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Working Paper

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MNB Working Papers, No. 2020/2

Provided in Cooperation with:
Magyar Nemzeti Bank, The Central Bank of Hungary, Budapest

Suggested Citation: Verner, Emil; Gyöngyösi, Gyîozîo (2020) : Household debt revaluation and the real economy: Evidence from a foreign currency debt crisis, MNB Working Papers, No. 2020/2, Magyar Nemzeti Bank, Budapest

This Version is available at:
http://hdl.handle.net/10419/241072

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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).

MNB Working Papers 2020/2

Household Debt Revaluation and the Real Economy: Evidence from a Foreign Currency Debt Crisis *

(Lakossági adósság átértékelődés reálgazdasági hatása: Egy devizahitel-válság értékelése)

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Budapest, March 2020

Published by the Magyar Nemzeti Bank

Publisher in charge: Eszter Hergár

Szabadság tér 9., H-1054 Budapest

www.mnb.hu

ISSN 1585-5600 (online)

*This research received financial support from the Alfred P. Sloan Foundation through the NBER Household Finance small grant program. We are extremely grateful to Atif Mian, Mark Aguiar, Adrien Matray, Motohiro Yogo, and Wei Xiong for valuable guidance and encouragement. For helpful comments we thank Adrien Auclert, Tamás Briglevics, Markus Brunnermeier, Will Dobbie, Sergio de Ferra, Bo Honoré, Oleg Itskhoki, Nobu Kiyotaki, Stefan Lewellen, Ben Moll, Dmitry Mukhin, Karsten Müller, Mikkel Plagborg-Møller, Emi Nakamura, Dániel Palotai, Jonathan Parker, Federico Ravenna, Judit Rariga, Michala Riis-Vestergaard, Eyno Rots, Jesse Schreger, Chris Sims, Amir Sufi, Gianluca Violante, Ben Young, and seminar participants at various conferences and seminars. We thank Ádám Szeidl for sharing CEU's establishment location dataset, Elisabeth Beckman and the Austrian Central Bank for sharing the Euro Survey data, and János Köllő for sharing T-Star data. Réka Zempléni provided excellent research assistance. The views in this paper are solely those of the authors and do not necessarily reflect the views of the National Bank of Hungary.

Contents

Abstract

We examine the consequences of a sudden increase in household debt burdens by exploiting variation in exposure to household foreign currency debt during Hungary's late-2008 currency crisis. The revaluation of debt burdens leads to higher default rates and a collapse in spending. These responses lead to a worse local recession, driven by employment losses at non-exporting firms, and negative spillover effects on nearby borrowers without foreign currency debt. The estimates translate into a multiplier on higher debt service of 1.67. The impact of debt revaluation is particularly severe when foreign currency debt is concentrated on household, rather than firm, balance sheets.

JEL: E2, E3, G2, F3, D12.

Keywords: household debt, foreign currency debt, currency crisis, financial crisis, business cycles.

Összefoglaló

A tanulmány a lakossági eladósodottság váratlan növekedésének hatásait vizsgálja, a 2008-at követő magyar lakossági devizahitel válságot értékelve. Az árfolyam leértékelődése miatti adósság átértékelődés magasabb nemteljesítési arányt és alacsonyabb fogyasztást eredményez. Ezek mélyebb helyi recesszióhoz vezetnek, amit a nem exportáló vállalatok visszaeső foglalkoztatottsága okoz. Az adósság átértékelődés a helyi, nem devizában eladósodott hitelesekre is hatással van. Ezek az eredmények 1,67-es adósságszolgálat multiplikátort jelentenek. Az adósság átértékelődésnek a hatása különösen negatív, ha a devizaadósság a háztartásoknál és nem pedig a vállalati szektornál van.

1 Introduction

Rapid credit expansions are often followed by severe economic downturns.[1] One explanation for this pattern is that a high burden of debt itself acts as a contractionary channel. The contractionary effects of debt can be especially severe when debt is denominated in *foreign currency*, as a depreciation against the funding currency leads to debt revaluation that can impair private sector balance sheets. While foreign currency financing by firms has received considerable attention, *households* often also borrow in foreign currency. A prominent recent case is the rapid growth in foreign currency household credit throughout emerging Europe in the 2000s, which was followed by large debt revaluations and severe household financial distress during the 2008 financial crisis. These dynamics raise several questions: What role does household foreign currency debt revaluation play in exacerbating economic crises? How does an economy adjust to a sudden increase in household debt burdens? And does it matter whether it is households or firms who borrow in foreign currency?

In this paper, we examine how a revaluation of household foreign currency debt affects the real economy in a currency crisis. Focusing on the case of Hungary, we exploit individual and spatial variation in households' exposure to foreign currency debt during the sharp depreciation of the Hungarian forint starting in late-2008. We provide three main results on the effects of household debt revaluation. First, the household debt revaluation causes a significant increase in household financial distress and a worse local recession, driven by a decline in local demand. Second, the debt revaluation has negative spillovers on nearby households, including households without foreign currency debt. Third, the contractionary effects of debt revaluation on the local economy are more severe when foreign currency debt is concentrated in the household sector, rather than the corporate sector.

Hungary provides an ideal setting to study the consequences of household foreign currency debt revaluation for two reasons. First, in 2008, 69 percent of household debt was denominated in foreign currency, primarily Swiss franc. Second, Hungary experienced a sharp depreciation of over 30 percent in late 2008. The depreciation was largely unexpected and was driven by factors unrelated to the household sector in Hungary, including a strong appreciation of the Swiss franc. This combination led to a sudden increase in household debt to GDP of over 6 percentage points. While we focus on Hungary, foreign currency retail lending, especially to households, was widespread throughout emerging Europe in the 2000s, leading to "unprecedented" levels of currency mismatch (Ranciere et al. (2010)).

We use administrative household credit registry data from Hungary to construct a new dataset on household debt and default at the individual and regional level. We match these household credit data at the regional level with measures of household spending, unemployment, and house prices. Moreover, we combine these data with firm-level census and credit registry data that include information on employment, investment, banking relationships, export status, payrolls, and firm debt by currency. Our data, therefore, provide a complete picture of private non-financial foreign currency borrowing. This allows us to compare the determinants and consequences of household and firm foreign currency financing.

Our empirical approach exploits variation in exposure to foreign currency debt across individuals and regions around the large depreciation of the Hungarian forint. Variation is primarily driven by the timing of borrowing due to changes in the availability of government-subsidized local currency loans. Areas with a greater initial depth of domestic banks experienced more domestic currency lending at first. After the subsidy was curtailed, foreign banks, the main foreign currency lenders, greatly expanded their branch network. This led to a catch up in indebtedness and higher foreign currency debt exposure in initially underserved regions.

At the individual level, various survey datasets reveal that foreign and local currency borrowers are broadly similar on observable dimensions, with foreign currency borrowers having slightly higher income and education. At the regional level, areas with a higher share of household debt in foreign currency have similar debt-to-income, loan-to-value ratios, export intensity, and corporate foreign currency debt. However, these regions have lower population, income, and education, as well as higher

[1] Several studies using country or region-level data show that rapid expansions in debt, especially household debt, predict financial crises and more severe subsequent economic downturns (e.g., King (1994),, Jordà et al. (2014), Mian et al. (2017)).

pre-crisis default rates. These patterns suggest that foreign banks lending in foreign currency entered lower income areas previously underserved by domestic banks. In our empirical analysis, we explicitly account for these differences in observable characteristics.

We first show that household debt revaluation leads to a strong increase in household defaults and a decline in durable spending. Using data across 2538 local areas (municipalities), we find that a one percentage point increase in debt-to-income induced by the debt revaluation leads to a 0.15 percentage point increase in default rates and a 1.4 percent decline in auto spending. Household foreign currency debt explains 71 percent of the rise in overall default rates, abstracting from aggregate equilibrium effects. The strong default and consumption response to debt revaluation is consistent with models with incomplete markets where households have unhedged foreign currency debt positions.

Next, we investigate how the household debt revaluation affects local labor markets. Standard theoretical models have different predictions about how a debt revaluation affects real activity. In neoclassical open economy models with flexible prices, debt revaluation lowers consumption, but increases employment and output, as households boost labor supply. In contrast, with frictions such as nominal rigidities, the debt-induced decline in consumption translates into a decline in employment and output.

In the data, regions with greater exposure to household foreign currency debt experience a significant and persistent rise in unemployment after the depreciation. A region where all debt is in foreign currency experiences a 1.65 percentage point rise in unemployment, relative to a region with only domestic currency debt. Exploiting firm-level census data, we show that the rise in unemployment is driven by employment losses at non-exporting firms and firms in the non-tradable sector. By contrast, exporting firms are unaffected. The rise in unemployment is consistent with the importance of local household demand effects on real activity. In terms of magnitudes, the estimates imply that a $29,000 (2008 PPP) increase in debt service destroys one job-year. This "debt service-per-job" estimate translates into an estimated peak output multiplier of 1.67 two years after the initial depreciation.

Why does the household debt revaluation lead to persistently higher local unemployment? We find evidence of limited adjustment through wage declines, migration, or reallocation to exporting firms, consistent with models containing frictions such as nominal and real rigidities. In addition, regions with more exposure to household foreign currency debt experience a persistent relative decline in house prices after the depreciation. The amplification through house price declines is broadly consistent with recent models of pecuniary externalities from collateralized foreign currency borrowing (e.g., Mendoza (2010), Bianchi (2011), Korinek (2011)).

The rise in unemployment and decline in house prices likely affects all households in a local economy, including those that did not borrow in foreign currency. The shock may thus propagate across households. We find direct evidence that foreign currency debt has negative spillover effects on other borrowers using loan-level data. A borrower living in regions where other households borrowed heavily in foreign currency is more likely to default, conditional on the borrower's own foreign currency debt position. The spillovers even affect borrowers with only domestic currency debt. The negative spillover effect is consistent with theories where debt has negative demand and pecuniary externalities (e.g., Farhi and Werning (2016), Korinek and Simsek (2016)).

In the final part of the paper, we compare the consequences of household foreign currency debt and a traditional channel of emerging market crises: firm foreign currency indebtedness. In contrast to households, in this setting, firms with foreign currency debt are strongly positively selected. Firms with foreign currency debt are larger, more productive, faster growing, and more likely to be exporters. Moreover, firm foreign currency debt is primarily denominated in euro, the main invoicing currency for exports. After the depreciation, firms with foreign currency exposure cut back sharply on investment. But these firms see stronger sales and employment growth during the crisis, as they use foreign currency financing to grow more quickly (Salomao and Varela (2016)). As a result, the impact of debt revaluation on the local economy is particularly severe when foreign currency debt is concentrated in the household sector.

This paper contributes to the international finance literature on foreign currency debt and currency crises. This literature has focused on firm, bank, and government foreign currency indebtedness.[2] To our knowledge, our paper is the first to analyze the effects of *household* foreign currency debt, despite the prevalence of household foreign currency debt throughout emerging

[2] Eichengreen and Hausman (2005) provide an overview of foreign currency financing in emerging markets. A number of studies analyze the causes and consequences of firm foreign currency exposures in emerging market crises (e.g. Krugman (1999), Caballero and Krishnamurthy (2003)). Some

Europe in the 2000s and several previous crises. In addition, whereas the previous literature has documented a foreign currency balance-sheet effect at the firm level, we show that household foreign currency exposure has local aggregate effects, including negative spillover effects on other borrowers. We thus also provide empirical evidence on the classic Transfer Problem, which asks how the economy adjusts to an increase in external debt burdens (Keynes (1929)).

This paper also contributes to a growing literature on household leverage and business cycles. A long tradition in macroeconomics, going back to Fisher (1933)'s "debt-deflation" hypothesis, emphasizes that a combination of high household debt, deleveraging, and asset price declines can exacerbate output declines in a recession.[3] To examine the role of debt, the existing literature has primarily focused on the consequences of expansions in household debt prior to crises.[4] However, expansions in household debt are often part of a broader cycle in real activity and financial conditions, which makes it difficult to disentangle whether and why higher debt itself causes more severe recessions. We contribute to this literature by tracing the effect of a shock directly to household debt, which allows us to estimate the direct effects of higher household debt, holding fixed other cyclical factors, capturing what Auclert (2016) refers to as the "Fisher channel" of nominal debt revaluation.

Our analysis, therefore, also connects with recent studies showing that borrowers who experience debt payment reductions have a lower probability of default and use additional funds to increase spending on durables (e.g., Agarwal et al. (2016), Di Maggio et al. (2017), Ganong and Noel (2019)). Relative to these studies, we examine a large shock to debt, with variation across individuals and regions. This allows us to focus on local equilibrium effects, estimate a multiplier on higher debt service, and show that foreign currency financing has negative spillover effects. Auclert et al. (2019) also explore local aggregate implications of debt and find that U.S. states with more generous bankruptcy exemptions experienced smaller declines in employment in the Great Recession.

The remainder of the paper is structured as follows. Section 2 discusses the background on the foreign currency debt crisis in Hungary. Section 3 describes the data. Section 4 discusses the theoretical framework and empirical methodology. Section 5 presents the main results and a host of robustness checks. Sections 6 and 7 provide evidence on the mechanisms and spillover effects of FC debt. Section 8 compares the impact of household and firm foreign currency exposures, and section 9 concludes.

firm-level studies find that firm foreign currency debt depresses investment and leads to higher firm exit rates (e.g., Aguiar (2005), Kim et al. (2015), Du and Schreger (2015)), but other studies suggest that many firms with FC debt are positively selected and often naturally hedged (e.g., Bleakley and Cowan (2008)). Cross-country studies find that the country-level FC debt exposure increases the probability and severity of a sudden stop crisis (e.g., Calvo et al. (2008)), but the use of aggregate data makes it difficult to disentangle the role of household, firm, and bank balance sheet effects, as well as other country-level shocks and policy responses.

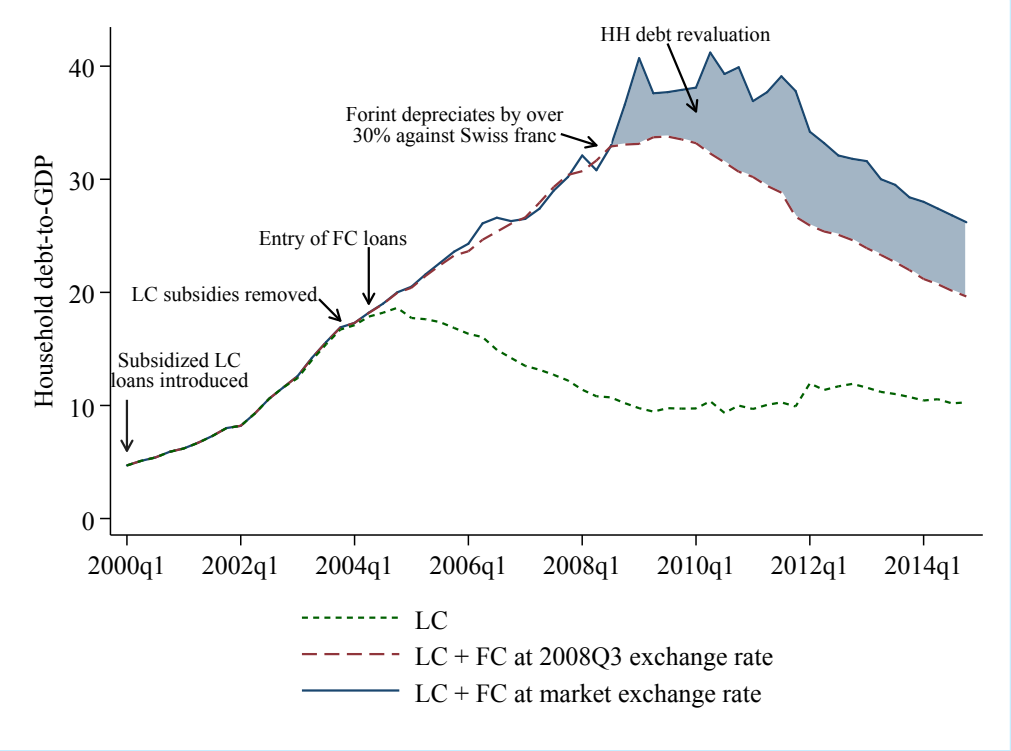
[3] See, for example, Mishkin (1978), King (1994), Iacoviello (2005), Mian et al. (2013), Eggertsson and Krugman (2012), Korinek and Simsek (2016), and Guerrieri and Lorenzoni (2017).

[4] Relevant studies include Schularick and Taylor (2012), Dynan (2012),, Jordà et al. (2014), Mian et al. (2017), Di Maggio and Kermani (2017), and Mian et al. (2019).

2 The Hungarian Foreign Currency Debt Crisis

Foreign currency (FC) retail lending was widespread throughout Europe prior to the 2008 financial crisis, especially in new EU member states.[5] Hungary experienced a particularly rapid expansion in household credit in both domestic and foreign currency. Figure 1 shows that between 2000 and 2008 household debt to GDP increased by 28 percentage points. The expansion was financed mainly by two categories of loans: government-subsidized local currency (LC) housing loans and unsubsidized foreign currency (FC) loans. In September 2008, 69 percent of outstanding housing debt was denominated in foreign currency, primarily Swiss franc. This directly exposed household balance sheets to the large depreciation of the Hungarian forint in the Global Financial Crisis.

Figure 1
Household Debt Revaluation



Notes: This figure shows the expansion in total household debt-to-GDP by currency and the revaluation of foreign currency debt induced by the depreciation of the Hungarian forint.

Household lending in Hungary was initially spurred by a government housing program that provided interest rate subsidies on LC mortgages. The subsidy was introduced in 2000 and fixed nominal interest rates for borrowers at levels similar to euro interest rates (4 to 6 percent).[6] Subsidized LC lending was driven primarily by domestic mortgage banks, as these banks had

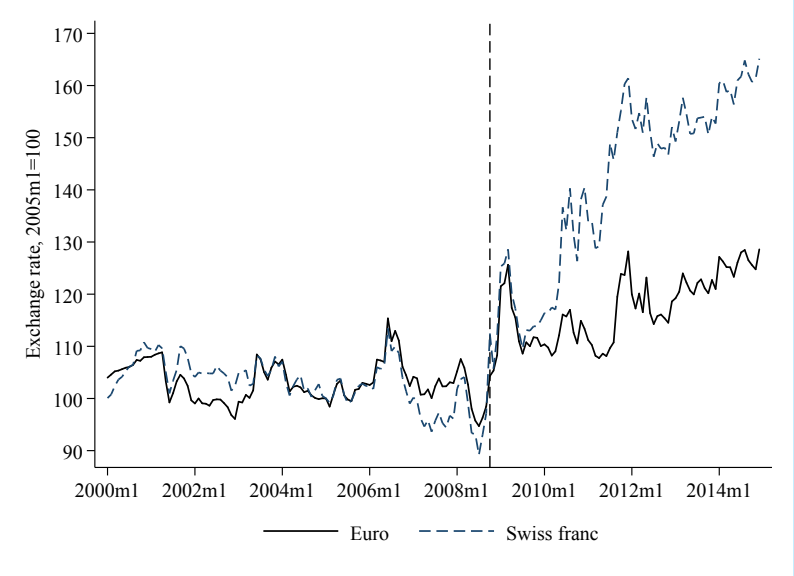
[5] For example, during the 2000s, a large proportion of housing and consumption loans were denominated in FC in the following countries: Austria, Iceland, Estonia, Latvia, Lithuania, Poland, Hungary, Slovenia, Croatia, Serbia, Bosnia and Herzegovina, Bulgaria, Romania, and Ukraine. Household lending in Swiss franc and yen was also common in Denmark, Greece, Spain, and the UK. Household foreign currency debt also played a role in previous currency crises in both advanced and emerging markets. In Australia during the first half of the 1980s, a substantial amount of bank lending to consumers and farmers was denominated in Swiss franc and Japanese yen, leading to widespread defaults and bankruptcies following the depreciation of the Australian dollar starting in 1986. As another example, prior to Argentina's crisis and devaluation in 2002, 80 percent of mortgages were denominated in U.S. dollars (IMF (2003)).

a tax advantage in originating subsidized loans (Rózsavölgyi and Kovács (2005)). Since average retail banking density following the transition from communism was low, subsidized LC housing credit growth was strongest in regions with a higher historical density of domestic mortgage banks.

The domestic currency mortgage subsidy program placed a significant burden on public finances, and subsidies on new loans were unexpectedly cut back in early 2004. The increased cost of LC loans led foreign banks to enter the retail lending market and compete with domestic banks by offering low-interest-rate FC housing loans. Figure 1 shows that the FC credit expansion began in the middle of 2004. Foreign banks competing for market share expanded FC credit aggressively, especially to areas with lower subsidized debt (Banai et al. (2011)). Interest rates on Swiss franc and euro loans averaged 4 to 6 percent, which implied savings of about 5 percentage points relative to domestic currency loans at market rates, holding the exchange rate constant. The increased foreign currency debt exposure was almost entirely unhedged, as households income and assets in foreign currency were negligible (Backé et al. (2007)).

The foreign currency credit expansion occurred during a stable exchange rate environment. Figure 2 shows that the forint exchange rate remained stable against the euro and Swiss franc up to October 2008. Up until February 2008, the National Bank of Hungary (MNB) maintained a crawling band with respect to the euro. Meanwhile, the Swiss franc was quasi-fixed against the euro.[7] This stability led market participants to believe that a large depreciation was unlikely. In a survey from November 2008, Pellényi and Bilek (2009) find that 87 percent of respondents with an FC loan did not expect exchange rate volatility at the late 2008 level. Appendix Figure 10 shows that Consensus Forecast also predicted a stable forint-euro exchange rate in mid-2008. Further, Hungary joined the EU in May 2004 and initially targeted adopting the euro in 2007. Survey evidence shows that the expectation of adopting the euro also boosted FC loan demand (Fidrmuc et al. (2013)).

Figure 2
Exchange Rate Dynamics



Notes: This figure shows the evolution of the forint-euro and forint-Swiss franc exchange rates. The de facto ±5 percent crawling band target maintained until February 2008 was followed by a series of depreciations starting in October 2008. The vertical dashed line represents September 2008, the month prior to the forint depreciation.

Following a decade of exchange rate stability, the forint depreciated by 27.5 percent against the euro and 32.3 percent against the Swiss franc between September 2008 and March 2009. The initial depreciation was caused by the general flight to safety away from emerging markets and was exacerbated by investor concerns about the Hungarian government's large external financing needs.[8] The forint weakened further against the Swiss franc in 2010 and 2011, as the Swiss franc appreciated during

[6] Unsubsidized local currency loans with market interest rates comprised 7 percent of local currency housing loans in September 2008. The typical subsidized mortgage loan had a 15- to 20-year maturity with a fixed rate for the first five years and capped interest rates paid by households at 6 percent. This placed all interest rate risk on the government budget. See Vas and Kiss (2003) for an overview of housing finance policies in Hungary.

[7] Ilzetzki et al. (2019) classify the forint regime as a *de facto* ±5 percent band around the euro and the Swiss franc regime a ±2 percent band around the euro.

the Eurozone crisis. From the perspective of this study, the depreciation provides a promising shock, as it was not caused by distress in household credit markets. This allays concerns of reverse causality from household distress to exchange rate depreciation.

Figure 1 compares the value of aggregate household debt at market exchange rates relative to a counterfactual where the exchange rate had remained at its September 2008 value. The large depreciation revalued household debt burdens by 6 percent of GDP by mid-2010.[9] The impact of the depreciation on debt service was reinforced by interest rates increases on variable rate unsubsidized loans (Szigel (2012)). Interest rate increases primarily affected foreign currency loans, as interest rates on subsidized domestic currency mortgages were capped. Interest rate increases have an analogous effect on debt service as an additional depreciation, and rising interest rates account for approximately 25 percent of the increase in debt service payments in the crisis.[10] For example, from September 2008 to the end of 2011, debt service for the average FC housing loan rose by 77 percent, with 58 percentage points of the increase being driven by the exchange rate depreciation and the remainder by higher interest rates.

