EUR indebtedness of the firms are instrumented by the share of CHF and EUR loan in the portfolio of the bank related to the firm before the currency lending boom. Heteroskedasticity-robust standard errors are reported in parentheses. *, **, *** represent that the coefficient is significantly different from 0 at the 10%, 5%, and 1% levels, respectively.

Figure 5: Databases



Note: The figure shows what databases are used and how they are matched.