The depreciation was associated with a current account reversal and a severe recession, marked by an especially sharp fall in consumption. Appendix Figure 11 presents the dynamics of other key aggregate variables. It shows that private consumption fell more than output and had yet to recover to its pre-crisis level by early 2015.

[8] Hungary received a $25 billion IMF loan to meet the government's external financing gap in late October 2008.

[9] Starting in the second half of 2011, the newly elected government implemented a variety of policies to alleviate the sharp rise in monthly installments. These efforts culminated in the conversion of the entire stock of foreign currency housing loans into domestic currency in November 2014. Our analysis focuses primarily on the period between 2008 and 2012, prior to when these policies were implemented.

[10] Variable rate loans originated by banks operating in Hungary generally did not specify an underlying benchmark and spread. This allowed banks to unilaterally increase interest rates relative to Swiss franc benchmark rates during the crisis. In 2014, the Hungarian Supreme Court (Curia) ruled that this practice was unlawful and required banks to provide compensation for borrowers in early 2015.

3 Data and Summary Statistics

We construct a new dataset at the regional level with information on household debt by currency and loan type, default, spending, unemployment rate, house prices, wages, and demographic variables. The primary level of aggregation in our data is a *settlement* (municipality). From the 3,152 settlements in Hungary, we construct a balanced panel covering 2538 settlements for which our main outcome and control variables are non-missing. The average population in our sample of settlements is 3,890 in 2007, and the sample covers 98.2 percent of the total population. We match this regional dataset with firm-level census data on employment, exports, balance-sheet information, and bank credit. For the analysis of individual defaults and local spillovers in section 7, we also use the underlying loan and individual-level credit registry data. This section summarizes the key features of the data. Appendix 11 provides further details on the data sources and variable definitions.

3.1 HOUSEHOLD CREDIT REGISTRY

The Hungarian Household Central Credit Information System (Household Credit Registry) contains all loans extended by all credit institutions to individuals outstanding on or after April 2012. The credit registry records information on the loan type, loan amount, date of origination, maturity, monthly payments, default status, and currency.[11] The household credit registry also reports the borrower's settlement of residence. The credit registry, however, does not report loan-to-value (LTV) ratios, so we estimate settlement LTV ratios combining credit registry information on lending by bank with bank-currency-year level information on the LTV distribution of new originations (see Appendix 11.1.6).

In order to measure a settlement's FC debt exposure prior to the 2008 forint depreciation, we reconstitute the credit registry back to 2000. Specifically, we use an annuity model and detailed interest rate data to estimate monthly payments and outstanding debt prior to 2012 for all loans in the credit registry. We then rescale local debt measures to match the aggregate Financial Accounts by currency. The unscaled credit registry accounts for 80.5 percent of aggregate housing debt in the Financial Accounts in September 2008. In Appendix 11 we also show that the annuity model also performs well at the loan level.

Loans that are terminated (repaid or refinanced) before 2012 but were outstanding in September 2008 present a potential measurement error problem for the estimation of a settlement's FC debt exposure. This primarily affects foreign currency loans, as, in the fall of 2011, the Hungarian government implemented an Early Repayment Program (ERP) that retired 21 percent of outstanding foreign currency debt. Accounting for the ERP raises the coverage of the credit registry in 2008 from 80.5 percent to 96 percent of aggregate housing debt.

In Appendix 11, we show that the main results in this paper are robust to three separate adjustments that proxy for debt prepaid in the ERP. The first adjustment uses a separate dataset on the universe of loans for three anonymous large banks in Hungary with a market share of 24 percent to approximate the amount of debt repaid through the 2011 ERP in each settlement. The second approach imputes the amount of debt prepaid in a settlement with the amount of new domestic currency borrowing (refinancing) during the window when the ERP was in operation. The third approach allocates debt prepaid per capita across settlements based on an assumed elasticity with respect to income or education. We experiment with a range of elasticities and find that the results are quantitatively similar for reasonable parameters.

Finally, in Appendix 11, we show that the aggregate default rate for loans in the credit registry closely matches the default rate reported separately from bank balance sheets before and during the crisis (see Appendix section 11.1.3). This suggests that the credit registry accurately captures the increase in credit risk during the crisis, even though some loans are missing.

[11] The household credit registry was preceded by a negative registry that contained information on default. Prior to 2010, the negative registry contains information on the most recent default. This allows us to extend default status back to 2006. Section 11.1.3 in the Online Appendix provides more detail on the default measure.

3.2 SETTLEMENT AND FIRM-LEVEL DATA

The main settlement-level variables are from the Hungarian Central Statistics Office (KSH). We proxy for settlement household durable spending using new auto registrations. KSH also provides settlement-level information on the unemployment rate (number of unemployed relative to working-age population), household income, tax payments, population, and net migration. Settlement level education shares are obtained from the 2011 census. We estimate settlement-level nominal hourly wages from the Structure of Earnings Survey, an annual survey of about 150-200 thousand workers, adjusting for compositional changes in the workforce following the procedure outlined in Beraja et al. (2016). We also use subregional (NUTS-4) house price indexes estimated from the National Bank of Hungary's home purchase transactions database.

Firm-level data are from corporate tax filings to the Hungarian Tax Authority (NAV) and include employment, payroll, export sales, and investment at the firm level for all double-bookkeeping firms in Hungary. The median firm has one establishment (including the headquarters), and, on average, a firm has establishments in 1.66 settlements. We therefore define a firm's exposure to local household FC debt by the settlement of the headquarters.[12] We construct a balanced panel and exclude firms with fewer than 3 employees and firms in the finance, real estate, public administration, education, and health and social work sectors. This yields a panel of 66,267 firms that we follow through the crisis from 2006 to 2012. Finally, we obtain firm debt by currency and firm default by matching loan-level data from the Hungarian Firm Credit Registry.

3.3 SUMMARY STATISTICS

Panels A and B of Table 1 report summary statistics for the settlement-level sample. The household FC debt share in September 2008, s^{FC}_{z08}, has a mean of 66 percent and a standard deviation of 8 percentage points. The household default rate rose by 3.9 percentage points between 2008 and 2010, and the unemployment rate increased by 2.1 percentage points. Auto spending fell by 70 percent (1.2 log points) on average, while house prices declined 7 percent. Panel C reports summary statistics for our sample of firms. Average employment growth from 2008 to 2010 was -6 percent. The average firm FC debt share is 11 percent, and 18 percent of firms have FC debt. One-fifth of firms are exporters and 18 percent are in the manufacturing sector.

[12] Results are similar if we only use single-establishment firms or if we take the establishment weighted average of household FC debt exposure.

Table 1
Summary Statistics

A: Foreign Currency Exposure	N	Mean	Std. dev.	10th	90th
HH FC debt share, s^{FC}_{z08}	2538	0.66	0.08	0.56	0.77
HH debt revaluation, 2008-10, $\Delta\widetilde{d}_z$	2538	22.15	2.20	19.64	24.97
HH debt to inc. revaluation, 2008-10, $\Delta\widetilde{d}^{Inc}_z$	2538	16.20	4.23	11.28	22.06
Fraction of housing loans in FC, 2008:9	2538	0.64	0.08	0.56	0.75
B: Settlement-Level Variables					
Default rate change, 2008-10	2538	3.85	2.09	2.32	5.89
Log new auto registration change, 2008-10	2538	-120.93	44.09	-177.07	-83.30
Unemployment rate change, 2008-10	2538	2.08	1.39	0.87	3.51
House price growth , 2008-10	2538	-6.82	18.45	-23.60	9.85
Debt to disp. income, 2008	2538	0.67	0.22	0.45	0.89
Disp. income per capita, 1000 HUF, 2007	2538	842.57	212.79	544.25	1,103.61
Vocational share	2538	0.20	0.05	0.12	0.26
High school share	2538	0.28	0.07	0.18	0.35
College share	2538	0.16	0.08	0.05	0.29
Share of population age 18-59, 2007	2538	0.61	0.03	0.59	0.64
Share of population age 60+, 2007	2538	0.22	0.03	0.17	0.25
Unemployment rate, 2007	2538	6.24	4.67	2.12	12.36
Housing loan default rate, 2008:9	2538	0.92	1.15	0.00	1.87
House price growth, 2003-07	2538	25.55	16.00	7.23	48.55
LTV	2538	0.62	0.03	0.58	0.65
Change in LTV, 2004-05 to 2007-08	2538	0.07	0.05	0.01	0.11
Firm default rate, 2008:Q3	2538	5.98	5.81	0.00	10.00
C: Firm-Level Variables					
Employment growth, 08-10	66267	-6.04	45.31	-66.67	40.00
Corporate FC debt share, 2007	66267	0.11	0.28	0.00	0.53
Firm has positive FC debt	66267	0.18	0.38	0.00	1.00
Export share of sales, 2007	66267	0.05	0.18	0.00	0.09
Exporter	66267	0.20	0.40	0.00	1.00
Manufacturing	66267	0.18	0.38	0.00	1.00
State owned	66267	0.00	0.06	0.00	0.00
Foreign owned	66267	0.07	0.25	0.00	0.00

Notes: Panels A and B report summary statistics for settlement (municipality) level variables. Observations are weighted by 2007 population. Panel C presents summary statistics for the firm-level census sample.

4 Theory and Empirical Framework

4.1 THEORETICAL PREDICTIONS

We are interested in how a revaluation of household foreign currency debt affects household spending and real economic activity. In line with our empirical setting, our discussion here will focus on a permanent increase in the value of long-term household debt obligations owed to foreign creditors.

4.1.1 CONSUMPTION RESPONSE TO A HOUSEHOLD DEBT REVALUATION

In the benchmark case of an open economy model with complete markets, the currency composition of debt does not affect household consumption or aggregate activity. In the classic model of Backus and Smith (1993), consumption is pinned down by an international risk sharing condition, which implies that consumption *increases* with a real exchange rate depreciation. Even without complete markets, households may be naturally hedged against an exchange rate depreciation through tradable income or wealth. Households may select into borrowing in foreign currency based on their foreign currency asset positions. Therefore, a necessary condition for a foreign currency debt revaluation to affect the real economy is for households to have unhedged exposure to FC debt.

An unhedged, permanent revaluation of long-term foreign currency debt burdens leads to an increase in present and future debt service obligations. This represents a decline in wealth for borrowers and the economy as a whole, depressing consumption. The strength of the consumption decline varies with the importance of precautionary savings motives or liquidity constraints and the remaining maturity of the debt obligation.

It is useful to first consider the consumption response in two polar cases: a permanent income (PI) consumer and a hand-to-mouth (HtM) consumer. For a PI consumer, the partial equilibrium consumption decline to the debt revaluation is the annuity value of the increase in debt, $r\Delta d$ (e.g, Hall (1978)). Here, Δd is the increase in debt and r in the interest rate faced by the consumer (see Appendix 12 for details). In contrast, for an HtM consumer, an extreme example of liquidity constraints, consumption declines one-for-one with the increase in per period debt service.

When debt obligations are short-term, the consumption response is substantially larger for an HtM agent. For example, if the debt is one period, the HtM consumer has to repay the entire revalued debt in that period, so the consumption decline is $\frac{1+r}{r}$ times larger than for the PI consumer. As the maturity increases, the HtM consumption response approaches the annuity value response of the PI consumer. In the limit of non-amortizing perpetual debt, the responses are identical. In our sample, the average housing loan has a remaining maturity of 18 years, which implies that the increase in debt service is about 1.5 to 2 times larger than the annuity value of the increase in debt (see Appendix 12 for details). Thus, the difference between the HtM and PI response is an order of magnitude smaller for a revaluation of long-term debt burdens than a transitory liquidity shock.

A variety of theories, beyond the basic HtM model, predict that the consumption response to a debt revaluation is larger than in the PI model. In the presence of a precautionary-savings motive and uninsurable income risk, consumption is concave in household net worth, so consumption is more sensitive to current resources than in the PI model (e.g., Carroll (2001)). de Ferra et al. (2019) develop a model of a household foreign currency debt revaluation and find that the consumption decline is larger when debt is concentrated among poorer households. The precautionary savings model also implies that an increase in *uncertainty* about the future exchange rate also strengthens the consumption decline.

Theories of credit constraints also predict that consumption responds more strongly to an increase in debt service than implied by the PI model. Financial accelerator models imply that an increase in debt lowers household creditworthiness and access to new financing (e.g., Bernanke and Gertler (1989)). For example, the large increase in debt can drive borrowers into negative equity, inhibiting the ability to refinance into local currency debt or lower interest rates.

4.1.2 DEBT REVALUATION AND REAL ACTIVITY

How does the increase in debt affect real economic activity? This depends on macroeconomic and financial market frictions. In an open economy neoclassical model with variable labor supply, the decline in household wealth induced by the debt revaluation leads households to boost labor supply, as leisure is a normal good (e.g., Devereux and Smith (2007)). With flexible prices and without other frictions, this labor supply effect translates into an increase in output. Similarly, Chari et al. (2005) and Lorenzoni (2014), show that a sudden stop that forces households to repay external debt raises output through an increase in labor supply.[13]

Macroeconomic frictions, such as nominal rigidities, however, can make the household debt revaluation contractionary, rather than expansionary. When prices and wages cannot adjust downward, the debt-induced decline in demand translates into lower employment. In Appendix 13, we present a standard New Keynesian small open economy model based on Galí and Monacelli (2005) that illustrates the contrasting neoclassical and Keynesian effects of a debt revaluation. Estimation of the impact of a debt revaluation, therefore, provides a test of standard flexible price versus sticky price open economy models, providing a useful "identified moment" for macroeconomic models (Nakamura and Steinsson (2018)). New-Keynesian models also predict that the decline in demand will have a stronger impact on output in more closed economies with less demand "leakage." Real rigidities, such as frictions that inhibit a reallocation of employment towards exporting firms, strengthen the negative effects of debt on output (e.g., Huo and Ríos-Rull (2016)).

In the presence of nominal rigidities, household foreign currency borrowing may be excessive from a social perspective. Farhi and Werning (2016) present a model with nominal rigidities and incomplete markets, where households can borrow using both foreign and local currency debt. In their model, borrowers do not internalize the contractionary equilibrium effects of a debt revaluation when making financing decisions, implying that foreign currency debt is associated with a negative demand externality. If the exchange rate tends to depreciate in bad times, a social planner would optimally choose to tax the accumulation of foreign currency debt.

Financing frictions can also amplify the equilibrium decline in consumption and output. The rise in debt may increase defaults and foreclosures, leading to fire sales that depress local house prices. A decline in house prices lowers household net worth and can tighten collateral constraints, further lowering consumption (Kiyotaki and Moore (1997)). A worse recession itself also depresses house prices, creating a two-way feedback between the demand and fire-sale channels. The decline in demand may also put downward pressure on domestic prices and reinforce the initial exchange rate depreciation, further increasing the value of foreign currency debt. Models of "international debt-deflation" stress the role of collateral constraints in amplifying the balance sheet effects of foreign currency debt following a depreciation (e.g., Mendoza (2010), Korinek (2011), Bianchi (2011)).

What about an offsetting increase in spending by savers? In a closed economy, a debt revaluation would represent a transfer to savers, who can offset the decline in spending by borrowers. If savers have a lower marginal propensity to consume (MPC) than borrowers, the shock would still depress aggregate consumption, as in the two-agent model of Eggertsson and Krugman (2012). In the small open economy context, the MPC of foreign savers on the output of the small open economy is likely close to zero. In this regard, the international debt revaluation examined in this paper can be seen as analogous to the closed economy case where savers have an MPC of zero.

4.2 EMPIRICAL SPECIFICATION

Our empirical specification isolates the debt revaluation channel by comparing the evolution of outcomes in regions with high exposure to foreign currency debt, relative to regions with low exposure, around depreciation of the Hungarian forint that started in October 2008. The basic empirical specification is:

$$y_{zt} = \alpha_z + \gamma_t + \beta(\text{HH FC Debt Exposure})_{z08} \times \text{Post}_t + \epsilon_{zt}, \quad (1)$$

[13] The labor supply expansion channel holds for most standard preferences assumed in the literature, including balanced-growth preferences. The same supply-side logic applies to why fiscal stimulus is expansionary in neoclassical models with variable labor supply (Ramey (2011)). An exception is GHH (quasi-linear) preferences, which eliminate the wealth effect on labor supply. Debt can also lower labor supply through a debt overhang effect (e.g. Donaldson et al. (2016)). Given that there was no consumer bankruptcy code in Hungary at the time of the crisis and therefore a small degree of limited liability, the wealth effect likely dominates the debt overhang effect in this context.

where y_{zt} is an outcome such as spending in settlement z, (HH FC Debt Exposure)$_{z08}$ is a measure of household exposure to FC debt prior to the depreciation, α_z and γ_t are settlement and time fixed effects, respectively, and Post$_t$ is a variable that equals zero up to 2008 and one from 2009 onwards.

We also estimate the impact of the household debt revaluation over time to test for pre-trends and the full dynamic propagation of the shock using

$$y_{zt} = \alpha_z + \gamma_t + \sum_{k \neq 2008} \left[\beta_k (\text{HH FC Debt Exposure})_{z08} \times \mathbf{1}_{k=t}\right] + \epsilon_{zt}, \tag{2}$$

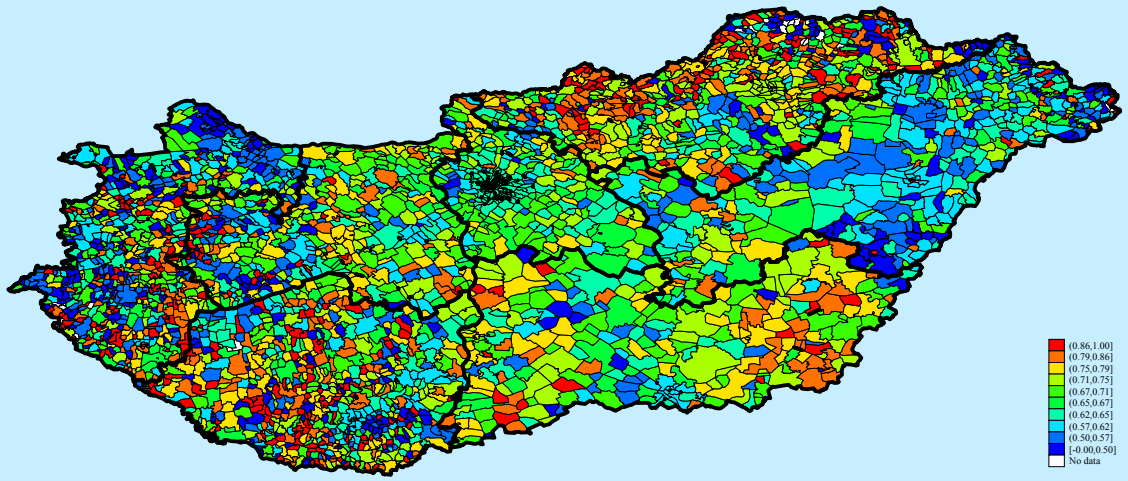
where $\mathbf{1}_{k=t}$ is an indicator that equals one in year t and zero otherwise. We expect that the dynamic impact of the shock may differ across outcome variables. For example, spending may decline immediately with the increase in debt obligations, whereas the impact on local unemployment may be more gradual.

We estimate (1) using a balanced panel of 2538 settlements, but we cluster standard errors on 175 subregions based on a test of the appropriate level of clustering developed by Ibragimov and Müller (2016). Our preferred specification weights by settlement population in 2007, but we report robustness checks for alternative weighting schemes.

Our baseline measure of local exposure to foreign currency debt is the *share* of household debt in foreign currency in September 2008, s^{FC}_{z08}. In September 2008, 97 percent of FC debt was denominated in Swiss franc. A settlement's share of household debt in FC thus captures most of the variation in exposure to the depreciation.

Figure 3 presents a map of the spatial variation in the household FC debt share, s^{FC}_{z08}. The share of household debt in foreign currency is not strongly clustered in specific regions. The FC debt share ranges from 48 percent on average in the lowest decile to 90 percent in the highest decile, and there is variation in the currency composition of debt within and across major regions.

Figure 3
Geographic distribution of household FC debt exposure



Notes: This figure presents a map of the September 2008 household FC debt share across settlements in Hungary. Thick black lines represent the borders of 7 major regions. The map shows that there is variation both within and across major regions in the FC debt share.

To obtain estimates that are more easily interpretable, we also directly estimate the effect of the *household debt revaluation shock* from 2008:9 to t, defined as

$$\Delta_{08-t}\widetilde{d}_z = \frac{\sum_{j \in C}\left(\mathcal{E}^j_t D^j_{z08} - \mathcal{E}^j_{08} D^j_{z08}\right)}{\sum_{j \in C} \mathcal{E}^j_{08} D^j_{z08}}, \tag{3}$$

where C is the set of currencies, $\mathcal{E}^j_t$ is the forint price of currency j at time t, and D^j_{z08} is debt in currency j in September 2008. The debt revaluation shock captures the percentage increase in debt induced by the depreciation. It can be related to the FC debt shares in each currency j as: $\Delta_{08-t}\widetilde{d}_z = \sum_{j \in C}[(\mathcal{E}^j_{t+h} - \mathcal{E}^j_{08})/\mathcal{E}^j_{08}]s^j_{z08}$.

The FC debt share and the debt revaluation shock exploit variation in the currency composition of household debt, but not the overall *level* of leverage. This allows us to hold fixed the overall expansion in debt, which may be correlated with other cyclical factors. While this is appealing from an identification perspective, from a theoretical perspective the overall increase in debt burdens relative to household resources is what matters. We therefore also present results using the household debt revaluation relative to income, which is defined as

$$\Delta_{08-t}\widetilde{d}_z^{inc} = \frac{\sum_{j\in C}\left(\mathcal{E}_t^j D_{z08}^j - \mathcal{E}_{08}^j D_{z08}^j\right)}{(\text{Household disp. income})_{z08}}. \quad (4)$$

The correlation between this measure and the FC debt share is 0.26. Finally, we present robustness using alternative measures of exposure such as the fraction of loans on FC, the number of FC loans per adult, the share of mortgage debt in FC (i.e. excluding home equity loans), and the share of debt in FC only for loans originated in years 2003 to 2005.

4.3 IDENTIFICATION AND VARIATION IN HOUSEHOLD FC DEBT

Equation (1) provides a consistent estimate of β under the identifying assumption of parallel trends. More precisely, identification assumes that the change in an outcome y_{zt} in low s_{z08}^{FC} settlements is a valid counterfactual for high s_{z08}^{FC} settlements, had those regions not been exposed to the depreciation through household FC debt. The threat to identification is a time-varying, region-specific shock that affects y_{zt} and is correlated with exposure to foreign currency debt.

A potential concern with our empirical strategy is that FC and LC borrowers may have different exposure to business cycle risk. *A priori*, the sign of such potential selection into FC loans is ambiguous, both at the individual and regional level. Households with higher or less risky income may be more likely to borrow in foreign currency.[14] Foreign banks, the main providers of FC credit, may also "cherry-pick" borrowers with low default risk (Beck and Brown (2015)). On the other hand, less financially sophisticated households who are more exposed to recession risk may be more likely to borrow in FC because they do not adequately assess exchange rate risk.

Table 2
Local and Foreign Currency Borrowers in Household Survey Data

	LC	FC	Non-borr.	FC−LC	FC−LC
	Mean	Mean	Mean	Difference	S.E.
Low education	0.18	0.12	0.27	-0.06	0.01
Medium education	0.64	0.67	0.57	0.04	0.02
High education	0.18	0.20	0.16	0.02	0.02
Low income	0.30	0.24	0.35	-0.06	0.02
Medium income	0.30	0.26	0.25	-0.04	0.02
High income	0.27	0.32	0.21	0.05	0.02
Age in 2008	41.50	40.56	48.26	-0.93	0.49
Household size	2.91	3.05	2.44	0.14	0.05
Employed	0.62	0.69	0.43	0.07	0.02
City pop. < 5,000	0.33	0.32	0.29	-0.01	0.02
City pop. 5,000 to 100,000	0.42	0.46	0.40	0.04	0.02
City pop. >100,000	0.25	0.22	0.31	-0.02	0.02
Observations	1171	1355	6587	2526	2526

Notes: This table presents average individual-level characteristics of local currency borrowers (LC), foreign currency borrowers (FC), and non-borrowers from the Austrian Central Bank's Euro Survey Project. We pool the biannual samples from 2008 to 2011. Education and income are reported in three categorical groups (low, medium, and high). Foreign (local) currency borrowers are borrowers who report have loans that are solely or predominantly in foreign (local) currency.

Table 2 presents the average characteristics of LC borrowers, FC borrowers, and non-borrowers from a representative survey of households in Hungary collected by the Austrian Central Bank's Euro Survey Project. We use households from the 2008

[14] For example, Beer et al. (2010) find that Swiss franc borrowers in Austria are typically high-income and financially sophisticated households.

to 2011 waves of the survey.[15] Compared to LC borrowers, FC borrowers have similar or slightly higher education, income, and employment rates. FC borrowers also tend to be younger and live in smaller towns. Notably, the difference between FC and LC borrowers is substantially smaller than between borrowers and non-borrowers, with borrowers having higher average education and income.[16] A borrower's loan currency denomination is largely determined by whether the loan was taken out during the subsidized LC period or the FC lending period. This explains why FC and LC borrowers are likely to be reasonably similar along most dimensions, but also why FC borrowers are younger on average.

Table 3
Correlates of Household FC Debt Exposure across Settlements

Right-hand-side variable	Coefficient	S.E.	R^2	*N*
Debt to disposable income, 2008:9	-0.034	0.017	0.008	2538
Log disposable income per capita, 2007	-0.064	0.015	0.048	2538
Log population, 2007	-0.006	0.002	0.031	2538
Share of population age 18-59, 2007	-0.228	0.136	0.005	2538
Vocational education share	0.332	0.097	0.044	2538
High school share	-0.284	0.061	0.051	2538
College share	-0.274	0.089	0.079	2538
Unemployment rate, 2007	0.369	0.096	0.044	2538
Household default rate, 2008:9	0.705	0.222	0.010	2538
Firm default rate, 2008Q3	0.101	0.033	0.005	2538
House price growth, 2003-07	0.133	0.028	0.067	2538
House price growth, 2005-07	0.050	0.040	0.006	2538
LTV	-0.090	0.130	0.001	2538
Change in LTV, 2004-05 to 2007-08	-0.158	0.066	0.009	2538
Export sales share, 2007	-0.026	0.028	0.007	2538
Export sales per capita, 2007	-0.168	0.630	0.000	2538
Log sales-employment ratio, 2007	-0.011	0.008	0.008	2538
Corporate FC indebtedness, 2008, $s_{z08}^{FC,Firm}$	-0.012	0.022	0.001	2538
Manufacturing employment share, 2007	0.008	0.019	0.001	2538
Construction employment share, 2007	0.011	0.038	0.000	2538
Agriculture employment share, 2007	0.042	0.023	0.005	2538

Notes: The table presents regressions of the September 2008 household foreign currency debt share on various settlement level characteristics: $s_{z08}^{FC} = \alpha + \beta x_z + u_z$. *Observations are weighted by 2007 population. Standard errors are clustered at the subregion level (175 units).*

While FC and LC borrowers are similar at the individual level, our analysis primarily exploits regional variation to examine the impact on local aggregate economic activity. Table 3 presents regressions of s_{z08}^{FC} on various settlement-level characteristics to provide a sense of the correlates of local HH FC debt exposure. The FC debt share is uncorrelated or weakly correlated with overall household debt to income, the average LTV ratio, export exposure of local firms, manufacturing and construction employment shares, and corporate FC indebtedness. The household FC debt share is also uncorrelated with house price growth from 2005 to 2007, but positively correlated with house price growth from 2003 to 2007.[17]

[15] The Euro Survey Project is a biannual survey that collects information on the role of the euro and other foreign currencies in Central and Eastern European countries. Results are similar, but less precise, using only the 2008 wave. Because lending effectively stopped after the depreciation, most borrowers with an FC loan after 2008 would have borrowed prior to the depreciation.

[16] Appendix Table 9 shows that these patterns are similar using another individual-level survey dataset, the Tarki Household Monitor, which also contains information on individuals' loan currency denomination. Table 9 again shows that, compared to LC borrowers, FC borrowers have similar or higher education, income, and employment rates, and that FC borrowers are slightly younger. Other studies using the Euro Survey and other households surveys also find that FC and LC borrowers in Hungary are broadly similar along observable dimensions (Fidrmuc et al. (2013), Pellényi and Bilek (2009)).

At the same time, Table 3 reveals that high s_{z08}^{FC} areas have significantly lower disposable income per capita, education levels, and population and higher pre-crisis unemployment. Areas with higher household FC debt exposure also have significantly higher pre-crisis default rates on household loans, though these relations are generally moderate in magnitude and goodness-of-fit. That is, while FC and LC borrowers are approximately comparable at the individual level according to survey data, FC borrowers tend to live in smaller cities with lower overall income and education and higher credit risk on some dimensions.

One explanation for the negative relation between s_{z08}^{FC} and local population, income, and education comes from the credit supply side. Following the transition from communism, average retail banking depth and competition were low, but varied substantially across regions.[18] Areas with a higher density of domestic banks experienced stronger growth in subsidized domestic currency household credit. Following the cutback of domestic currency subsidies in 2004, foreign banks filled into areas with lower branch density, providing FC credit to previously underserved areas. Appendix Table 10 shows that areas with a higher banking density in 1995 have a higher domestic currency debt-to-income in 2008, lower FC debt-to-income, and therefore a lower share of debt in FC.

In the empirical analysis below, we report estimates that control for pre-crisis settlement-level observables in Table 3, interacted with the Post_t indicator, to capture any time-varying shocks that interact with these observables. In particular, we present tests that control for September 2008 debt to disposable income, log 2007 population, log 2007 disposable income per capita, education (vocational, high school, and college) shares, the population shares age 18-59 and above 60, and the intensity of a public jobs program that was expanded in 2011 (*Baseline controls*).[19]

To capture potential differences in *ex ante* credit quality, we control for the pre-crisis household and firm default rates (measured in 2008Q3), house price growth from 2003 to 2007, average LTV from 2004 to 2008, and the change in LTV between 2004-05 and 2007-08 (*Credit quality controls*). We also control for time-varying regional shocks by including fixed effects for seven major regions (*Region FE*). In addition, we present tests that control for one-digit industry employment shares, export revenues as a share of total firm revenues, and export revenues per capita (*Industry employment shares* and *Export exposure controls*). In firm-level employment regressions, we include firm-level measures of productivity, size, firm leverage and firm FC indebtedness, ownership structure, and two-digit industry fixed effects (*Firm controls*).

[17] Prior to 2008, the house price index is based on *median* transaction values. The positive correlation between $s_{z,08}^{FC}$ and 2003-07 house price growth may partly reflect that foreign currency loans increased purchases of larger homes.

[18] Gál (2005) provides a detailed analysis of the geographic differences in the density of retail banking after the transition from communism, showing that there are significant differences in the number of retail banks per capita across regions. He argues these differences are driven by a high degree of centralization in a few major cities dating back to communism.

[19] The public jobs program lowered unemployment starting in 2011. The program attenuates the estimated effect on unemployment (but not employment) starting in 2012, as it was targeted toward regions with the largest rise in unemployment, as seen by comparing Figures 6 and 12.

5 Main Results

5.1 HOUSEHOLD DEFAULT

Table 4 panel A analyzes the effect of the household foreign currency debt revaluation on the settlement-level household default rate. Column 1 presents the estimate of equation (1), controlling only for settlement and time fixed effects. The estimation sample is a quarterly settlement level panel from 2006Q1 to 2012Q4. The estimate implies that taking the FC debt share from zero to one is associated 9.30 percentage point higher default rate after the depreciation. In columns 2 and 3 we progressively include the controls sets defined in the previous section. The estimate falls to 5.73, but remains highly significant. In terms of which controls matter most, we find that once we control for education shares, the estimates are stable when adding additional controls.[20]

The estimated impact on household default rate is large in magnitude. For example, applying the estimate to the average household FC debt exposure implies that household FC debt explains 71 percent ($5.73 \times 0.66/5.29$) of the average rise in the default rate from the pre-crisis to the crisis period. This calculation abstracts from potential general equilibrium effects across local areas, which we discuss further in section 5.4. Housing loans in Hungary are full recourse loans, and debt cannot be discharged in bankruptcy. Thus, a household's decision to default mainly reflects limited ability, as opposed to willingness, to repay. The large rise in defaults caused by exposure to foreign currency debt, therefore, represents a severe increase household financial distress.

Figure 4 presents the effect of FC debt exposure on the default rate over time. It plots the estimates of $\{\beta_k\}$ from equation (2) for the settlement default rate on housing loans at a quarterly frequency. The omitted period is 2008Q3, the last quarter before the depreciation. The evolution of the default rate in high and low FC debt regions is similar prior to the depreciation. Higher FC debt regions begin experiencing higher default rates starting in 2009Q1. The default rate rises gradually in more exposed settlements through 2014. The gradual rise is likely due to a combination of the additional depreciation and the full recourse environment, which provides an incentive to avoid default.

Column 4 in Table 4 presents the estimated effect in terms of the household debt revaluation shock, $\Delta\widetilde{d}_z$, defined in (3). To fix the size of the shock affecting a given settlement, the debt revaluation is measured based on the depreciation from 2008Q3 to 2010Q3, a period that approximately corresponds to the average depreciation from the outbreak of the crisis until 2012 of 36 percent relative to the Swiss franc. This specification can be thought of as the "second stage" regression of the effect of debt revaluation on default, where the second stage variable is computed as the exact debt revaluation shock implied by FC debt exposure.[21] Column 4 implies that a 10 percent increase in household debt raises the settlement default rate by 2 percentage points.

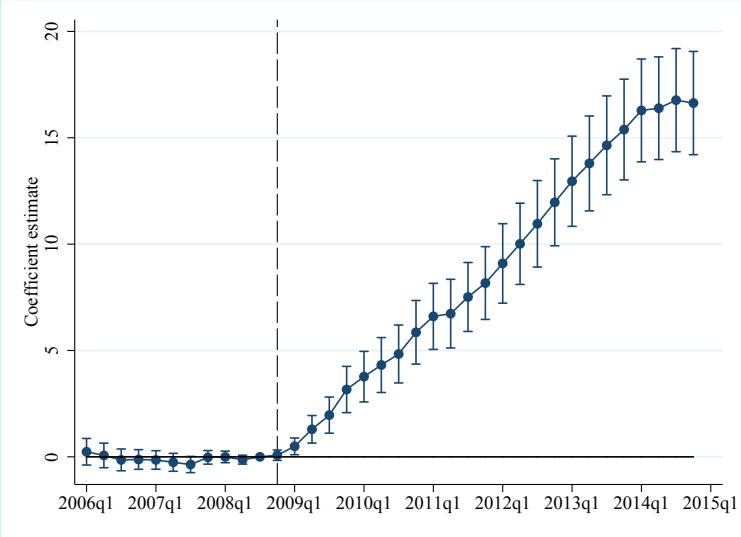
Column 5 in Table 4 presents the same regression with the household debt revaluation to income, defined in (4), as the right-hand-side variable. According to this specification, a 10 percentage point increase in debt-to-income raises the local default rate by 1.5 percentage points.[22] In contrast to the FC debt share (s^{FC}_{z08}), the debt revaluation relative to income is *positively* correlated with income and education (see Appendix Table 12). The fact that we find similar results with this measure suggests that the baseline results are not driven by an unobservable shock that differentially affects poorer regions.

[20] Appendix Table 13 explores the impact of adding various control sets more systematically, showing that the estimates are most sensitive to the inclusion of the education share controls. Table 13 also suggests that once education shares are included as controls, the estimates are stable when adding a broad range of additional controls, including controls for local demographics, household income, credit quality, export exposure, and industry shares.

[21] Results are almost identical if we instead instrument the increase in household debt with the FC debt share.

[22] Appendix Table 14 presents a simpler cross-sectional specification of the change in various outcomes from 2008 to 2010 on the household debt revaluation measures, $\widetilde{\Delta d_{z,08-10}}$ and $\widetilde{\Delta d^{Inc}_{z,08-10}}$ defined over the same period. The estimates from this simpler specification are similar to the estimates in Table 4.

Figure 4
Household Foreign Currency Debt Exposure and Default Rates



Notes: This figure presents estimates of $\{\beta_q\}$ *from*

$$Default_{zt} = \alpha_z + \gamma_t + \sum_{q \neq 2008Q3} \beta_q (s^{FC}_{z08} \cdot \mathbf{1}_{q=t}) + \sum_{q \neq 2008Q3} \Gamma_q (X_z \cdot \mathbf{1}_{q=t}) + \epsilon_{zt}.$$

The outcome variable is the settlement default rate on housing loans, defined as the fraction of housing loans in default. Control variables in X_z *correspond to all the controls in Table 4 column 3. Appendix Figure 12 presents the estimates without controls. For reference, the aggregate default rate on housing loans increased from 0.9 percent in 2008Q3 to 4.7 percent in 2010Q3 and 13.9 percent in 2014Q3. Observations are weighted by 2007 population. Error bars represent 95 percent confidence intervals from standard errors clustered at the subregion level.*

5.2 DURABLE SPENDING

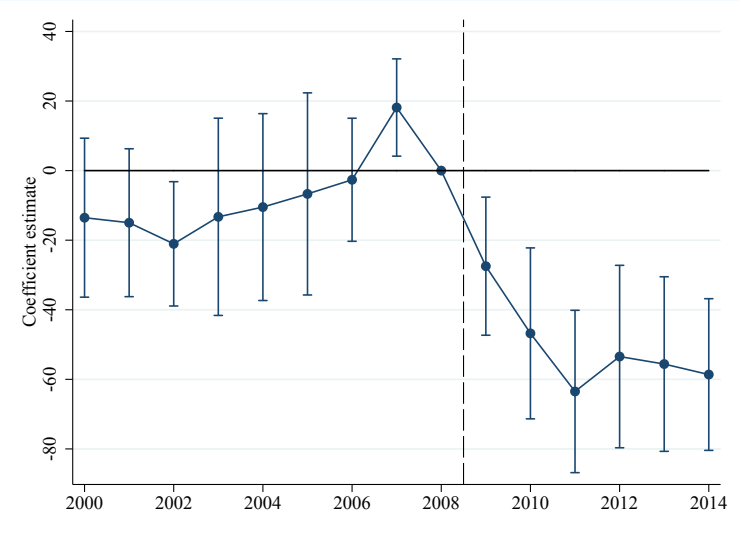
In Table 4 panel B, we ask whether the household debt revaluation translates into a decline in local spending on durables. Columns 1-3 report estimates of equation (1) with the log of the number of new auto registrations as the dependent variable.[23] The estimates imply that settlements with full exposure to FC debt experience a 41 percent (.53 log point) decline in auto purchases relative to regions with no foreign currency debt. In terms of magnitudes, the estimate implies that household FC debt accounts for 34 percent ($-53.1 \times 0.66/101.5$) of average the decline in auto spending in the crisis from 2006-08 to 2009-12, abstracting from aggregate equilibrium effects. The estimated effect is highly significant and robust to including a host of controls. However, it is important to note that the point estimate declines by one-half with the inclusion of controls, especially the education controls.

Columns 4 and 5 in Table 4 Panel B report the estimated effect on new auto registrations using the household debt revaluation variables as the measures of the shock. Both measures imply that the debt revaluation translates into a highly significant decline in durable spending. For example, the estimate in column 5 implies that a one percentage point increase in debt to income lowers durable spending by 1.26 percent.

Figure 5 illustrates how FC debt exposure affects new auto registrations over time by plotting estimates of $\{\beta_k\}$ from equation (2). In the years leading up to the depreciation, auto spending evolves similarly in high relative to low s^{FC}_{z08} settlements. There is some evidence of relatively rapid growth in high exposure areas in 2003 and 2007, though this increase is substantially smaller than the subsequent decline. In 2009, following the depreciation, auto spending falls sharply in regions with a higher FC share and continues to fall in 2010, remaining significantly below the pre-crisis level even by 2014. The persistent effect on durable expenditure is consistent with the fact that debt revaluation permanently increases household debt service requirements.

[23] To allow for small settlements with zero auto registrations, we add one before taking logs, i.e. $\ln(1 + C_{zt})$. The estimates are quantitatively similar when dropping small settlements with zero auto registrations.

Figure 5
Foreign Currency Debt Exposure and Household Spending



Notes: This figure presents estimates of $\{\beta_k\}$ *from*

$$\ln(C_{zt}) = \alpha_z + \gamma_t + \sum_{k \neq 2008} \beta_k (s^{FC}_{z08} \cdot \mathbf{1}_{k=t}) + \sum_{k \neq 2008} \Gamma_k (X_z \cdot \mathbf{1}_{k=t}) + \epsilon_{zt}$$

for durable spending (new auto registrations). Coefficients are multiplied by 100. Observations are weighted by 2007 population. Error bars represent 95 percent confidence intervals from standard errors clustered at the subregion level.

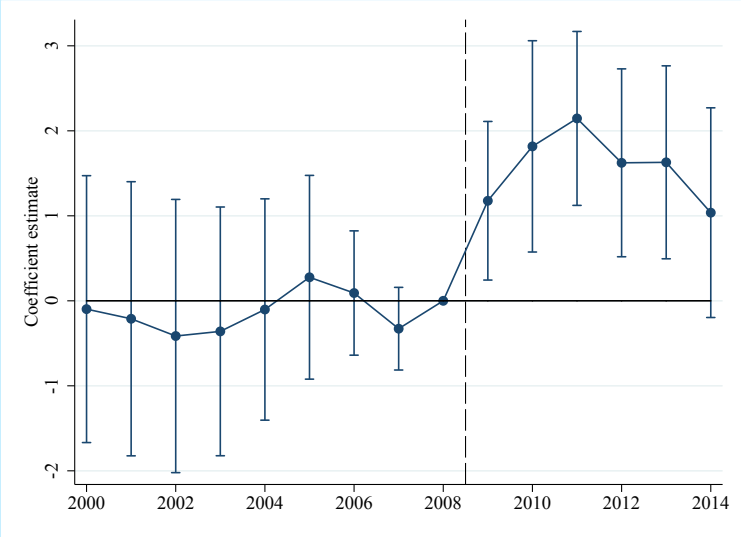
5.3 LOCAL UNEMPLOYMENT

The rise in the real burden of foreign currency household debt leads to a rise in default rates and a sharp decline in durable spending. How does the local economy absorb this shock? Table 5 explores the effect of the household debt revaluation on the settlement unemployment rate. Column 1 reveals that settlements with higher exposure to household FC debt see a larger rise in unemployment after the depreciation. Columns 2 and 3 show that the effect is robust to the inclusion of a variety of controls. The coefficient in column 3 implies that a region with full exposure to FC debt experiences a 1.65 percentage point increase in unemployment, relative to a region with only domestic currency debt. Based on the estimate in column 3, the debt revaluation channel accounts for 49 percent ($1.65 \times 0.66/2.22$) of the increase in the unemployment rate from the pre-crisis period to the crisis period in a partial equilibrium sense. Hence, household FC debt can explain a substantial fraction of the labor market deterioration in the crisis.

Columns 4 and 5 present the estimates in terms of the debt revaluation measures, defined in (3) and (4). Both estimates are highly statistically significant. The estimate in column 5 on the debt revaluation to income implies that a 10 percentage point increase in debt-to-income raises the local unemployment rate by 0.36 percentage points.

Figure 6 presents the full dynamic impact of FC debt exposure on unemployment from estimating equation (2). During the pre-crisis period from 2000 to 2008, there is a limited relation between s^{FC}_{z08} and the change in unemployment, consistent with parallel trends. It is worth noting that parallel trends hold during 2005 and 2006, despite fluctuations in aggregate unemployment driven by an economic slowdown and a fiscal consolidation program (see Appendix Figure 11). After the depreciation in late 2008, the coefficient rises gradually to 2.3 percentage points in 2011, and unemployment remains persistently higher in more exposed regions for several years. By 2014, six years after the initial shock, unemployment in exposed regions had still not fully recovered to its relative pre-crisis level.

Figure 6
Foreign Currency Debt Exposure and Unemployment



Notes: This figure presents the estimates of $\{\beta_k\}$ *from*

$$u_{zt} = \alpha_z + \gamma_t + \sum_{k \neq 2008} \beta_k (s_{z08}^{FC} \cdot \mathbf{1}_{k=t}) + \sum_{k \neq 2008} \Gamma_k (X_z \cdot \mathbf{1}_{k=t}) + \epsilon_{zt},$$

where u_{zt} *is the settlement unemployment rate. Observations are weighted by 2007 population. Error bars represent 95 percent confidence intervals from standard errors clustered at the subregion level.*

5.4 INTERPRETATION OF THE ESTIMATES: THE DEBT REVALUATION MULTIPLIER

The evidence that the household debt revaluation leads to a rise in default rates and a collapse in spending is consistent with models of incomplete markets where agents have unhedged exposure to FC debt. The rise in local unemployment caused by the household debt revaluation is qualitatively consistent with macroeconomic frictions such as nominal rigidities that translate declines in demand into higher unemployment, as discussed in section 4.1. Moreover, the results imply that the higher burden of debt leads to a significantly weaker local economy, which, in turn, exacerbates the burden of debt repayment.

What is the quantitative impact of the household debt revaluation? To answer this question, we compute the multiplier on the increase in debt service induced by the household debt revaluation. We follow recent studies that estimate government spending multipliers by computing "integral multipliers," which captures the cumulative real economic response relative to the cumulative impact of a given economic shock (e.g., Mountford and Uhlig (2009), Ramey (2016)). In our context, the integral multiplier relates cumulative implied jobs lost to the cumulative increase in household debt service:

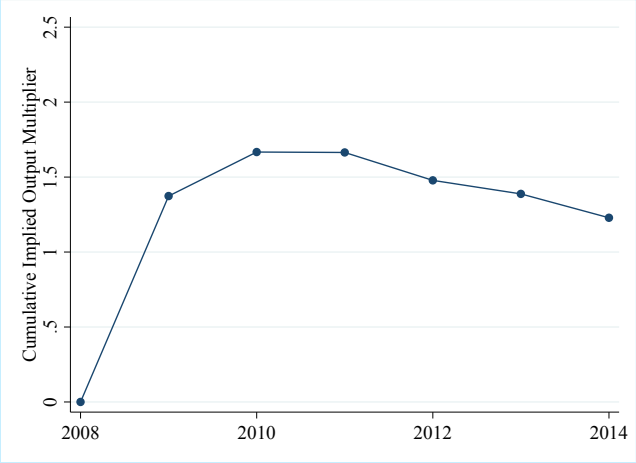
$$M_h^{Job} = \frac{\sum_{j=2009}^{h} \text{JobsLost}_j}{\sum_{j=2008:9}^{h} \text{DebtServiceShock}_j}. \tag{5}$$

We calculate the numerator using the estimated effect on unemployment from 2009 to 2014 in Figure 6, combined with the distribution of household FC debt exposure. This calculation implies that the debt revaluation led to an increase of 9.4 unemployment-rate-years, or 1.6 percentage points per year. Applying this to the total labor force in 2008 implies that the shock destroyed 259 thousand job-years from the start of the crisis through 2014, or 43 thousand jobs per year. To compute the denominator in (5), we use the cumulative increase in households' monthly debt service from the initial depreciation through the end of year *h*, which equals USD-PPP 10.5bn (5.1 percent of GDP). This captures the cumulative flow increase in debt service induced by the depreciation.

Relating the number of job-years lost from 2009 to 2014 with the increase in debt service implies that a $40,500 (2008 PPP, or HUF 5.3 million) increase in debt service destroys one job-year. This provides the analogue of the "cost-per-job" estimated

in studies on the impact of government spending on employment. Following Chodorow-Reich (2019), we can obtain a back-of-the-envelope estimate of the output multiplier by relating this number to nominal GDP per worker in 2008 ($49,800 PPP). This calculation implies that for each dollar increase in debt service, output declines by 1.23 dollars. This estimate is based on the full cumulative impact from 2009 to 2014. We can also examine the implied output multiplier over time by varying *h* in our calculation. Figure 7 shows the results. At the peak effect in 2010, a $29,000 (2008 PPP, or HUF 3.9 million) shock to debt service destroys one job-year, corresponding to a peak output multiplier of 1.67.

Figure 7
Implied Output Multiplier



Notes: This figure presents the cumulative output multiplier implied by the estimates from Figure 6. See text for details on computation.

Is the magnitude of this estimated multiplier reasonable? Recall that the MPC out of the increase in debt service for a hand-to-mouth agent is 1, and for a PI agent it is approximately 1/2 to 2/3, given the persistence of the increase in future debt service. Supposing that the increase in debt service translates one for one into a decline in consumption, we can compare this to the multiplier on deficit or outside financed government spending estimated using cross-regional variation. Surveying the recent literature, Chodorow-Reich (2019) reports that many studies find multipliers in the range of 1.5 to 2. Thus, our peak estimated debt revaluation multiplier of 1.67 appears to be within the range of cross-sectional fiscal multipliers.

This cross-sectional multiplier abstracts from a variety of aggregate general equilibrium effects. This raises the question of how this cross-sectional multiplier relates to the aggregate multiplier. There are several contrasting general equilibrium considerations. Leakage of local demand through purchases of goods produced in other areas within Hungary implies that the aggregate multiplier is larger than the cross-sectional multiplier. Similarly, a decline in relative prices in affected areas may lead to expenditure switching toward tradable goods produced by these areas, which also implies a larger aggregate multiplier.

In contrast, interregional factor mobility, such as out-migration from more affected areas to other domestic areas, would imply a smaller aggregate multiplier. In the next section, we find no expansion in employment among local exporters, limited evidence of a decline in local wages, and no differential out-migration from exposed areas. This suggests that adjustment through expenditure switching and factor mobility may be limited in the short term.

A potentially important general equilibrium effect that we cannot estimate is any additional depreciation caused by the debt shock. An additional depreciation has both positive effects, by improving competitiveness, and negative effects, by reinforcing the debt revaluation. Overall, these considerations suggest that our cross-sectional multiplier can be seen as an approximation to the national aggregate multiplier of a revaluation in long-term household debt, holding fixed the exchange rate and monetary policy.[24]

[24] See Chodorow-Reich (2019) for an extensive discussion of the relationship between cross-sectional and aggregate multipliers.

5.5 ROBUSTNESS

Alternative hypotheses. An important threat to identification is that areas with higher exposure to foreign currency debt are inherently more cyclical. So far we have controlled for several factors that may capture local cyclicality, including education and industrial composition. Column 1 of Appendix Table 15 goes a step further and shows that the estimates are robust to controlling for a settlement's historical loading on the aggregate unemployment rate, estimated from 1995 to 2007.

To further support the argument that regions with higher exposure to FC debt are not generally more sensitive to business cycle shocks, Appendix Figure 13 uses the 1998 Russian Sovereign Debt Crisis as a placebo sample. Russia's devaluation and sovereign default in August 1998 led to capital outflow from Hungary and a collapse in Hungary's exports to Russia. These adverse shocks were associated with a 1.3 percentage point increase in the unemployment rate in 1998, followed by a strong recovery in 2000. Figure 13 shows that re-estimating (2) on the 1995-2001 sample yields estimates that are close to zero and insignificant for all years. While local exposure to business cycle risk can change over time, this test supports the view that the baseline results are not driven by higher cyclicality in more exposed areas.

A related concern is that s_{z08}^{FC} is correlated with lower credit quality, so that exposed areas would have seen higher defaults and a worse recession even without exposure to FC debt. Our main analysis controls for several credit quality measures, and Table 15 presents several additional checks. Column 2 shows that the results are robust to controlling for the local unemployment rate in 2007 and the home equity share of foreign currency mortgages. Anecdotal evidence suggests mis-selling of foreign currency loans was most prevalent for home equity loans (Bethlendi (2015)), and a higher presence of home equity loans indeed predicts a higher default rate. In column 3 we instead instrument s_{z08}^{FC} with the FC debt share for mortgage loans, exploiting only variation in FC exposure driven by mortgage loans. Because credit quality deterioration was more severe for foreign currency home equity loans, the mortgage FC debt share is *uncorrelated* with 2007 household income and education (see Appendix Table 12). The instrumental variables estimate in column 3 are similar to the baseline estimates.

Foreign currency borrowers generally borrowed later in the credit expansion, so a related concern is that credit quality deteriorated during the boom. Table 15 column 4 instruments the overall FC debt share with the FC debt share using only loans originated in years 2003 through 2005. The estimates using this instrument are similar to the baseline for all three outcome variables.

Credit booms, high household debt, and credit supply cycles are closely related. One may therefore wonder whether high household FC exposure areas simultaneously experienced a boom and reversal in credit supply to firms and households. The forint depreciation was associated with a large capital outflow that depressed overall credit supply. Concerns about a large-scale disorderly withdrawal of foreign credit from emerging Europe led to the Vienna Initiative, launched in February 2009. Through the Vienna Initiative, western European banks agreed to maintain specific levels of exposure to emerging Europe and to recapitalize their subsidiaries in the region, mitigating a disruptive withdrawal of credit (De Haas et al. (2015)).

In section 6.1 below we discuss the role of credit supply to *firms* in more detail. Disentangling the direct effect of the increase in household debt from a credit supply shock to *households* is challenging, and the estimates likely capture a combination of these factors. The increase in debt burdens and the deterioration of the local economy would likely depress credit demand in exposed regions, but it would also reduce household creditworthiness. Column 5 in Table 15 presents a test that attempts to control for credit supply to households. The test is based on the intuition that credit supply expansions often mean-revert, so the overall expansion in credit may serve as a proxy for the subsequent contraction in credit supply to households. Column 5 shows that the estimates are slightly smaller compared to the baseline when controlling for the overall expansion in household debt-to-income from 2004 to 2008. Column 6 goes a step further and explicitly controls for new housing lending in the crisis, from 2008Q4 through 2011Q4, relative to 2008 disposable income. Areas with stronger lending in the crisis experienced stronger auto spending and a smaller decline in unemployment. Of course, the decline in lending may stem in part from the FC debt shock, so this specification likely "over-controls." Nevertheless, the effect of household FC debt exposure remains robust.

Finally, to account for other potential shocks operating at a broad regional level, Table 15 column 7 includes tighter region fixed effects for 20 major regions (NUTS-3) interacted with the Post_t dummy. The effect remains highly significant, albeit smaller, which is likely because exploiting variation within NUTS-3 regions absorbs some local labor market level variation.

Measurement of the shock. Our results are robust to measuring household FC debt exposure using the fraction of loans in FC (Table 15 column 8) and the number of FC loans relative to the working-age population (column 9). The latter measure ensures

that the results are not spuriously driven by settlements with a small number of loans but a high FC debt share. Column 10 reports a substantially smaller and generally insignificant effect using the number of *local* currency loans per adult.

Table 19 in the Appendix explores an alternative to the continuous exposure measure by defining "treated" settlements as those in the top quartile of s_{z08}^{FC} and "control" settlements as those in the bottom quartile. Relative to "control" areas, "treated" areas see a 1.1 percentage points rise in default rates, a 10.3 percent decline in auto spending, and a 0.35 percentage points rise in the unemployment rate (columns 1 and 2). Columns 3 and 4 present the same analysis on a sub-sample of propensity-score-matched settlements to ensure that the distribution of covariates in treatment and control areas have common support.[25] The estimates are broadly similar using the propensity-score-matched sample. Columns 5 and 6 replace the binary treatment variable with the continuous measure of exposure, s_{z08}^{FC}, and reestimate the baseline specification on the matched sample. The magnitudes of the estimates on this sample are, in some cases, smaller than the baseline, but the effects remain highly significant.

Weights, heterogeneity by city size, and aggregation. Our baseline estimation weights settlements by their population in 2007. Appendix Table 20 column 1 shows that the estimates fall by one-third to one-half when weighting settlements equally. This is because the effect is stronger among larger, more densely populated settlements, which generally constitute their own labor markets (columns 2-4). Larger cities are more closed economies and therefore subject to less "leakage" of local demand. Table 20 columns 5 and 6 address the concern that settlements may be too fine a unit of analysis to capture local labor market effects.[26] Specifically, we estimate our main specification using data aggregated up to 175 subregions that correspond to commuting zones (Paloczi et al. (2016)). The point estimates are slightly larger but similar using this higher level of aggregation.

[25] Appendix Table 18 shows that the matched settlements are similar on key observables such as debt-to-income, income, and education.

[26] Lalive et al. (2015) conduct a local labor markets analysis of unemployment insurance spillovers using a similar level of aggregation in Austria (2,361 communities). According to the 2001 census, 70 percent of households in Hungary live and work in the same settlement.

Table 4
Household Debt Revaluation, Local Default Rates, and Durable Spending

Panel A: Default Rate (Quarterly Panel Estimation)					
	(1)	(2)	(3)	(4)	(5)
HH FC debt share, $s^{FC}_{z08} \times$ Post	9.30	5.65	5.73		
	(1.02)	(0.69)	(0.68)		
HH debt revaluation, $\Delta\widetilde{d}_z \times$ Post				0.20	
				(0.025)	
HH debt to inc. revaluation, $\Delta\widetilde{d}^{inc}_z \times$ Post					0.15
					(0.019)
R^2	0.84	0.87	0.87	0.87	0.87
Number of Settlements	2538	2538	2538	2538	2538
Observations	71064	71064	71064	71064	71064
Panel B: New Auto Registrations (Annual Panel Estimation)					
	(1)	(2)	(3)	(4)	(5)
HH FC debt share, $s^{FC}_{z08} \times$ Post	-109.1	-53.0	-53.1		
	(16.6)	(9.10)	(8.92)		
HH debt revaluation, $\Delta\widetilde{d}_z \times$ Post				-2.01	
				(0.33)	
HH debt to inc. revaluation, $\Delta\widetilde{d}^{inc}_z \times$ Post					-1.26
					(0.35)
R^2	0.82	0.84	0.85	0.85	0.85
Number of Settlements	2538	2538	2538	2538	2538
Observations	17766	17766	17766	17766	17766
Settlement and Time FE	Yes	Yes	Yes	Yes	Yes
Baseline Controls		Yes	Yes	Yes	Yes
Region FE (7 units)		Yes	Yes	Yes	Yes
Credit Quality Controls		Yes	Yes	Yes	Yes
Export Exposure Controls			Yes	Yes	Yes
Industry Employment Shares			Yes	Yes	Yes

Notes: This table presents estimates of equation (1) *for the household default rate (Panel A) and the log number of new auto registration (Panel B). The default rate is measured as the fraction of loans in arrears in a settlement (city or municipality). Columns 1-3 use the household FC debt share as the measure of household FC debt exposure, while columns 4 and 5 report results using the household debt revaluation measures defined in equations* (3) *and* (4)*. All controls are interacted with Post, an indicator that equals one from 2009 onward. Baseline controls are 2007 household disposable income, 2008Q3 household debt-to-income, 2007 log population, education shares, 2007 18-59 and 60+ population shares, and public employment program intensity. Region fixed effects refer to 7 major regions (NUTS-2). Credit quality controls are the 2008Q3 household default rate, 2003 to 2007 house price growth, a proxy for average LTV at origination, the change in average LTV between 2004-05 and 2007-08, and the firm default rate in 2008Q3. Export exposure controls are the export share of firm revenues and total firm export revenues per capita. Industry employment shares refer to one digit NACE industries. Observations are weighted by 2007 population. Standard errors are clustered at the subregion level (175 units).*

Table 5
Impact of Household Debt Revaluation on Local Unemployment

	2006 to 2012 Annual Panel Estimation				
(lr)2-6	(1)	(2)	(3)	(4)	(5)
HH FC debt share, $s_{z08}^{FC} \times$ Post	2.42	1.62	1.65		
	(0.75)	(0.51)	(0.52)		
HH debt revaluation, $\Delta\widetilde{d}_z \times$ Post				0.060	
				(0.019)	
HH debt to inc. revaluation, $\Delta\widetilde{d}_z^{inc} \times$ Post					0.036
					(0.013)
Settlement and Year FE	Yes	Yes	Yes	Yes	Yes
Baseline Controls		Yes	Yes	Yes	Yes
Region FE (7 units)		Yes	Yes	Yes	Yes
Credit Quality Controls		Yes	Yes	Yes	Yes
Export Exposure Controls			Yes	Yes	Yes
Industry Employment Shares			Yes	Yes	Yes
R^2	0.61	0.65	0.65	0.65	0.65
Number of Settlements	2538	2538	2538	2538	2538
Observations	17766	17766	17766	17766	17766

Notes: This table presents estimates of specification (1) *with the settlement unemployment rate as the dependent variable. Columns 1-3 use the household FC debt share in September 2008 as the measure of FC debt exposure. Columns 4 and 5 replace the household FC debt share with the household debt revaluation shock measures, defined in equations* (3) *and* (4)*. All controls are interacted with Post and are defined in Table 4. Observations are weighted by 2007 population. Standard errors are clustered at the subregion level (175 units).*

6 Mechanisms

Why does the household debt revaluation translate into a large and persistent rise in local unemployment? This section presents additional evidence on the role of a local demand channel, labor market frictions, and housing market distress in explaining the worse local recession.

6.1 LOCAL DEMAND

The differential decline in consumption and rise in unemployment in regions that are more exposed to FC debt is evidence that household debt revaluation affects the local economy through a decline in household demand. Debt revaluation should, therefore, more strongly affect firms catering to local markets (Mian and Sufi (2014)). To provide further evidence for a local household demand channel, we draw on firm-level census data to test whether the debt revaluation shock leads to a stronger decline in employment of non-exporting firms relative to exporting firms.

Table 6 displays estimates of the effect of household FC debt exposure on firm-level log employment for a balanced panel of 66,267. We estimate the following specification:

$$\ln(E_{it}) = \alpha_i + \gamma_t + \beta(s^{FC}_{z08} \times \text{Post}_t) + (X_{iz} \times \text{Post}_t)\Gamma + \epsilon_{it}, \quad (6)$$

where α_i a firm fixed effect, γ_t is a year fixed effect, and X_{iz} represents firm and settlement-level controls. In Table 6 column 1, we find that firms in settlements with greater exposure to the household debt revaluation experience a significant decline in employment. Estimating the equation at the firm level allows us to control for detailed firm characteristics. Column 2 shows that the elasticity is similar but more precisely estimated when including firm-level controls, settlement-level controls, two-digit NACE industry fixed effects, and fixed effects for major regions. Firm-level controls are a firm's own FC debt share in 2007, a quadratic in 2007 log employment, 2007 log sales, 2007 leverage (debt-to-sales ratio), and indicator variables for whether the firm is majority state or foreign-owned. Settlement controls correspond to the *Baseline controls* and *Credit quality controls*. Two-digit industry fixed effects interacted with Post_t ensure that the estimate is not driven by time-varying industry-specific employment shocks.[27]

Table 6 columns 3 and 4 report estimates separately for non-exporters and exporters. The decline in employment and output is driven primarily by non-exporting firms. Relative to a settlement with no FC debt, non-exporting firms in a settlement with all debt in FC experience a 10.6 percent greater decline in employment. In contrast, employment at exporting firms is largely shielded from the variation in local demand induced by the debt revaluation. This test provides evidence that the effect of household debt revaluation on employment is not spuriously driven by the exchange rate channel or another shock to exporters. It also suggests that real rigidities may inhibit a reallocation of labor toward exporting firms. The fact that exporters do not differentially expand employment, despite the large depreciation, suggests that there is limited adjustment through "exporting out of the downturn" in the short run.

Column 5 focuses on firms in more strictly-defined non-tradable industries. We classify the restaurant and retail industries and four-digit NACE industries with below-median geographic Herfindahl indexes as non-tradable, following Harasztosi and Lindner (2019)'s implementation of the Mian and Sufi (2014) classification for Hungarian firm-level census data.[28] We also exclude firms that have positive exports in 2007, since these are less likely to cater primarily to local markets. Focusing on the subset of firms

[27] The appendix presents several robustness tests for these firm-level employment results. Panel A in Table 21 shows that results are similar when controlling for firm-level lagged employment growth, ensuring that the estimates are not driven by trends in firm employment. The baseline estimates weight firms equally, but Panel B in Table 21 shows that results are robust to weighting firms by their log employment in 2007. Table 22 shows results are robust to using the household debt revaluation to income shock instead of the FC debt share.

[28] A limitation of the NAV data is that we do not observe employment at the establishment level, only at the firm (tax ID) level. This means that we cannot capture local employment changes for national retailers. This data limitation biases the estimates toward zero.

Table 6
Impact of Household Debt Revaluation on Firm Employment

	All Firms		Non-Exporters	Exporters	Non-Tradable
	(1)	(2)	(3)	(4)	(5)
HH FC debt share, $s^{FC}_{z08} \times$ Post	-8.28	-9.78	-10.6	-1.35	-11.1
	(3.04)	(2.77)	(3.01)	(7.16)	(4.76)
Firm and Year FE	Yes	Yes	Yes	Yes	Yes
Firm Controls		Yes	Yes	Yes	Yes
Settlement Controls		Yes	Yes	Yes	Yes
2-Digit Industry FE		Yes	Yes	Yes	Yes
Region FE (7 units)		Yes	Yes	Yes	Yes
R^2	0.0092	0.071	0.078	0.062	0.081
Number of Firms	66267	66267	53336	12931	16761
Observations	463869	463869	373352	90517	117327

Notes: This table presents estimates of equation (6) *for the firm-level panel dataset. Firm controls are the firm FC debt share in 2007, log firm sales in 2007, leverage (debt-to-sales) in 2007, a quadratic in log firm employment in 2007, and indicator variables for whether a firm is majority state-owned or foreign-owned. Settlement Controls refer to the Baseline controls and Credit quality controls in Table 4. All controls are interacted with the* $Post_t$ *indicator. Export status is defined as whether a firm has positive export revenues in 2007. Non-tradable industries are defined as retail and catering industries and four-digit NACE industries with a geographic Herfindahl index below the median, following Harasztosi and Lindner (2019)'s implementation of the Mian and Sufi (2014) classification for Hungary. Standard errors are clustered at the subregion level (175 units).*

in the non-tradable sector yields an estimate on household FC debt exposure of -11.1 percent, which is similar to the overall decline for non-exporters.

A potential concern with this firm-level evidence is that the household debt revaluation may coincide with a differential contraction in bank lending to firms. In Appendix Table 23, we explicitly control for bank lending shocks. We obtain information on firm-bank relationships from a register of firms' bank account numbers and assume that a firm-bank pair have a lending relationship if the firm has an account with a given bank between 2006 and 2008. Ongena et al. (2017) demonstrate a strong bank lending channel of monetary policy for these firm-bank pairs. We estimate employment specifications at the firm-bank relationship level and incorporate bank fixed effects, re-weighting observations by the inverse of a firm's number of relationships. Table 23 shows that including bank fixed effects does not substantially change the estimated effect of household FC debt exposure. For example, with controls, the coefficient declines slightly from -10.1 to -9.8 percent.[29]

6.2 LIMITED LABOR MARKET ADJUSTMENT

Appendix Table 24 shows that there is limited labor market adjustment following the household debt revaluation shock. Columns 1-4 present estimates of the effect of the household debt revaluation on nominal wages. Columns 1 and 2 compute wages as firm payrolls per worker in the firm-level census data. Columns 3 and 4 use settlement-level composition-adjusted residual wages estimated from the Structure of Earnings Survey.[30] Both sources suggest that there is limited downward adjustment in wages following the depreciation, despite the increase in local unemployment. These results are consistent with downward nominal wage rigidity generating higher unemployment following a negative demand shock, as in Schmitt-Grohé and Uribe (2016).

[29] There are two additional reasons why we do not believe the household debt revaluation results are explained by a bank lending channel operating through firms. First, prior to the currency crisis, banks operating in Hungary did not have currency mismatch on their own balance sheets, and Hungary did not experience a severe banking crisis. Second, the effect of household FC debt on employment is stronger among non-exporters and non-tradable sector firms, which are firms that are less reliant on bank credit. In our sample, 63.3 percent of exporters have bank credit in 2008, while only 48.8 of non-exporters and 51.3 percent of non-tradable firms have a bank loan in 2008.

[30] The advantage of the payroll per worker measure is that it covers the universe of firms in NAV, whereas the Structure of Earnings Survey only contains a sample of workers. The advantage of the nominal wage growth estimates from the Structure of Earnings Survey is that we can compute wages residualized with worker-level characteristics. Note that while the nominal sample size in columns 3 and 4 is only 794 settlements, this sample represents 87.8 percent of the overall 2007 population.

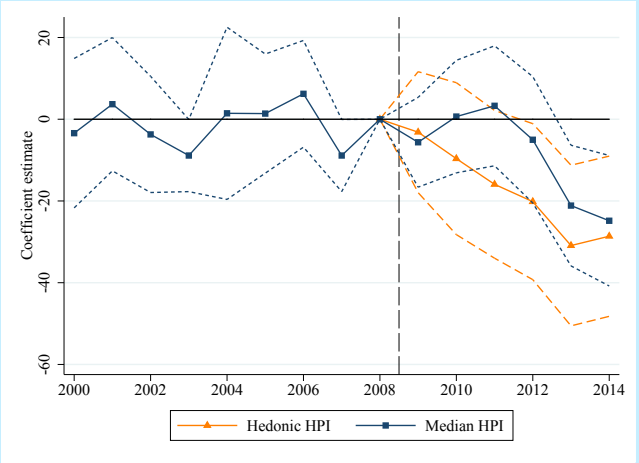
Columns 5 and 6 focus on migration. We find no evidence of an increase in net out-migration from settlements with higher FC debt exposure following the depreciation. The estimates are close to zero and, if anything, indicate an increase in net in-migration. The lack of adjustment through migration accords with recent studies that find limited adjustment to local labor market shocks through interregional migration in the short run (e.g., Autor et al. (2013)).

6.3 HOUSE PRICES AND HOUSING MARKET DISTRESS

House price declines can amplify the effects of a shock to debt burdens in the presence of collateral constraints. The decline in house prices reduces housing equity, reinforcing the direct loss to household wealth from the debt revaluation. The decline in housing equity can also limit the scope for refinancing into lower rates or into a local currency loans. Both of these effects may reinforce the spending and employment declines.

Figure 8 examines the dynamic effect of FC debt exposure on subregional house prices, and Appendix Table 25 presents the corresponding regression estimates. Our dataset contains median subregional home sale prices going back to 2000 and hedonic house price indices (HPI) starting in 2008, so we present estimates for both indices. Both the median and hedonic HPI estimates show a gradual and persistent decline in house prices in high exposure areas after the depreciation. The estimates imply that by 2012, the debt revaluation depressed house prices by 13 percent in a settlement at the mean of FC debt exposure.

Figure 8
Household Foreign Currency Debt Exposure and House Prices



Notes: This figure presents the estimates of $\{\beta_k\}$ *from*

$$\ln(P_{zt}^H) = \alpha_z + \gamma_t + \sum_{k \neq 2008} [\beta_k (s_{z08}^{FC} \cdot \mathbf{1}_{k=t}) + \Gamma_k (X_{z08} \cdot \mathbf{1}_{k=t})] + \epsilon_{zt},$$

where $\ln(P_{zt}^H)$ *is (100 times) the log of the settlement median or hedonic home price index. The hedonic home price index is available starting in 2008. The specification includes controls as in Table 4 column 3. See Figure 12 for the estimates without controls. Observations are weighted by 2007 population. Dashed line represent 95 percent confidence intervals computed from standard errors clustered at the subregion level.*

The household debt revaluation channel and housing market dynamics are closely related. However, one concern is that the estimated effects of the household debt revaluation are in fact driven by a housing market cycle, for instance, through a bubble and bust in house prices or a construction boom that results in an excess supply of housing. The median HPI estimates in Figure 8 reveal that pre-trends are approximately parallel between 2005 and 2008, though there is some evidence of an uptick in prices in high exposure regions prior to 2005. Unlike many other countries Hungary did not experience a major house price boom in the years leading up to the crisis. For example, the aggregate real house price index was flat from 2004 to 2008 (see Figure 11). In addition, the decline in house prices following the depreciation appears to be gradual. Appendix Table 25 columns 4-6 focuses on new housing unit construction. There is no evidence of a boom and reversal in the number of new housing units in areas with more exposure to household FC debt. To summarize, the household debt revaluation appears to depress local house

prices. But the worse recession in high s^{FC}_{z08} regions is unlikely to be driven by a bubble and bust in house prices or a housing supply overhang.

7 Financial Spillovers

The household debt revaluation causes a more severe local recession and a fall in house prices. Thus, in addition to the direct effect on FC borrowers, the shock may negatively affect other nearby households indirectly through its impact on the local economy. In this section, we use loan-level data on individual FC debt positions to separately estimate the direct and spillover effects of the debt revaluation on defaults.

Table 7
Financial Spillovers: Loan-Level Evidence from Defaults

		LC and FC Housing Loans			LC Borrowers	FC Borrowers
(lr)2-5 (lr)6-6 (lr)7-7	(1)	(2)	(3)	(4)	(5)	(6)
$FC_i \times$ Post	4.03	2.01	8.40	3.99		
	(0.21)	(0.22)	(1.25)	(0.22)		
$FC_i \times \text{HighLev}_b \times$ Post		3.82				
		(0.16)				
$FC_i \times \text{Maturity}_i \times$ Post			-0.22			
			(0.052)			
$s^{FC}_{z,-b,08} \times$ Post				3.99	1.93	5.52
				(0.75)	(0.83)	(0.99)
Loan and Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes
Borrower Controls	Yes	Yes	Yes	Yes	Yes	Yes
Settlement Controls	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.037	0.038	0.041	0.037	0.050	0.038
Number of Loans	664659	664659	664659	664659	224479	440180
Observations	20960622	20960622	20960154	20960622	7501797	13458825

Notes: This table presents loan-level estimates of equation (7). The dependent variable is an indicator for whether a loan is in default in quarter t. FC_i is an indicator that equals one for loans in foreign currency. $s^{FC}_{z,-b,08}$ is the household foreign currency debt share in the borrower's settlement of residence, excluding debt owed by borrower b. HighLev_b is an indicator variable that equals one when a borrower's debt in 2008 relative to settlement income per capita is above the median. Columns 1-4 present estimates for both local and foreign currency borrowers. Columns 5 and 6 split the sample into local and foreign currency borrowers. Maturity_i is loan i's maturity in years. Local currency borrowers are defined as borrowers who have no individual exposure to FC debt. Loan controls refer to loan type fixed effect (mortgage or HE). Borrower controls are the total number of mortgage and HE loans, log total borrower debt in 2008Q3, and five-year age bin fixed effects. Settlement controls refers to all the controls in Table 4, column 3. All controls are interacted with the Post indicator. Standard errors are clustered at the subregion level (175 units).

Table 7 presents estimates from loan-level default models of the form

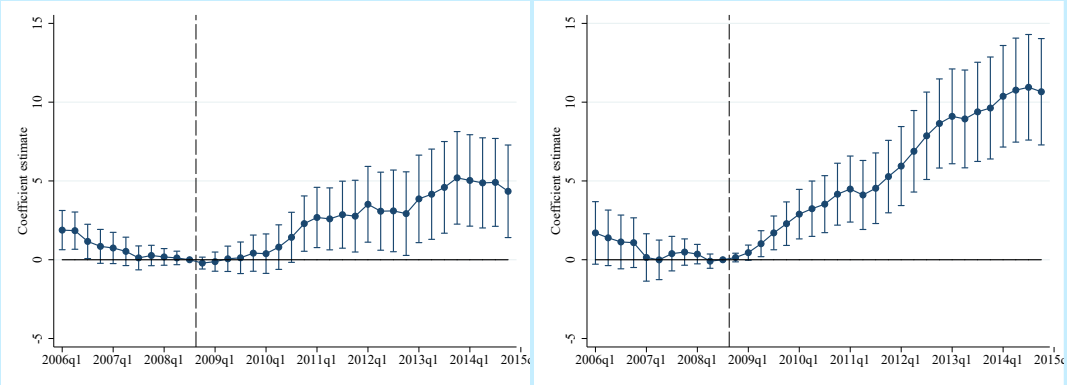
$$\text{Default}_{ibzt} = \alpha_i + \gamma_t + \beta_1(FC_i \times \text{Post}_t) + \beta_2(s^{FC}_{z,-b,08} \times \text{Post}_t) + (X_{ibz} \times \text{Post}_t)\Gamma + \epsilon_{ibzt}, \quad (7)$$

where Default_{ibzt} in an indicator for whether loan i is in default at time t, FC_i is an indicator that equals one if the loan is in foreign currency, $s^{FC}_{z,-b,08}$ is settlement z's FC debt share excluding borrower b's debt, and X_{ibz} captures loan-, borrower-, and settlement-level controls. Column 1 in Table 7 reveals that FC loans on average have a 4.0 percentage point higher probability of default than LC loans after the depreciation. Columns 2 and 3 show that the impact of FC exposure on default is stronger for borrowers with higher leverage and shorter maturity loans, consistent with the importance of liquidity constraints.

Next, we ask whether a borrower is more likely to default if many nearby households have FC debt. Column 4 includes the overall settlement FC debt share, excluding the borrower's own debt, $s^{FC}_{z,-b,08}$. Both the currency of the loan, FC_i, and the local settlement FC exposure, $s^{FC}_{z,-b,08}$, raise the probability of default. The positive effect of $s^{FC}_{z,-b,08}$ on loan i's default rate is

consistent with local financial spillovers through the negative effect of FC debt on local employment and house prices. The estimates imply that a borrower residing in a settlement at the mean level of local FC debt exposure is 2.6 percentage points more likely to default, conditional on her own foreign currency debt position, relative to a borrower in a settlement with zero local FC debt exposure.[31]

Figure 9
Financial Spillovers over Time



Local currency borrowers

Foreign currency borrowers.

Notes: This figure presents estimates of $\{\beta_q\}$ *from*

$$Default_{ibzt} = \alpha_i + \gamma_t + \sum_{q \neq 2008Q3} \beta_q(\mathbf{1}_{t=q} \cdot s^{FC}_{z,-b,08}) + \sum_{q \neq 2008Q3} (\mathbf{1}_{t=q} \cdot X_{ibz})\Gamma_q + \epsilon_{ibzt},$$

where the dependent variable is an indicator for whether loan i, held by borrower b, residing in settlement s is in default at time t. The specification is estimated separately for local and foreign currency borrowers. Controls in X_{ibz} *are as in Table 7. Error bars represent 95 percent confidence intervals computed from standard errors clustered at the subregion level.*

Does local foreign currency exposure affect individuals that did not borrow in foreign currency? Columns 5 and 6 split the sample of loans by borrowers who only have LC debt and borrowers who have at least one FC loan. Local exposure to the household debt revaluation, $s^{FC}_{z,-b,08}$, predicts a higher probability of default for both types of borrowers. The effect on LC borrowers in column 5 suggests that borrowing in FC imposes negative spillovers on individuals without FC debt. Despite the impact on LC borrowers, the spillover effect is stronger for FC borrowers. FC borrowers are presumably more sensitive to local shocks because the exchange rate depreciation simultaneously impairs their own balance sheets. Figure 9 shows the dynamic effect of local FC debt exposure on LC and FC borrowers, showing that the spillover effect appears to be highly persistent.

Finally, it is worth noting that when we include $s^{FC}_{z,-b,08} \times$ Post in the estimating equation, the estimate of β_1 declines by a modest amount from 4.03 in column 1 to 3.99 in column 4. As we show formally using a simple statistical model in Appendix 14, the small decline in the coefficient suggests that local-level selection on unobservables must be small. The reason is that local-level unobserved selection would be captured in $s^{FC}_{z,-b,08}$. Therefore, if an unobserved local-level variable that affects both FC_i and default were an important component of the variation in FC_i, the estimate of β_1 would decline substantially when controlling for $s^{FC}_{z,-b,08}$. This small decline in the estimate of β_1 is reassuring, as it also suggests that omitted variable bias in the estimate of β_2 is limited.

[31] Gupta (2016) shows evidence of foreclosure spillovers through an information channel or peer effects. The spillovers in Gupta (2016) dissipate beyond a 0.1 mile radius and therefore do not appear to be driven by a local demand externality. Huber (2018) presents evidence that bank lending contractions can have negative spillover affects on other local firms through negative demand spillovers.

8 Household and Firm Foreign Currency Debt

Since the Latin American and East Asian crises of the 1990s, several studies have found that firm FC indebtedness leads to a fall in business investment and a higher probability of bankruptcy after a devaluation. Prior to the forint depreciation in late-2008, 48 percent of Hungarian non-financial firm debt was denominated in FC. This raises two questions. First, are the determinants of FC borrowing similar for households and firms? Second, in a currency crisis, does it matter whether it is households or firms that have FC debt exposure?

Unlike households, in this setting, firms with FC debt are strongly positively selected. Appendix Table 26 shows that firms with FC debt are larger, more productive, and more likely to be exporters.[32] Moreover, three-fourths of firm FC debt is in euro, which corresponds to the primary invoicing currency for exports, as the euro area is the main destination for Hungarian exports. In contrast, 97 percent of household FC debt is in Swiss franc, but household income and assets in Swiss franc are negligible. In addition, firm FC financing started already in the mid-1990s and was a more mature market by the 2000s. These differences in the determinants of household and firm FC borrowing explain why household and firm FC debt shares are uncorrelated across space, as we saw in Table 3. Table 27 confirms that this holds across the firm size distribution. This implies that the contractionary effect of the household debt revaluation channel is not explained by firm FC debt.

Do firm balance sheet effects play a complementary role in the currency crisis? Table 8 presents regressions similar to equation (6) for various firm-level outcomes on a firm's FC debt share in 2008 and the local household FC debt share in 2008. Columns 1 and 2 reveal that firms with a higher fraction of debt denominated in FC reduce their investment after the depreciation. However, columns 3 through 5 show that firms with FC debt experience *stronger* growth in sales, value added, and employment. One explanation for why firm with FC debt exposure do not experience declines in sales and employment is that these firms are more productive and have better growth opportunities. These firms therefore temporarily cut back on investment following a balance-sheet shock, but retain their employees in anticipation of stronger growth in the future.[33] Household FC debt exposure, meanwhile, predicts a decline in all firm outcomes.

While the euro is the main currency denomination for foreign currency business loans, a substantial fraction of firms also borrow in Swiss franc. Appendix Table 28 explores the evolution of firm outcomes, separating firms by the currency denomination of foreign currency debt. We decompose the overall firm FC debt share into the Swiss franc (CHF) share and the euro (EUR) share of total debt. The forint depreciated substantially more against the Swiss franc (44 percent from 2008 to 2010) than the euro (15 percent). Therefore, one might expect the investment and employment declines to be larger for firms with a greater proportion of FC debt in Swiss franc. Appendix Table 28 confirms this intuition. Relative to firms with debt in euro, firms with debt in Swiss franc see stronger declines in investment, and weaker sales, output, and employment growth around the depreciation. These results are consistent with a stronger negative balance sheet effect for firms with Swiss franc debt than firms with euro debt. Nevertheless, in contrast to the effect of household FC debt exposure, firms with Swiss franc debt do not perform worse in the crisis compared to firms without FC debt for all outcomes except investment.

[32] Salomao and Varela (2016) also find that Hungarian firms with FC debt are more productive and have a higher share of revenues from exports.

[33] Endrész and Harasztosi (2014) and Salomao and Varela (2016) find similar negative effects of foreign currency exposure on firm investment around the forint exchange rate depreciation. Salomao and Varela (2016) also find that firms with foreign currency debt had stronger sales growth and did not have higher exit rates following the exchange rate depreciation. Salomao and Varela (2016) present a model in which more productive firms select into cheaper but riskier FC financing to grow more quickly.

Table 8
Firm FC Debt, Household FC Debt, and Firm-Level Outcomes

	Log Invest.	Invest./ Capital	Log Sales	Log Real Val. Added	Log Empl.
(lr)2-2(lr)3-3(lr)4-4(lr)5-5(lr)6-6	(1)	(2)	(3)	(4)	(5)
Firm FC debt share × Post	-38.5	-16.6	9.91	10.2	4.21
	(2.44)	(1.31)	(1.14)	(1.10)	(0.49)
HH FC debt share, s_{z08}^{FC} × Post	-32.9	3.68	-14.3	-18.9	-9.38
	(16.7)	(4.06)	(7.42)	(7.70)	(2.82)
Exporter × Post	11.8	1.97	5.73	5.21	3.87
	(1.99)	(0.74)	(1.61)	(1.02)	(0.51)
Firm and Year FE	Yes	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes	Yes
Settlement Controls	Yes	Yes	Yes	Yes	Yes
Region FE (7 units)	Yes	Yes	Yes	Yes	Yes
2-Digit Industry FE	Yes	Yes	Yes	Yes	Yes
R^2	0.052	0.047	0.037	0.064	0.067
Number of Firms	66263	66267	66267	66259	66267
Observations	418239	463869	463869	461860	463869

Notes: This table presents firm-level regressions comparing the effects of local household FC debt and firm FC debt on the evolution of firm outcomes around the late-2008 forint depreciation. The dependent variables are log investment (column 1), the investment-to-lagged capital ratio (columns 2), log firm sales (column 3), log firm real value added (column 4), and log firm employment (columns 5). The firm FC debt share is measured in 2007. The number of observations in column 1 is lower than in column 2, as investment can be negative in the NAV data. Investment-to-capital is winsorized at the 5th and 95th percentiles due to outliers caused by very low levels of measured capital. Firm controls are as in Table 6, but we also control for firm export status, as indicated. Settlement controls refer to the "Baseline controls" and "Credit quality controls." All controls are interacted with $Post_t$. Standard errors are clustered at the subregion level (175 units).

9 Conclusion

Foreign currency lending to households was widespread in Europe prior to the 2008 financial crisis. This led to severe increases in debt burdens when domestic currencies depreciated sharply against funding currencies including the Swiss franc. Using data at the household and local level from Hungary, we trace the effects of a sudden, large-scale revaluation of household foreign currency debt burdens on household defaults, durable spending, local economic activity, and house prices.

Exploiting spatial variation in exposure to foreign currency debt, we find that a revaluation in household debt burdens increases household financial distress and sharply reduces local consumption, employment, and house prices. Employment losses are driven by firms reliant on local demand. The estimates imply that a $29,000 (2008 PPP) increase in per-period debt service destroys one job-year. This translates into a peak cross-sectional output multiplier on debt service of 1.67 after two years. In addition, we find negative spillover effects of local household foreign currency debt on nearby borrowers without foreign currency debt. Our results are broadly consistent with recent models emphasizing demand and pecuniary externalities of foreign currency financing.

Our results have several interesting policy implications. First, we provide an empirical rationale for macro-prudential policies to limit leverage. The case for prudential policy is particularly strong for risky financing, such as foreign currency borrowing by agents without a natural hedge against exchange rate risk. Second, our results imply that monetary policy faces a dilemma in a crisis in economies with foreign currency debt, as highlighted by Lorenzoni (2014). When foreign currency leverage is high, it becomes counterproductive to stimulate external demand by depreciating the exchange rate because a weaker exchange rate deteriorates private-sector balance sheets. This may help explain why policymakers in emerging markets may have a “fear of floating” (Calvo and Reinhart (2002)), as pointed out by de Ferra et al. (2019). By using information on the foreign currency exposures of both households and firms, our results indicate that the debt revaluation channel is particularly strong when households have foreign currency debt.

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10 Appendix Tables and Figures

Table 9
Additional Survey Evidence on Characteristics of LC and FC Borrowers

	FC	LC	Non-borr.	FC-LC Difference	Borr.-non-borr. Difference
	Mean/s.d.	Mean/s.d.	Mean/s.d.	b/t	b/t
Primary	0.18	0.33	0.31	-0.15	-0.06
	(0.38)	(0.47)	(0.46)	(-4.41)	(-2.76)
Vocational	0.32	0.35	0.30	-0.03	0.03
	(0.47)	(0.48)	(0.46)	(-0.77)	(1.27)
High school	0.34	0.21	0.28	0.13	0.00
	(0.48)	(0.41)	(0.45)	(3.86)	(0.03)
College	0.16	0.11	0.11	0.05	0.03
	(0.37)	(0.32)	(0.31)	(1.87)	(1.86)
HH income in	2778.53	2703.11	2228.05	75.43	515.34
2009 (1000 HUF)	(1365.64)	(1377.13)	(1191.66)	(0.70)	(7.84)
Employed	0.60	0.51	0.36	0.08	0.19
	(0.49)	(0.50)	(0.48)	(2.15)	(7.64)
Retired/student	0.30	0.37	0.53	-0.07	-0.23
	(0.46)	(0.48)	(0.50)	(-1.89)	(-8.42)
Age	41.43	44.59	53.34	-3.16	-10.44
	(13.38)	(15.32)	(18.49)	(-2.85)	(-12.89)
HH size	3.40	3.41	2.62	-0.01	0.78
	(1.35)	(1.60)	(1.48)	(-0.05)	(10.07)
Observations	365	331	1137	696	1833

Notes: This table is similar to Table 2, but uses data from a separate individual-level survey with information on loan currency denomination. In particular, this table presents average individual-level characteristics of local currency borrowers (LC), foreign currency borrowers (FC), and non-borrowers from the February 2010 wave of the Tarki Household Monitor, a household survey. Foreign currency borrowers are individuals who report having positive loan payments in foreign currency. Local currency borrowers are individuals who report having positive loan payments, but zero foreign currency loan payments. Non-borrowers are individuals who report having no loan payments.

Table 10
Initial Banking Density and Household Foreign Currency Debt

	(1) DTI 08	(2) LC DTI 08	(3) FC DTI 08	(4) HH FC debt share, s^{FC}_{z08}
Log branch density in 1995	-0.040	0.059	-0.099	-0.11
	(0.082)	(0.037)	(0.062)	(0.035)
Baseline Controls	Yes	Yes	Yes	Yes
Credit Quality Controls	Yes	Yes	Yes	Yes
Export Exposure Controls	Yes	Yes	Yes	Yes
Industry Employment Shares	Yes	Yes	Yes	Yes
Region FE (7 units)	Yes	Yes	Yes	Yes
R^2	0.33	0.35	0.25	0.35
Observations	2538	2538	2538	2538

Notes: This table presents regressions of various measures of households' debt portfolios in September 2008 on the log retail banking density in 1995. Banking density is defined as the number of bank branches per capita. Settlements with a higher initial banking density (of domestic banks) have lower overall debt-to-income in 2008 (column 1), higher debt-to-income in local currency (column 2), lower debt-to-income in foreign currency (column 3), and therefore a lower share of debt in foreign currency (column 4). Observations are weighted by 2007 population. Standard errors are clustered at the subregion level (175 units).

Table 11
Correlates of Alternative Measures of Household FC Debt Exposure

Panel A: Household debt revaluation to income, $\widetilde{\Delta d}_z^{Inc}$

Right-hand-side variable	Coefficient	S.E.	R^2	N
Debt to disposable income, 2008:9	15.336	1.352	0.640	2538
Log disposable income per capita, 2007	2.134	1.004	0.021	2538
Log population, 2007	0.074	0.124	0.002	2538
Share of population age 18-59, 2007	15.061	6.248	0.008	2538
Vocational education share	-1.440	4.633	0.000	2538
High school share	12.315	5.078	0.037	2538
College share	4.299	4.211	0.007	2538
Unemployment rate, 2007	-21.628	6.415	0.057	2538
Household default rate, 2008:9	-26.188	9.963	0.005	2538
Firm default rate, 2008:Q3	0.987	1.431	0.000	2538
House price growth, 2003-07	1.541	1.696	0.003	2538
House price growth, 2005-07	0.136	1.883	0.000	2538
LTV	-22.151	6.060	0.025	2538
Change in LTV, 2004-05 to 2007-08	-1.338	3.271	0.000	2538
Export sales share, 2007	-2.297	1.174	0.018	2538
Export sales per capita, 2007	-45.821	29.142	0.012	2538
Log sales-employment ratio, 2007	-0.421	0.339	0.005	2538
Corporate FC indebtedness, 2008, $s_{z08}^{FC,Firm}$	-0.588	1.158	0.001	2538
Manufacturing employment share, 2007	-1.338	1.328	0.006	2538
Construction employment share, 2007	9.304	2.777	0.026	2538
Agriculture employment share, 2007	-4.355	1.170	0.020	2538

Notes: The table presents regressions of alternative measures of household foreign currency debt exposure on various settlement level characteristics:

$$[\text{HH FC Debt Exposure}]_z = \alpha + \beta x_z + u_z.$$

In Panel A, the measure of exposure is the household debt revaluation to income, from 2008 to 2010, defined in equation (4)*. In Panel B, the measure of exposure is the mortgage FC debt share in September 2008. Observations are weighted by 2007 population. Standard errors are clustered at the subregion level.*

Table 12
Correlates of Alternative Measures of Household FC Debt Exposure (cont.)

Panel B: Mortgage FC debt share, September 2008

Right-hand-side variable	Coefficient	S.E.	R^2	*N*
Debt to disposable income, 2008:9	-0.043	0.019	0.009	2538
Log disposable income per capita, 2007	0.014	0.021	0.002	2538
Log population, 2007	0.005	0.001	0.013	2538
Share of population age 18-59, 2007	-0.239	0.170	0.004	2538
Vocational education share	-0.034	0.136	0.000	2538
High school share	0.064	0.090	0.002	2538
College share	-0.013	0.097	0.000	2538
Unemployment rate, 2007	0.010	0.142	0.000	2538
Household default rate, 2008:9	-0.218	0.321	0.001	2538
Firm default rate, 2008:Q3	0.070	0.043	0.002	2538
House price growth, 2003-07	0.081	0.042	0.017	2538
House price growth, 2005-07	-0.034	0.046	0.002	2538
LTV	0.139	0.145	0.002	2538
Change in LTV, 2004-05 to 2007-08	0.011	0.088	0.000	2538
Export sales share, 2007	-0.006	0.030	0.000	2538
Export sales per capita, 2007	0.148	0.609	0.000	2538
Log sales-employment ratio, 2007	0.018	0.011	0.016	2538
Corporate FC indebtedness, 2008, $s_{z08}^{FC,Firm}$	0.048	0.032	0.013	2538
Manufacturing employment share, 2007	-0.015	0.034	0.001	2538
Construction employment share, 2007	-0.058	0.053	0.002	2538
Agriculture employment share, 2007	-0.063	0.034	0.008	2538

Table 13

Robustness: Impact of Including Individual Sets of Controls on the Baseline Results

Panel A: Default Rate	(1) No Controls	(2) Education	(3) HH Lev. and Inc.	(4) Demogr.	(5) Industry and Export	(6) Public Emp.	(7) Credit Quality	(8) Region FE
HH FC debt share, s^{FC}_{z08} × Post	9.30	6.49	7.33	8.61	8.55	8.82	7.08	8.82
	(1.02)	(0.80)	(0.76)	(0.92)	(0.92)	(0.93)	(0.66)	(0.79)
R^2	0.84	0.86	0.85	0.85	0.84	0.85	0.86	0.85
Observations	71064	71064	71064	71064	71064	71064	71064	71064
Panel B: Log New Auto Reg.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
HH FC debt share, s^{FC}_{z08} × Post	-109.1	-49.4	-73.3	-99.2	-87.1	-103.8	-65.7	-111.0
	(16.6)	(13.3)	(14.0)	(15.1)	(13.7)	(15.9)	(13.2)	(11.9)
R^2	0.82	0.83	0.83	0.83	0.83	0.82	0.83	0.83
Observations	17766	17766	17766	17766	17766	17766	17766	17766
Panel C: Unemployment rate	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
HH FC debt share, s^{FC}_{z08} × Post	2.42	1.36	1.78	2.60	2.11	2.56	1.71	2.78
	(0.75)	(0.77)	(0.76)	(0.69)	(0.75)	(0.75)	(0.72)	(0.56)
R^2	0.61	0.62	0.61	0.61	0.61	0.61	0.61	0.63
Observations	17766	17766	17766	17766	17766	17766	17766	17766

Notes: This table examines the impact of adding various sets of controls separately on the baseline results. All controls are interacted with the $Post_t$ indicator variable. Column 1 presents the estimates of (1) *without controls. Column 2 includes the education share controls (vocational share, high school share, and college share). Column 3 controls for household debt-to-income in 2008 and log disposable income per capita in 2007. Column 4 controls for log population, the share age 18-59, and the share over 60. Column 5 controls for one-digit NACE industry employment shares, export sales per capita in 2007, and the export sales share in 2007. Column 6 controls for the public employment program that was expanded significantly in 2012. Column 7 includes all the "Credit quality controls" (settlement-level household default rate in 2008Q3, LTV, change in LTV from 2004-05 to 2007-08, house price growth from 2004 to 2007, and the settlement-level firm default rate in 2008). Column 8 controls for region fixed effects (7 units). Standard errors are clustered at the subregion level (175 units).*

Table 14
Robustness: Household Debt Revaluation Shock in the Cross Section from 2008 to 2010

Panel A: ΔDefault$_z$	(1)	(2)	(3)	(4)
HH debt revaluation, $\Delta\widetilde{d}_z$	0.26	0.17		
	(0.031)	(0.024)		
HH debt to inc. revaluation, $\Delta\widetilde{d}_z^{Inc}$			0.051	0.11
			(0.014)	(0.019)
R^2	0.078	0.28	0.011	0.28
Observations	2538	2538	2538	2538

Panel B: ΔLog New Auto Reg.$_z$	(1)	(2)	(3)	(4)
HH debt revaluation, $\Delta\widetilde{d}_z$	-4.22	-1.65		
	(0.76)	(0.46)		
HH debt to inc. revaluation, $\Delta\widetilde{d}_z^{Inc}$			-0.69	-1.33
			(0.39)	(0.38)
R^2	0.044	0.36	0.0043	0.36
Observations	2538	2538	2538	2538

Panel C: ΔUnemp. rate$_z$	(1)	(2)	(3)	(4)
HH debt revaluation, $\Delta\widetilde{d}_z$	0.093	0.060		
	(0.026)	(0.024)		
HH debt to inc. revaluation, $\Delta\widetilde{d}_z^{Inc}$			0.024	0.037
			(0.012)	(0.013)
R^2	0.022	0.18	0.0055	0.18
Observations	2538	2538	2538	2538
Baseline Controls		Yes		Yes
Credit Quality Controls		Yes		Yes
Export Exposure Controls		Yes		Yes
Industry Employment Shares		Yes		Yes
Region FE (7 units)		Yes		Yes

Notes: This table shows that the main settlement level results are robust to using the household debt revaluation shock measures defined in equations (3) *and* (4). *The regressions are estimated using cross-sectional differences from 2008 to 2010. Observations are weighted by 2007 population. Standard errors are clustered at the subregion level (175 units).*

Table 15
Robustness: Alternative Hypotheses and Other Measures of Exposure

Panel A: Default rate

	Alternative Hypotheses							Other Measures of Exposure		
(lr)2-8(lr)9-11	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	OLS	OLS	IV: Mort. FC share	IV: 03-05 FC share	OLS	OLS	OLS	OLS	OLS	OLS
HH FC debt share, $s^{FC}_{z08} \times POST_t$	5.44	5.53	5.04	4.92	4.02	5.54	5.44			
	(0.69)	(0.70)	(0.90)	(1.14)	(0.78)	(0.69)	(0.64)			
Fraction of loans in FC, $f^{FC}_{z08} \times$ Post								6.13		
								(0.76)		
FC loans per adult (std.) × Post									0.90	
									(0.10)	
LC loans per adult (std.) × Post										-0.33
										(0.14)
Unemployment rate $\widehat{\beta}_z \times$ Post	0.15									
	(0.062)									
Unemployment rate, 2007 × Post		-0.10								
		(0.025)								
Home equity share in FC debt × Post		2.49								
		(0.73)								
DTI Increase, 2004-2008 × Post					0.069					
					(0.013)					
New HH lending, 2008-2011 × Post						2.17				
						(1.57)				
Baseline Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Credit Quality Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Export Exposure Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Employment Shares	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE (7 units)	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes	Yes
Region FE (20 units)							Yes			
IV 1st Stage F-statistic			1824.8	449.5						
R^2	0.58	0.59	0.58	0.58	0.59	0.58	0.59	0.58	0.58	0.58
Observations	70616	71036	71064	71036	70896	71064	71064	71064	71064	71064

Notes: This table shows that the effect of household foreign currency debt exposure on local unemployment is robust to a variety of specification and robustness checks. Panels A, B, and C present the results for the settlement default rate (quarterly), log new auto registrations (annual), and unemployment rate (annual). Controls are as defined in Table 4 and are interacted with $Post_t$. Observations are weighted by 2007 population. Standard errors are clustered at the subregion level (175 units).

Table 16
Robustness: Alternative Hypotheses and Other Measures of Exposure (cont.)

Panel B: Log New Auto Registrations

	Alternative Hypotheses							Other Measures of Exposure		
(lr)2-8(lr)9-11	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	OLS	OLS	IV: Mort. FC share	IV: 03-05 FC share	OLS	OLS	OLS	OLS	OLS	OLS
HH FC debt share, $s_{z08}^{FC} \times POST_t$	-55.0	-47.5	-46.8	-43.5	-51.0	-54.2	-35.8			
	(9.17)	(9.00)	(10.4)	(16.5)	(10.4)	(9.12)	(8.27)			
Fraction of loans in FC, $f_{z08}^{FC} \times$ Post								-74.2		
								(10.9)		
FC loans per adult (std.) × Post									-17.6	
									(1.98)	
LC loans per adult (std.) × Post										1.80
										(1.54)
Unemployment rate $\widehat{\beta}_z \times$ Post	-2.22									
	(0.97)									
Unemployment rate, 2007 × Post		-1.59								
		(0.51)								
Home equity share in FC debt × Post		-31.7								
		(7.82)								
DTI Increase, 2004-2008 × Post					-0.24					
					(0.23)					
New HH lending, 2008-2011 × Post						53.0				
						(28.5)				
Baseline Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Credit Quality Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Export Exposure Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Employment Shares	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE (7 units)	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes	Yes
Region FE (20 units)							Yes			
IV 1st Stage F-statistic			1822.0	449.1						
R^2	0.77	0.77	0.77	0.77	0.77	0.77	0.78	0.77	0.77	0.77
Observations	17654	17759	17766	17759	17724	17766	17766	17766	17766	17766

Table 17
Robustness: Alternative Hypotheses and Other Measures of Exposure (cont.)

Panel C: Unemployment Rate

	Alternative Hypotheses							Other Measures of Exposure		
(lr)2-8(lr)9-11	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	OLS	OLS	IV: Mort. FC share	IV: 03-05 FC share	OLS	OLS	OLS	OLS	OLS	OLS
HH FC debt share, $s_{z08}^{FC} \times POST_t$	1.54	2.18	1.49	1.86	1.39	1.58	1.47			
	(0.51)	(0.48)	(0.58)	(0.76)	(0.58)	(0.52)	(0.49)			
Fraction of loans in FC, $f_{z08}^{FC} \times$ Post								2.04		
								(0.54)		
FC loans per adult (std.) × Post									0.29	
									(0.079)	
LC loans per adult (std.) × Post										-0.10
										(0.074)
Unemployment rate $\widehat{\beta}_z \times$ Post	0.25									
	(0.047)									
Unemployment rate, 2007 × Post		-0.22								
		(0.023)								
Home equity share in FC debt × Post		0.84								
		(0.40)								
DTI Increase, 2004-2008 × Post					0.011					
					(0.0086)					
New HH lending, 2008-2011 × Post						-1.64				
						(0.86)				
Baseline Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Credit Quality Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Export Exposure Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Employment Shares	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE (7 units)	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes	Yes
Region FE (20 units)							Yes			
IV 1st stage F-statistics			1822.0	449.1						
R^2	0.63	0.65	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
Observations	17654	17759	17766	17759	17724	17766	17766	17766	17766	17766

Table 18
Covariate Balance on the Propensity-Score Matched Sample

	Treat. Mean	Control Mean	Treat.-Control Diff.	t-stat. for Diff.	Norm. Diff.
[1.5ex] Debt to disposable income, 2008:9	0.63	0.61	0.02	0.92	0.05
Log disposable income per capita, 2007	13.47	13.49	-0.02	0.25	-0.05
Log population, 2007	8.77	8.76	0.01	0.01	0.00
Share of population age 18-59, 2007	0.61	0.61	0.00	0.97	0.08
Share of population older than 60, 2007	0.22	0.21	0.00	1.00	0.07
Vocational education share	0.23	0.22	0.01	0.46	0.10
High school share	0.24	0.24	0.00	0.06	0.01
College share	0.10	0.11	-0.01	0.52	-0.14
Unemployment rate, 2007	8.27	7.21	1.06	1.20	0.16
Default rate, 2008:9	1.11	1.13	-0.02	0.14	-0.01
Firm default rate, 2008:Q3	6.34	5.54	0.80	1.67	0.08
LTV	0.62	0.61	0.00	0.98	0.08
Change in LTV, 2004-05 to 2007-08	0.06	0.06	0.00	0.16	0.02
House price growth, 2003-07	31.10	26.58	4.51	1.64	0.19
House price growth, 2005-07	16.14	15.25	0.89	0.36	0.04

[1.5ex]

Notes: This table presents the covariate balance for the propensity-score matched sample. Treatment and Control settlements are defined as those in the top and bottom quartiles of the household FC debt share in September 2008. For each variable X, the normalized difference is defined following Imbens and Wooldridge (2009) as $\frac{\overline{X}_T - \overline{X}_C}{\sqrt{S_T^2 + S_C^2}}$*, where* $\overline{X}_T$ *and* $\overline{X}_C$ *are the treatment and control sample means, and* S_T^2 *and* S_C^2 *are the variances of X in the treatment and control samples.*

Table 19
Robustness: Propensity Score Matching Based on Top and Bottom Quartile of Household FC Debt Exposure

	OLS		PS-Matched Sample			
(lr)2-3(lr)4-7 **Panel A: Default**	(1)	(2)	(3)	(4)	(5)	(6)
Treatment × Post	1.89	1.09	1.18	1.11		
	(0.22)	(0.19)	(0.29)	(0.20)		
HH FC debt share, s^{FC}_{z08} × Post					6.30	4.94
					(1.11)	(0.82)
R^2	0.44	0.84	0.41	0.81	0.41	0.81
Observations	48440	48440	29148	29148	29148	29148
Panel B: New Auto Reg.	(1)	(2)	(3)	(4)	(5)	(6)
Treatment × Post	-23.8	-10.4	-18.6	-10.1		
	(3.74)	(2.58)	(6.05)	(2.58)		
HH FC debt share, s^{FC}_{z08} × Post					-77.5	-45.8
					(23.7)	(10.5)
R^2	0.71	0.83	0.69	0.82	0.69	0.82
Observations	12110	12110	7287	7287	7287	7287
Panel C: Unemployment Rate	(1)	(2)	(3)	(4)	(5)	(6)
Treatment × Post	0.44	0.35	0.38	0.27		
	(0.18)	(0.14)	(0.16)	(0.12)		
HH FC debt share, s^{FC}_{z08} × Post					1.66	1.23
					(0.63)	(0.46)
R^2	0.55	0.62	0.52	0.59	0.52	0.59
Observations	12110	12110	7287	7287	7287	7287
Settlement and Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Baseline Controls		Yes		Yes		Yes
Region FE (7 units)		Yes		Yes		Yes
Credit Quality controls		Yes		Yes		Yes
Export Exposure Controls		Yes		Yes		Yes
Industry Employment Shares		Yes		Yes		Yes

Notes: This table examines the robustness of the main settlement level results when matching settlements in the top and bottom quartile of exposure using propensity score matching. Treatment in an indicator variable that equals one for settlements in the top quartile of exposure based on s^{FC}_{z08} and zero for settlements in the bottom quartile of exposure. Columns 1 and 2 report OLS regressions as in equation (1) *Treatment as the measure of exposure. Column 3-6 estimate the regressions on the propensity-score matched sample. The sample is matched using our full set of controls. Columns 5 and 6 use the continuous measure of treatment, s^{FC}_{z08}, on the matched sample. Standard errors are clustered at the subregion level (175 units).*

Table 20
Robustness: Weighting and Subsamples

Panel A: Default rate	(1) Full sample	(2) 50% Smallest Settlements	(3) 50% Largest Settlements	(4) Largest Cities	(5) 175 Subregions	(6) 175 Subregions
HH FC debt share, s^{FC}_{z08} × Post	3.95	3.20	5.70	3.77	10.2	5.72
	(0.80)	(0.86)	(1.02)	(1.40)	(1.82)	(1.44)
R^2	0.47	0.39	0.60	0.65	0.51	0.69
Observations	71064	35532	35532	8568	4900	4900
Panel B: New auto reg.	(1)	(2)	(3)	(4)	(5)	(6)
HH FC debt share, s^{FC}_{z08} × Post	-24.8	-13.7	-63.3	-96.1	-152.3	-102.8
	(6.33)	(7.09)	(10.7)	(22.1)	(29.9)	(27.5)
R^2	0.60	0.48	0.72	0.82	0.80	0.87
Observations	17766	8883	8883	2142	1225	1225
Panel C: Unemployment rate	(1)	(2)	(3)	(4)	(5)	(6)
HH FC debt share, s^{FC}_{z08} × Post	1.10	0.84	1.65	2.46	1.92	2.38
	(0.42)	(0.46)	(0.59)	(1.15)	(0.98)	(1.03)
R^2	0.38	0.30	0.54	0.64	0.65	0.73
Observations	17766	8883	8883	2142	1225	1225
Weights	Equal	Equal	Equal	Equal	Pop.	Pop.
Settlement FE	Yes	Yes	Yes	Yes		
Subregion FE					Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Baseline Controls	Yes	Yes	Yes	Yes	Yes	Yes
Region FE (7 units)	Yes	Yes	Yes	Yes	Yes	Yes
Credit Quality Controls	Yes	Yes	Yes	Yes	Yes	Yes
Export Exposure Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry Employment Shares	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This tables examines the robustness of the main settlement-level results to weighting schemes, subsamples, and the level of aggregation. In columns 5 and 6, the data are aggregated to the level of 175 subregions. Controls are as in Table 4 column 3, and all controls are interacted with the $Post_t$ indicator. Standard errors are clustered at the subregion level (175 units).

Table 21

Robustness: Firm Employment Regressions Controlling for Lagged Employment Growth and Weighting by Log Employment

Panel A: Lagged Employment Growth Control				
	All Firms	Non-Exporters	Exporters	Non-Tradable
(lr)2-2(lr)3-3(lr)4-4(lr)5-5	(1)	(2)	(3)	(4)
HH FC debt share, s^{FC}_{z08} × Post	-8.05	-8.77	-1.48	-10.9
	(2.74)	(3.03)	(6.76)	(5.00)
Lagged growth rate × Post	0.35	0.34	0.45	0.35
	(0.0064)	(0.0082)	(0.016)	(0.012)
Firm and Year FE	Yes	Yes	Yes	Yes
Firm-level Controls	Yes	Yes	Yes	Yes
Settlement Controls	Yes	Yes	Yes	Yes
Region (7 units) FE	Yes	Yes	Yes	Yes
2-Digit Industry FE	Yes	Yes	Yes	Yes
R^2	0.094	0.10	0.098	0.11
Observations	463869	373352	90517	117327
Panel B: Log Employment Weights				
	All Firms	Non-Exporters	Exporters	Non-Tradable
(lr)2-2(lr)3-3(lr)4-4(lr)5-5	(1)	(2)	(3)	(4)
HH FC debt share, s^{FC}_{z08} × Post	-8.86	-10.5	-2.52	-10.1
	(3.45)	(3.90)	(7.54)	(6.14)
Firm and Year FE	Yes	Yes	Yes	Yes
Firm-level Controls	Yes	Yes	Yes	Yes
Settlement Controls	Yes	Yes	Yes	Yes
Region (7 units) FE	Yes	Yes	Yes	Yes
2-Digit Industry FE	Yes	Yes	Yes	Yes
R^2	0.065	0.075	0.059	0.075
Observations	463869	373352	90517	117327

Notes: This table shows that the firm employment growth estimates in Table 6 are robust to controlling for firm-level lagged employment growth (Panel A) and to weighting observations by 2007 log firm employment (Panel B). Lagged employment growth is computed from 2006 to 2007. Panel B weights by log employment instead of the level of employment because the firm size distribution is highly skewed, so the mean and variance of the level weights are not necessarily finite. Standard errors are clustered at the subregion level (175 units).

Table 22
Household Debt Revaluation to Income and Firm Employment

	All Firms	Non-Exporters	Exporters	Non-Tradable
(lr)2-2(lr)3-3(lr)4-4(lr)5-5	(1)	(2)	(3)	(4)
HH debt to inc. revaluation × Post	-0.18	-0.23	0.16	-0.20
	(0.071)	(0.081)	(0.21)	(0.13)
Firm and Year FE	Yes	Yes	Yes	Yes
Firm-level controls	Yes	Yes	Yes	Yes
Settlement controls	Yes	Yes	Yes	Yes
Region (7 units) FE	Yes	Yes	Yes	Yes
2-Digit Industry FE	Yes	Yes	Yes	Yes
R^2	0.066	0.073	0.057	0.076
Observations	463869	373352	90517	117327

Notes: This table is similar to Table 6, but uses the household debt revaluation relative to income from 2008 to 2010 defined in equation (4) *as the measure of the household foreign currency debt shock. The dependent variable is log firm employment. Standard errors are clustered at the subregion level (175 units).*

Table 23
Household Debt Revaluation and Firm Employment: Controlling for Bank Credit Supply Shocks

	(1)	(2)	(3)	(4)
HH FC debt share, s^{FC}_{z08} × Post	-8.52	-6.81	-10.1	-9.77
	(3.81)	(3.76)	(3.34)	(3.35)
Firm and Year FE	Yes	Yes	Yes	Yes
Bank FE		Yes		Yes
Firm-level Controls			Yes	Yes
Settlement Controls			Yes	Yes
Region (7 units) FE			Yes	Yes
2-Digit Industry FE			Yes	Yes
R^2	0.92	0.92	0.92	0.92
Number of Firms	66267	66267	66267	66267
Observations	775533	775533	775533	775533

Notes: This table presents regressions at the firm-year-bank relationship level to control for unobserved time-varying bank lending shocks. The specification is

$$\ln(E_{ibt}) = \alpha_i + \gamma_t + \delta_{bank,Post} + \beta(s^{FC}_{z08} Post_t) + (X_i Post_t)\Gamma^F + (X_z Post_t)\Gamma^S + \epsilon_{ibt}.$$

The dependent variable is log firm employment. $\alpha_{bank,Post}$ is a bank by $Post_t$ fixed effect that absorbs time-varying bank-relationship-specific shocks. Controls are as defined in Table 6, and all controls are interacted with $Post_t$. To recover the firm-level estimates, observations are re-weighted by the inverse of a firm's total number of relationships. A firm is assumed to have a banking relationship if it has a relationship in 2006, 2007, or 2008. We also include a separate fixed effect interacted with $Post_t$ for firms without a banking relationship. One-tenths of firms have no banking relationship, 48 percent of firms have exactly one banking relationship, and the remaining 42 percent of firms have two or more relationship. Standard errors are dually clustered on bank identifier and subregion (175 units).

Table 24
Labor Market Adjustment: Wages and Migration

	Log Payroll Per Worker		Log Nominal Wages		In-Migration Rate	
(lr)2-3(lr)4-5(lr)6-7	(1)	(2)	(3)	(4)	(5)	(6)
HH FC debt share, s^{FC}_{z08} × Post	-3.07	-4.13	7.18	7.27	0.0055	0.0063
	(3.40)	(3.64)	(4.63)	(5.64)	(0.0032)	(0.0027)
Unit of Obs.	Firm	Firm	Settl.	Settl.	Settl.	Settl.
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes				
Settlement FE			Yes	Yes	Yes	Yes
Firm Controls		Yes				
2-Digit Industry FE		Yes				
Settlement Controls		Yes		Yes		Yes
Region (7 units) FE		Yes		Yes		Yes
R^2	0.027	0.033	0.63	0.64	0.0013	0.074
Observations	461682	461682	8321	8321	17488	17488

Notes: This table presents estimates of the effect of household FC debt exposure on wages and the in-migration rate. There is limited evidence of a gradual downward adjustment in wages following the debt revaluation shock, and no evidence of an increase in out-migration. Payroll per worker is total payroll expenses divided by the number of employees in the firm-level census data (NAV). Nominal Wages refers to the settlement average of residualized hourly wages multiplied by 100, estimated from the worker-level Structure of Earnings Survey. The in-migration rate is the settlement in-migration to population ratio. Observations in columns 3-6 are weighted by 2007 population. Standard errors are clustered at the subregion level (175 units).

Table 25
Household Debt Revaluation and Housing Markets

	Log Median House Prices		Log Hedonic House Prices		New Housing Units Per 1000 Inhabitants	
(lr)2-3(lr)4-5(lr)6-7	(1)	(2)	(3)	(4)	(5)	(6)
HH FC debt share, $s^{FC}_{z08} \times \mathbf{1}_{2009-10}$	-34.0	5.97	-13.1	-5.32	3.15	0.30
	(6.25)	(6.70)	(9.51)	(8.14)	(0.99)	(0.94)
HH FC debt share, $s^{FC}_{z08} \times \mathbf{1}_{2011-12}$	-51.2	-7.09	-31.6	-18.9	7.31	3.82
	(9.15)	(7.80)	(10.8)	(9.13)	(0.98)	(0.85)
Baseline Controls		Yes		Yes		Yes
Credit Quality Controls		Yes		Yes		Yes
Export Exposure Controls		Yes		Yes		Yes
Industry Employment Shares		Yes		Yes		Yes
Region FE (7 units)		Yes		Yes		Yes
R^2	0.39	0.49	0.13	0.23	0.24	0.29
Observations	17766	17766	12690	12690	17760	17760

Notes: This table explores the connection between household foreign currency exposure and housing markets. The dependent variable in columns 1 and 2 is the log median house price index. Columns 3 and 4 use the hedonic house price index (Figure 8 shows the estimates over time for both indices). House price indexes are measured at the subregion level. The dependent variable in columns 5 and 6 is the number of new housing units relative per 1000 inhabitants. Variables $\mathbf{1}_{2009-10}$ and $\mathbf{1}_{2011-12}$ equal one in year 2009-10 and 2011-12, respectively, and zero otherwise. Observations are weighted by 2007 population. Standard errors are clustered at the subregion level (175 units).

Table 26
Determinants of Firm Foreign Currency Financing

Right-hand-side variable	Coefficient	S.E.	R^2	*N*
[1.5ex] Log employment, 2007	0.032	.001	0.019	66267
Log sales per worker, 2007	0.020	.001	0.006	66267
Employment growth, 2004-07	0.024	.002	0.002	61448
Export sales share, 2007	0.146	.011	0.009	66267
Exporter	0.071	.007	0.010	66267
Manufacturing	0.045	.003	0.004	66267
[1.5ex]				

Notes: This table presents firm-level univariate regressions of a firm's foreign currency debt share on various firm characteristics:

$$(\text{Firm FC debt share})_{i08} = \alpha + \beta x_i + u_i.$$

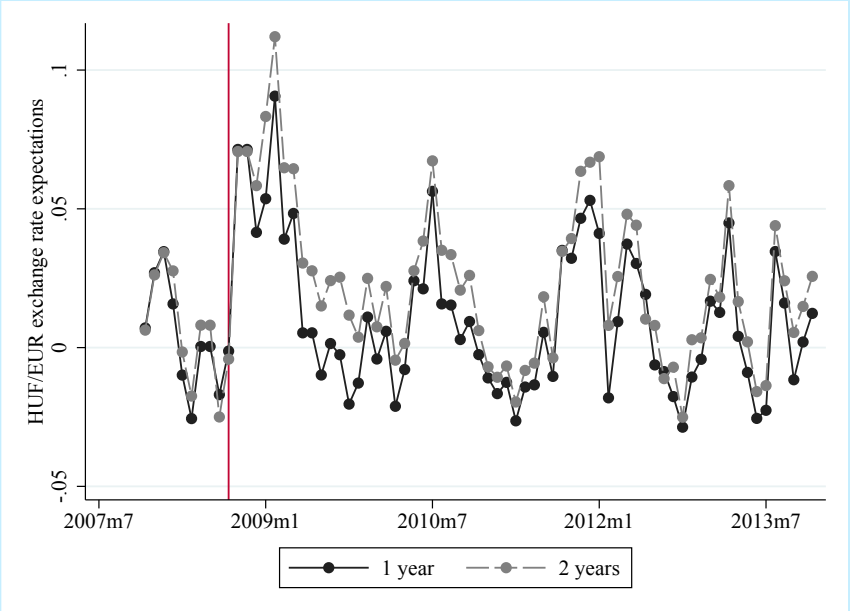
Standard errors are clustered at the subregion level (175 units).

Table 27
Household and Firm FC Debt Exposure by Firm Size

	All Firms	Small (3 to 9)	Medium (10 to 50)	Large (≥ 51)
(lr)2-2(lr)3-3(lr)4-4(lr)5-5	(1)	(2)	(3)	(4)
HH FC debt share, s^{FC}_{z08}	0.041	0.056	0.0093	-0.0050
	(0.034)	(0.030)	(0.054)	(0.11)
R^2	0.000090	0.00019	0.0000041	0.00000092
Observations	66267	47015	15443	3809

Notes: This table reports the correlation between firm foreign currency debt share against the local settlement household FC debt share. Standard errors are clustered at the subregion level (175 units).

Figure 10
Consensus Forecasts of the HUF-EUR Exchange Rate



Notes: The figure plots the expected depreciation of the Hungarian forint (HUF) relative to the euro (EUR) from Consensus Forecasts, a survey of professional forecasters. Exchange rate expectations are reported at the one and two year horizons. The vertical line represents September 2008.

Table 28
Firm FC Debt and Firm-Level Outcomes: Exploiting Variation across Swiss Franc and Euro Exposure

	Log Invest.	Invest./ Capital	Log Sales	Log Real Val. Added	Log Empl.
(lr)2-2(lr)3-3(lr)4-4(lr)5-5(lr)6-6	(1)	(2)	(3)	(4)	(5)
Firm CHF share × Post	-36.9	-12.8	1.88	2.00	1.18
	(2.95)	(1.58)	(1.34)	(1.28)	(0.72)
Firm EUR share × Post	11.2	-3.03	11.4	12.8	4.59
	(4.95)	(1.14)	(2.97)	(3.23)	(1.91)
HH FC debt share, s^{FC}_{i08} × Post	-31.4	3.25	-14.7	-18.6	-7.57
	(16.9)	(4.13)	(7.37)	(7.66)	(2.82)
Exporter × Post	17.4	3.88	3.42	4.21	0.14
	(1.40)	(0.50)	(0.97)	(0.74)	(0.44)
Firm and Year FE	Yes	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes	Yes
Settlement Controls	Yes	Yes	Yes	Yes	Yes
Region FE (7 units)	Yes	Yes	Yes	Yes	Yes
2-Digit Industry FE	Yes	Yes	Yes	Yes	Yes
R^2	0.052	0.047	0.036	0.063	0.023
Number of Firms	66263	66267	66267	66259	66267
Observations	418239	463869	463869	461860	463869

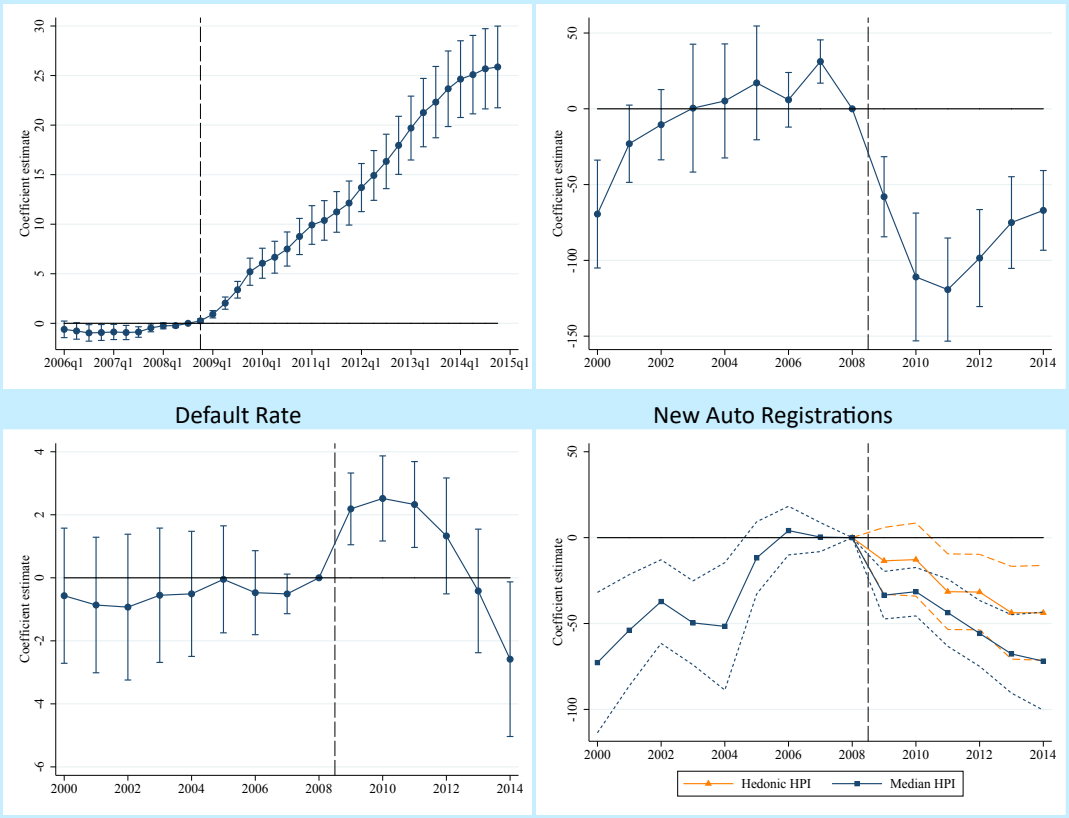
Notes: This table is similar to Table 8 but it separates the firm FC debt share in 2008 into two components: the Swiss franc (CHF) share and the euro (EUR) share. Both shares are measured in 2008. We include the small fraction of dollar debt as part of the CHF share. The dependent variables are log investment (column 1), the investment-to-lagged assets ratio (columns 2), log firm sales (column 3), log firm real value added (column 4), and log firm employment (columns 5). The firm FC debt share is measured in 2008. Settlement controls refer to the "Baseline controls" and "Credit quality controls." All controls are interacted with $Post_t$*. Standard errors are clustered at the subregion level (175 units).*

Figure 11
Macroeconomic Context

[Current Account to GDP ratio (%)] [Components of GDP] [Consumption] [Unemployment Rate]
[Real House Price Index]

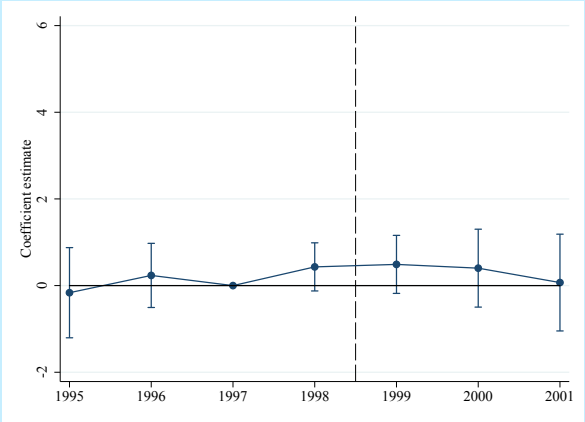
Notes: This figure presents the evolution of key macroeconomic aggregates up to and after the October 2008 forint depreciation.

Figure 12
Estimates over Time without Controls



Notes: This figure presents estimates of $\{\beta_k\}$ *from equation* (2) *for various outcomes without control variables. Observations are weighted by 2007 population. Error bars represent 95 percent confidence intervals computed from standard errors clustered at the subregion level.*

Figure 13
Placebo Test: 1998 Russian Financial Crisis



Notes: This figure uses the second half of the 1990s as a placebo sample. Figure 11 shows that unemployment in Hungary rose around the 1998 Russian Financial Crisis, and then subsequently recovered. This figure presents estimates of the following specification for the period 1995-2001, where 1997 is the omitted year,

$$u_{zt} = \alpha_z + \gamma_t + \sum_{k \neq 1997} \beta_k \{s_{z08}^{FC} \cdot \mathbf{1}_{k=t}\} + \epsilon_{zt}.$$

For the late 1990s placebo sample the coefficients $\{\widehat{\beta_y}\}$ *are precisely estimated and not significantly different from zero. Observations are weighted by 2007 population. Error bars represent 95 percent confidence intervals computed from standard errors clustered at the subregion level.*

11 Data Appendix

11.1 HOUSEHOLD CREDIT REGISTRY AND OTHER CREDIT MARKET DATA

The Hungarian Household Credit Registry records information on all loans granted to households starting in April 2012. This allows us to observe loan information for all loans that are outstanding in April 2012 or later and loan repayment in all months thereafter. In order to construct a measure of households' balance sheet exposure to the depreciation, we reconstitute the credit registry back to January 2000 using information on the origination date, originated amount, loan type, currency, and variable interest rate. We have interest rates at the bank-product level, where product includes loan type (mortgage, home equity loan, auto loan, etc.), maturity, and currency.[34]

With this information we use an annuity formula to impute the monthly payment and remaining balance for each loan in the credit registry. Specifically, for each loan i in currency c of type k originated at time t_0 with maturity m and remaining periods $n = t_0 + m - t + 1$, we denote the imputed values of the monthly payment and remaining loan balance as $\widetilde{P}_{it}$ and $\widetilde{D}_{it}$. These are computed as

$$\widetilde{P}_{it} = \widetilde{D}_{it}\left(\frac{1 - R_{ckmbt}^{-n}}{R_{ckmbt} - 1}\right)^{-1}$$

$$\widetilde{D}_{it} = \widetilde{D_{i,t-1}} \cdot R_{ckmb,t-1} - P_{i,t-1}, \quad D_{it_0} = \widetilde{D}_{it_0} \text{ given as originated amount,}$$

where R_{ckmbt} is the average monthly gross interest rate charged by bank b for that specific loan product (currency, loan type, maturity at issuance) in period t. This formula thus computes the sequence of payments and loan balances that we would observe in the absence of default, assuming that loan i pays the average variable rate charged by bank b for that loan product. We do not believe that the assumption that loans remain current is severe drawback for this methodology because default rates were very low before the 2008 crisis (see Figure 16).[35]

11.1.1 ACCURACY OF THE IMPUTATION WITHIN THE CREDIT REGISTRY

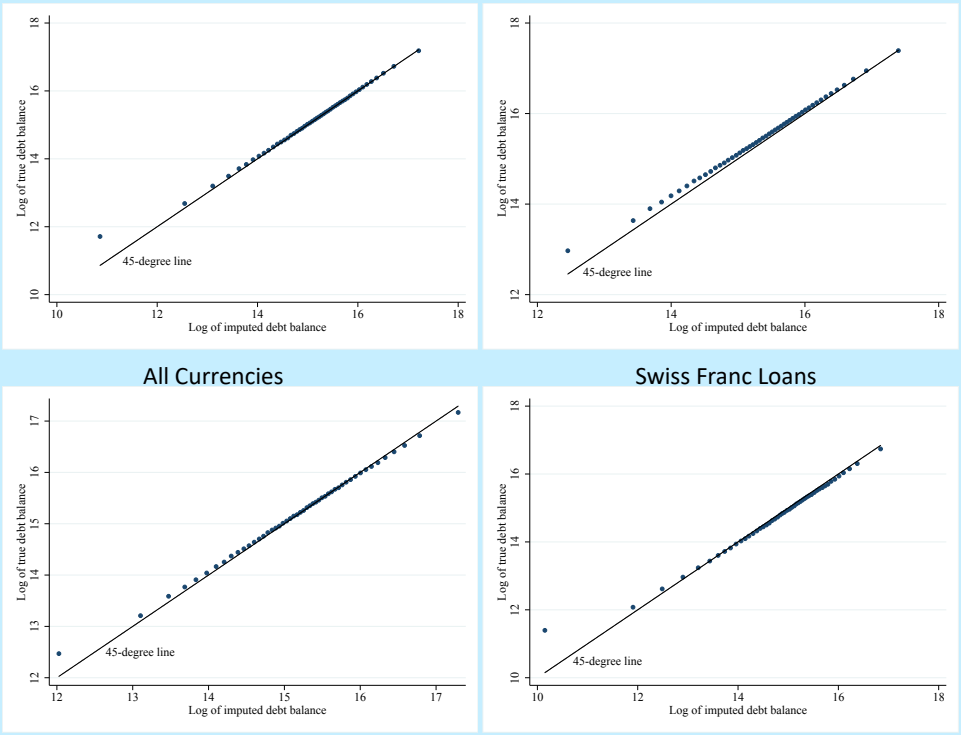
As a first test of the accuracy of the annuity model, Figure 14 plots binned bivariate means of the imputed and actual loan balances in December 2012. Panel (a) plots the binned means for all mortgage and home equity loans in our sample, and panels (b)-(d) presents subsamples by currency. On average our imputation performs well: most bins lie on or very close to the 45-degree line. The imputed balances slightly underestimate the true balances, which may be explained partly by loans falling into arrears during the crisis. Note that since default rates increased substantially in the crisis, our approximation is likely to be more accurate in earlier years, closer to the time of origination and before the sharp uptick in defaults.

To provide a sense of the goodness of fit, Table 29 reports regressions of the true loan balance on the imputed balance in 2012:12. The table shows that the R^2 for the regression of the true balance on the imputed balance in 83 percent for all loans, and lies between 80-96 percent for various subsets of loans. The coefficient on the slope is naturally biased downward from unity because of classical measurement error in $\widetilde{D}_{it}$, and similarly the coefficient on the constant is biased upward since the average loan balance is positive.

[34] Note that the credit registry does not report interest rates at the loan level. Instead, we draw on interest rate information from a separate database maintained by the National Bank of Hungary, which reports the average monthly interest rate across different loan products charged by banks operating in Hungary.

[35] Statistics from the National Bank of Hungary show that the fraction of non-performing loans was below 1 percent for both local currency loans and foreign currency housing loans in 2008Q3.

Figure 14
Validation of Imputation Procedure: Binned Bivariate Means of Imputed and Actual Loan Balance in 2012



Notes: This figure plots binned bivariate means (binscatter) of imputed and actual loan balances in 2012:12 using 50 quantiles. The imputed loan balance is modeled using an annuity formula using loan-level information on the originated amount, time of origination, and bank-by-product specific interest rate to construct monthly interest payments, amortization, and remaining loan balance. The figure shows that on average the imputed values line on or near the 45-degree line and are thus close to the true values.

Table 29
Regressions of True Loan Balance in 2012:12 on Imputed Balance

	Dependent variable: true balance in 2012:12, $\ln(D_{it})$						
(lr)2-8	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Imputed balance, $\ln(\widehat{D_{it}})$	0.873	0.890	0.840	0.871	0.916	0.835	0.930
	(0.00039)	(0.00048)	(0.00067)	(0.00053)	(0.0010)	(0.00060)	(0.0020)
Constant	1.942	1.672	2.471	2.088	1.290	2.411	1.259
	(0.0059)	(0.0072)	(0.010)	(0.0082)	(0.016)	(0.0089)	(0.030)
Sample	All	Mortgage	Home equity	CHF	EUR	HUF	JPY
R^2	0.833	0.849	0.802	0.866	0.915	0.793	0.947
Observations	1002891	618714	384177	414899	74106	501142	12735

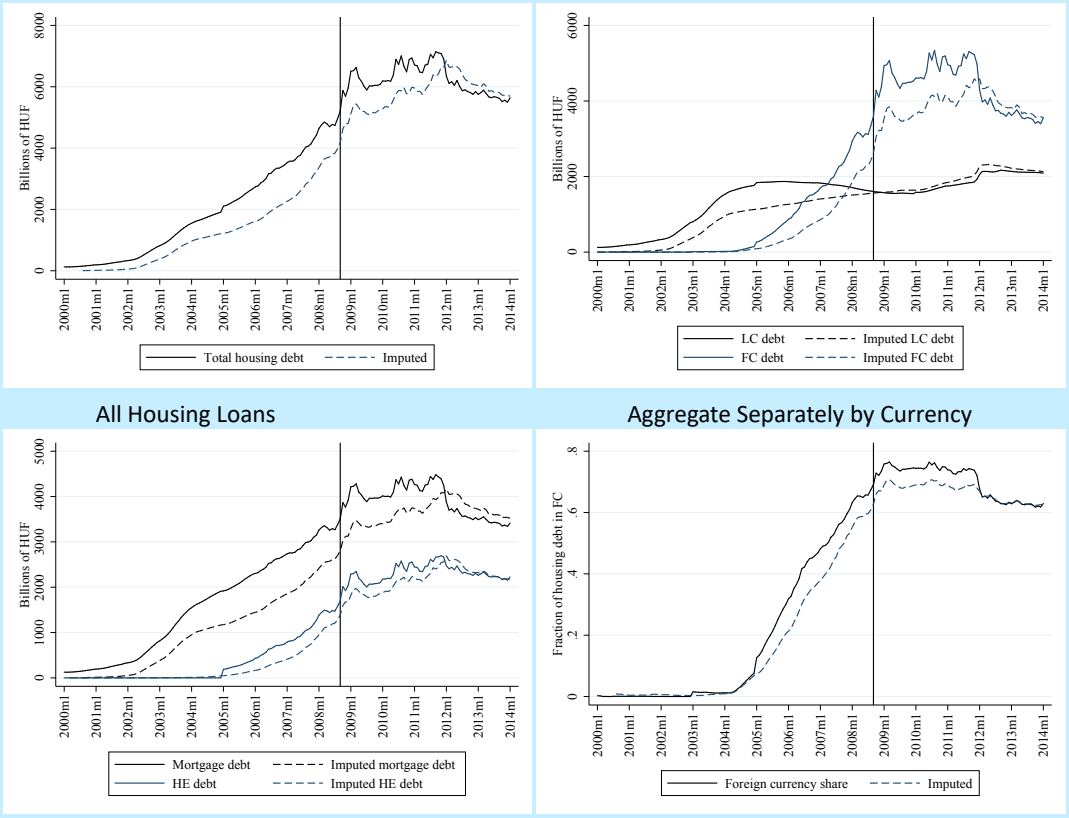
Notes: This table presents regressions of the log true loan balance in 2012:12 on the log imputed loan balance in 2012:12. Standard errors are reported in parentheses.

11.1.2 MISSING LOANS AND COMPARISON WITH AGGREGATE FINANCIAL ACCOUNTS

A concern arising from the fact that the credit registry starts in early 2012 is that some loans that were outstanding in late 2008 may not exist in early 2012, leading us to mis-measure a region's exposure to the depreciation. To provide an impression of the credit registry's coverage of outstanding balances over time, Figure 15 presents a comparison of the aggregate outstanding

housing debt in the Household Credit Registry reconstituted back to 2000 and the "true" aggregate from the flow of funds (Financial Accounts), reported by the National Bank of Hungary. The Financial Accounts are constructed from bank balance sheet data and measure all outstanding debt by loan type and currency.

Figure 15
Comparison of Imputed Aggregate Debt and Financial Accounts



Notes: This figure compares outstanding housing credit aggregates from Financial Accounts data published by MNB (the "true" credit aggregate) and credit aggregates computed from the Household Credit Registry using the imputation procedure described in the text. The vertical line represents the month for which our exposure variable is computed (September 2008). Panel (a) compares the national aggregate for all mortgage and home equity loans, while panels (b) and (c) present sub-aggregates by currency and loan type. The figures show that our imputation procedure captures a substantial (over 80 percent) fraction of outstanding balances in 2008:9. However, prepayments from the 2011 Early Repayment Program means that we fail to account for about 23 percent of outstanding FC debt (measured as of 2011:10, immediately before the program). Panel (d) shows that the aggregate foreign currency share in the imputed data is similar but lower than the true aggregate share (62.7 percent compared to a true value of 69.1 percent in 2008:9).

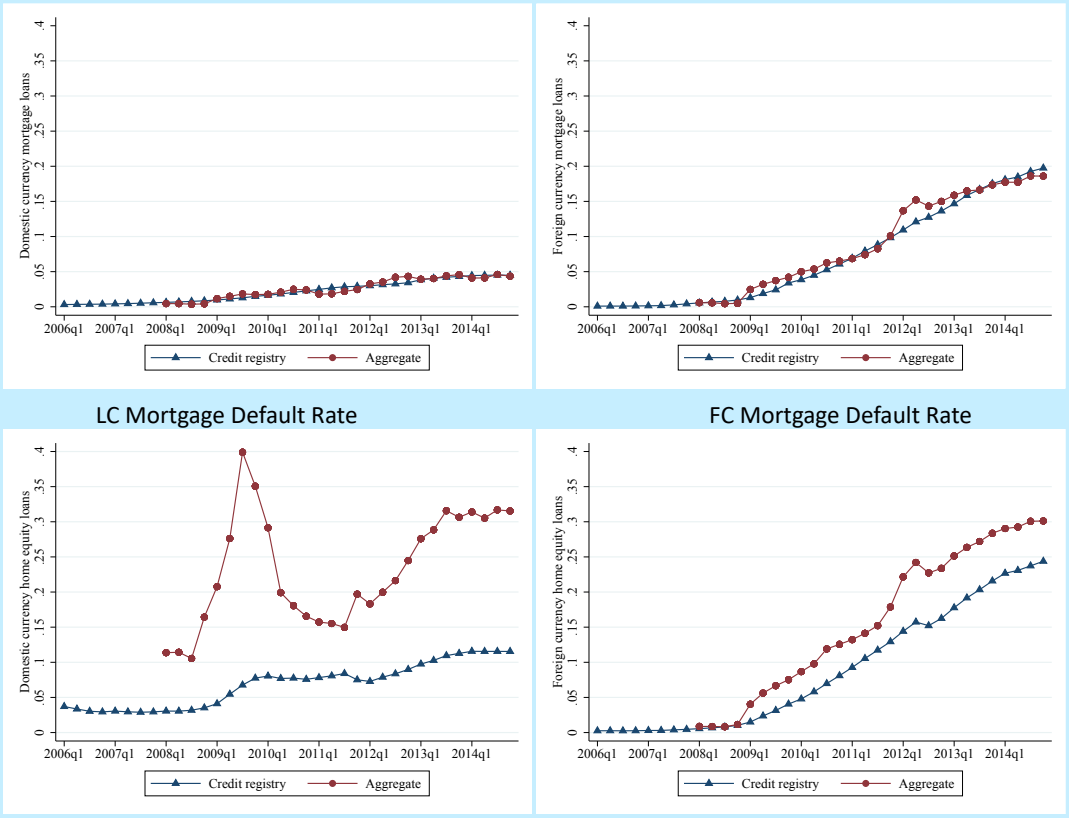
Figure 15 reveals that the imputed aggregate matches the time series behavior of the true aggregate closely, although, as expected, our measure shows a lower level of outstanding credit. In particular, we account for 80.5 percent of total outstanding housing debt and 73.0 percent of foreign currency housing debt in September 2008 (panels (a) and (b)). Panel (b) shows that we match the aggregate level of local currency debt almost perfectly by September 2008. The shortfall in our imputed series thus comes from missing FC debt. As a result, panel (d) shows that in September 2008 the aggregate share of foreign currency debt is 62.7 percent in the imputed series compared to 69.1 percent in the Financial Accounts.

There are three potential reasons for this shortfall in FC loans: the 2011 Early Repayment Program for FC loans, short maturities and repayment, and other forms of prepayment and refinancing. It turns out the 2011 Early Repayment Program explains most of the shortfall.

11.1.3 COMPARISON OF DEFAULTS FROM THE CREDIT REGISTRY AND MNB AGGREGATE STATISTICS

The household default registry records information on all default spells starting in 2010, and it contains the *last* default spell before 2010 for each loan. For example, if a loan originated in January 2006 enters into default in January 2007, is cured in June 2007, and enters into default again in June 2008, then we observe the default spell from June 2008, but not the spell from January to June 2007. Default is recorded when cumulative payments exceeding on month's full-time minimum wage are at least 90 days in arrears. Since the default registry contains information on default spells prior to 2010, we extend the default indicator back to 2006. Given that we only observe the last default, the credit registry potentially underestimates defaults prior to 2010.

Figure 16
Aggregate Default Rates from the Credit Registry and MNB Financial Stability Statistics



Notes: This figure compares household default rates from the Household Credit Registry with MNB's aggregate non-performing loan rates from the Financial Stability Statistics ("Aggregate"). The Financial Stability Statistics measure is based on information reported directly from bank balance sheets to MNB and does not rely on the Household Credit Registry. This measure is available from 2008 onward.

Figure 16 compares the aggregate default rate by currency and loan type from the credit registry with aggregate non-performing loan rates from MNB's Financial Stability Statistics. The non-performing loan rates from the Financial Stability Statistics are reported to MNB by all banks operating in Hungary and is not based on information in the credit registry. Non-performing loans are defined as loans that are at least 90 days in arrears. The aggregate non-performing loan rates from MNB are available starting in 2008, so we cannot cross-validate the credit registry default measure prior to 2008.

The figure shows that aggregate default rates estimated from the credit registry track the aggregate non-performing loan rates reported directly by banks across loan types and currencies. The exception is LC home equity loans in panel (c). However, local currency home equity loans are a small segment of the market. For example, local currency home equity loans are only 2.0 percent of total home equity debt and 0.6 percent of total housing debt in September 2008. Therefore, overall the credit registry captures the increase in credit risk as reported from bank balance sheets. Note that this also suggests that missing loans do not substantially distort average credit quality captured by the credit registry.

11.1.4 EARLY REPAYMENT PROGRAM OF 2011

The primary reason for the FC housing debt shortfall in the Household Credit Registry relative to the financial accounts is that 21.3 percent of outstanding FC debt (15.9 percent of total debt) was prepaid in late 2011 through an Early Repayment Program (ERP). The ERP allowed borrowers to repay FC loans in full at a discount on market exchange rates of approximately 25 percent, with the majority of losses imposed on lenders.[36] The program explains the sharp fall in aggregate FC debt in late 2011 along with a rise in LC debt as some borrowers refinanced into LC loans (Figure 15).

Because the 2011 ERP required that borrowers repay the FC loan in full, it disproportionately benefited borrowers with higher income or liquid wealth, as well as more creditworthy borrowers who could finance the repayment with a new LC loan.[37] If these determinants of participation in the program are correlated with shocks to the local economy and to FC exposure, our estimates will be biased unless we appropriately account for this selection. For example, high income regions where borrowers are more likely to participate in the ERP may also be less exposed to business cycle shocks, leading us to overestimate the effect the foreign currency debt shock. We address this potential selection in several ways.

First, in the main analysis we control for settlement disposable income per capita, as income is expected to be a key determinant of participation in the 2011 ERP. As we describe in section 5, the estimates are reasonably similar when controlling for income (see Table 13), which indicates that any systematic mis-measurement of s_{z08}^{FC} induces at most a modest bias in the estimates.

In addition, we take three different approaches to *explicitly correct* our measure of FC exposure for loans that are not in the credit registry because of the 2011 ERP. We refer to these as ERP Adjustments #1, #2, and #3. The first two approaches draw on additional loan-level information, while the third approach presents simulations under assumptions about participation in the ERP across settlements.

ERP Adjustment #1 (Three-banks dataset). The first approach draws on a separate loan level dataset for three of the largest banks in Hungary. The data includes all loans originated starting in 2004 (and thus virtually all FC loans to households), so it covers almost all loans that were prepaid through the 2011 Early Repayment Program for these three banks. These three banks have a combined market share of 24 percent of total consumer lending, and this database captures 34.4 percent of the debt that prepaid through the ERP.

We use this dataset to construct a settlement-level estimate of the amount of debt that was prepaid through the 2011 ERP for every other bank in the sample. Let x_z^{3b} be the fraction of the three banks' housing debt that is repaid in settlement z, $\bar{x}^{3b}$ be the overall fraction that is repaid for the three banks, and $\bar{x}_b$ be the overall fraction of debt that is repaid for any other bank b. With these three observable objects, the aim is to recover the fraction of bank b's debt that is repaid in z, x_{bz}, for the remaining banks. We assume that this variable can be approximated as follows

$$x_{bz} = x_z^{3b}\left(\frac{\bar{x}_b}{\bar{x}^{3b}}\right). \tag{8}$$

That is we scale the average ERP propensity for the three banks in z with aggregate ERP propensity of bank b relative to the three banks. Thus, a bank that has a higher aggregate fraction of its debt repaid in the ERP relative to the three banks is also assumed to have a higher propensity in a given settlement.

With x_{bz} the bank-settlement prepaid amount is reconstructed as $\widehat{D_{bz}^{prepaid}} = \frac{x_{bz}}{1-x_{bz}} D_{bz}^{FC}$. With the imputed prepayment $\widehat{D_{zb}^{prepaid}}$ we calculate the implied debt level in September 2008 assuming a representative Swiss franc loan for each bank-settlement that was originated in March 2007, in the middle of the FC credit boom.[38] Summing over all banks in z gives us a measure of the

[36] The discount varied by currency denomination and ranged from 20-36 percent.

[37] The program did not facilitate refinancing into loans in domestic currency, and banks actively avoided granting loans that would allow borrowers to participate in the ERP. In 2013 the Hungarian Competition Authority fined 11 major financial institutions for colluding to limit the full prepayment of foreign currency loans.

[38] We choose March 2007 based on the average month of origination for prepaid loans issued by the three banks for which we have complete data. Two-thirds of prepaid loans are mortgages and one-third are HE loans, so we use a weighted average of the bank-product interest rate for the representative loan.

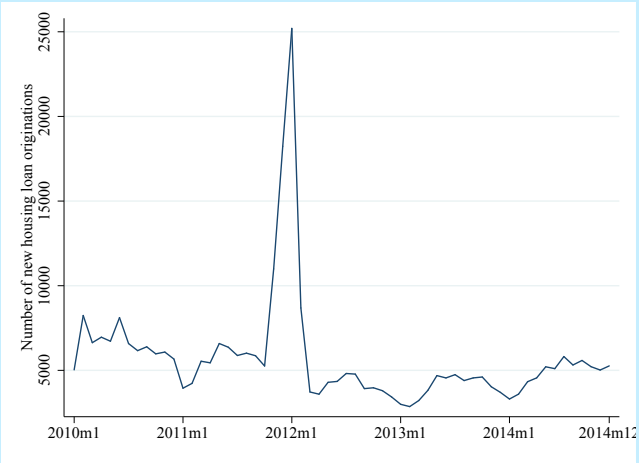
September 2008 loan balance for ERP participants in settlement z, $\widehat{D_{z08}^{prepaid}}$. We then simply adjust the foreign currency share of total housing debt for this term:

$$\widehat{s_{z08}^{FC}} = \frac{\sum_c \mathcal{E}_{08}^{c} D_{z08}^{*c} + \mathcal{E}_{08}^{chf} \widehat{D_{z08}^{prepaid}}}{D_{z08} + \sum_{c \in C} \mathcal{E}_{08}^{c} D_{z08}^{*c} + \mathcal{E}_{08}^{chf} \widehat{D_{z08}^{prepaid}}}. \tag{9}$$

ERP Adjustment #2 (LC Refinancing). The second method draws on information contained in the volume of LC debt origination in a settlement around the time of the 2011 Early Repayment Program. Refinancing into LC loans accounts for 33.0 percent of the participation in the 2011 ERP (approximately HUF 349.4 bn),[39] so the volume of refinancing provides an alternative indication of how intensively households participated in the program in a given area.

To construct a measure of ERP prepayment based on refinancing, we assume that all LC loans originated in the fourth quarter of 2011 were FC loans originated before September 2008 that were refinanced in the ERP. Figure 17 shows that there is a spike in originations in 2011Q4 during ERP window. The volume of new issuance in surrounding months is low, so it is reasonable assume that all loans originated in this period were refinancing loans to take advantage of the ERP. We scale up the refinanced debt in each settlement so that it accounts for the entire 2011 ERP. This assumes that debt that was repaid is proportional to the amount that was refinanced. Note that method #2 explicitly targets aggregate, unlike ERP Adjustment #1. With an estimate of the prepaid debt in settlement z we model the loan balance in September 2008 using a representative Swiss franc loan and assuming a monthly interest rate equal to the average interest rate set by the eight major banks in Hungary. The foreign currency share variable is then adjusted as in method #1.

Figure 17
Number of New Housing Loan Originations



Notes: This figure shows the number of new housing loan originations per month. The figure illustrates the sharp spike in new originations around the ERP window, reflecting an increase in local currency loan issuance used to prepay foreign currency loans through the ERP.

Table 30
Aggregate Prepayment in 2011 Early Repayment Program

Prepaid debt in 2011 ERP (bn HUF)	1,135
Imputed prepayment #1	1,058
Imputed prepayment (targets aggregate) #2	1,135

[39] To arrive at this number we assume that all new LC loans originated in 2011:11-2012:2 minus the average of the originated amount in 2011:10 and 2012:3 are used in the ERP. We scale originated value up by 38.05 percent to reflect the 27.5 percent discount on the market exchange rate.

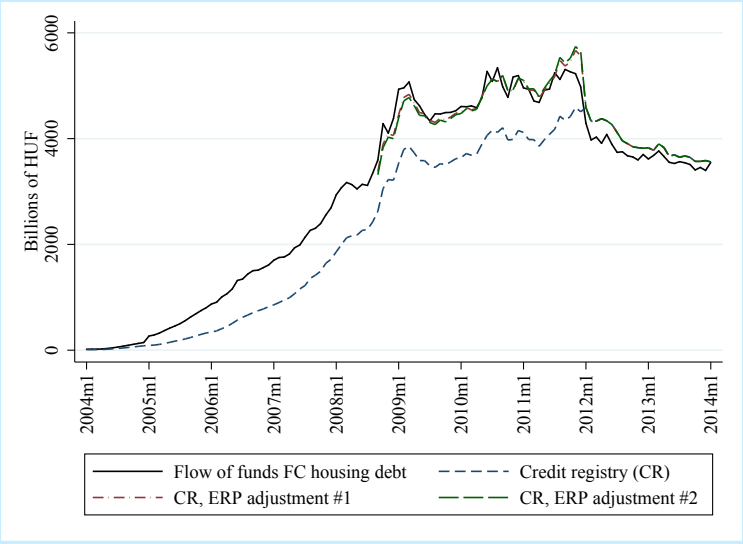
Table 31
Correlation of ERP Participation across ERP Adjustment Methods

	ERP Adj. #1	ERP Adj. #2	Bank 1 $x_z^{Bank,1}$	Bank 2 $x_z^{Bank,2}$	Bank 3 $x_z^{Bank,3}$
ERP Adj. # 1	1.00				
ERP Adj. # 2	0.05	1.00			
Bank 1, $x_z^{Bank,1}$	0.35	0.25	1.00		
Bank 2, $x_z^{Bank,2}$	0.23	0.37	0.19	1.00	
Bank 3, $x_z^{Bank,3}$	0.26	0.33	0.16	0.20	1.00
Observations	2538				

Notes: This table presents the correlation matrix for various estimates of participation in the 2011 Early Repayment Program. ERP Adj. #1 refers to the share of foreign currency debt that is prepaid in a settlement according to the estimate from the Three-banks dataset. ERP Adj. #2 is defined similarly, but where prepaid debt is estimated using the volume of local currency refinancing. Variables $x_z^{Bank,j}$, for $j = 1, 2, 3$, are defined as the share of foreign currency debt prepaid in settlement z for a bank j, where bank j is one of the three anonymous banks in the Three-banks dataset.

Performance of ERP Adjustments #1 and #2. Table 30 compares the aggregate prepayment through the ERP with the prepayment implied by methods #1 and #2. Method #1 matches the aggregate level closely, with HUF 1,058bn compared the target of HUF 1,135bn, or 3.7bn euros. Recall that method #2 mechanically matches the aggregate.

Figure 18
Early Repayment Program Adjustment and Aggregate FC Debt



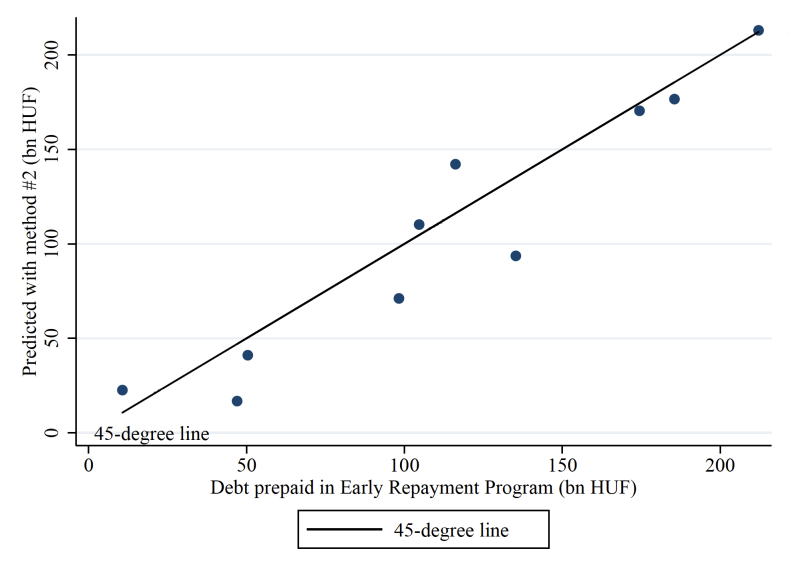
Notes: This figure compares aggregate FC housing debt in the flow of funds (Financial Accounts) against aggregate FC housing debt in the credit registry when we adjust the credit registry using ERP adjustments #1 and #2. The figure illustrates that the ERP adjustments account for most of the missing debt in the credit registry.

Figure 18 shows the impact of the ERP adjustment on aggregate FC debt. With the imputation we account for 95 percent of total debt in September 2008 (with method #1), and the imputed aggregate for all methods tracks the level of outstanding FC debt closely. This implies that four-fifths of the FC debt shortfall in the Household Credit Registry is explained by the ERP.

Table 31 presents a correlation matrix of various estimates of ERP participation propensity at the settlement level. The share of debt prepaid according ERP Adjustments #1 and #2 are positively correlated, but the correlation is low at only 0.05. The share of debt prepaid at the bank level for the banks in the Three-banks dataset is more strongly positively correlated across settlements. This implies that, for example, in local areas where customers of bank 1 had a higher repayment propensity, customers of bank 2 and 3 also had higher propensity to participate in the ERP. This supports the assumption behind ERP Adjustment #1, namely that repayment propensities are higher for other banks in a settlement with high ERP propensity for the three banks.

We also obtained data on the total prepayment for each bank in our sample, and Figure 19 plots the predicted prepayment for method #1 against the true value for the eight major banks in Hungary, (i.e. $\widehat{D_b^{prepaid}} = \sum_z \widehat{D_{zb}^{prepaid}}$ and $D_b^{prepaid}$). Our simple non-parametric in method #1 yields an R^2 of 90.1 percent.

Figure 19
Method #1 Predicted and Actual 2011 Early Repayment Program Debt Reduction by Bank



Notes: This figure plots the amount of debt prepaid through the 2011 Early Repayment Program for the 8 major banks, the savings cooperatives, and the rest of the banks against the predicted amount using ERP Adjustment #1.

Figure 20 compares the original and ERP-adjusted foreign currency debt shares, s^{FC} and $\widehat{s^{FC}}$. As expected, the adjustment raises the FC share in all settlements, and more so in settlements with a lower original share. The correlation between the original and the two adjusted measures is high (0.873 and 0.961 for ERP Adjustments #1 and #2, respectively).

Effect of Controlling for the Early Repayment Program on the Main Results. Table 32 presents robustness tests for the main results using the two adjusted foreign currency exposure variables. The point estimates are reasonably similar to the baseline estimates. The estimates for the adjusted variables tend to be slightly lower (especially for Adjustment #2). While the standard errors increase, the main results retain their statistical significance.

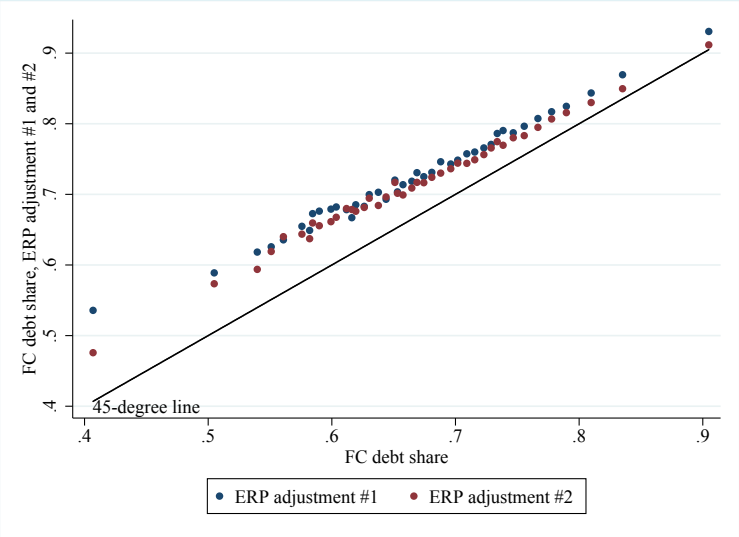
ERP Adjustment #3 (Simulation approach). The third approach to assess the robustness of the main results to accounting for debt missing due to the Early Repayment Program is to allocate debt across settlements based on a simple formula. Specifically, we assume that the amount of debt prepaid in settlement z is given by

$$D_z^{prepaid,\epsilon_x} = C(x_z)^{\epsilon_x} Pop_{z,07}, \tag{10}$$

where x_z is settlement characteristic that captures ability to prepay, such as disposable income per capita or the college share, ϵ_x is the elasticity of prepayment with respect to x_z, $Pop_{z,07}$ is settlement population in 2007, and C is a constant that we adjust so that the sum of the allocated prepaid debt sums to the aggregate amount prepaid through the ERP. Note that an elasticity $\epsilon_x = 0$ implies that prepaid debt is allocated proportionally to settlement population. After allocating debt according to (10), we adjust the foreign currency debt share as in ERP Adjustment method #1.

What is a reasonable value for the elasticity ϵ_x? A useful starting point is the elasticity of estimated ERP prepayment from methods #1 and #2. Table 33 presents estimates of these elasticities. These estimates imply an elasticity of about 0.4 to 1.9 with respect to disposable income per capita and 0.1 to 1.1 with respect to education. We will consider a full range of elasticities from −5 to 5, and will focus on elasticities between 0 and 2 as our preferred values.

Figure 20
Original and ERP Adjusted FC Debt Shares



Notes: This figure plots binned bivariate means (binscatter) of the foreign currency debt share adjusted for the Early Repayment Program against the original FC share (s^{FC}_{z08}).

Figure 21 presents the results of reestimating the key regressions in Tables 4 and 5 using the the adjusted household FC debt share. We present estimates with and without our full set of controls. Panels (a)-(c) present the estimates where x_z equals disposable income per capita, and panels (d)-(f) present the estimates where x_z is the college share. Each point is the estimate when the household FC debt share, $s^{FC}_{z,08}$ is adjusted according to allocation rule (10) with a given elasticity.

For negative elasticities, the estimates are generally not highly sensitive to the ERP adjustment. For positive elasticities the estimates decline in magnitude as the elasticity rise. The auto registration estimate is the most sensitive to the adjustment, and the unemployment estimate the least sensitive. For reasonable income elasticities of around 0 to 2, the estimates are within the ranges reported in the baseline results in Tables 4 and 5. For example, the unemployment estimates are around 2 in panel (c) and slightly below 2 in panel (f), values not too different from the baseline estimate of 1.65 in Table 5. The estimates with controls are generally also more robust to the adjustment, since the control variables capture part of any selection bias attributed to missing data (based on this parametric allocation rule).

11.1.5 SHORT MATURITIES AND REPAYMENT

Another potential source of measurement error is that loans may have short maturities or come due before April 2012, but be outstanding around the depreciation. We do not believe this is a serious concern from the perspective of our study for the following reasons. First, our study focuses on housing-related obligations (mortgage and home equity loans). These are long-dated, with a median maturity at origination of 20 years for mortgages and 15 years for home equity loans. Aggregate credit series from MNB reveal that the fraction of housing loans with maturity shorter than 5 years in September 2008 is 1.69 percent, and the average of this fraction from January 2000 to September 2008 is 2.41 percent. Second, any short-term loan that would be fully repaid in this 3.5 year period would likely have a low remaining balance in the run-up to the crisis and not represent a significant exposure to the depreciation. Third, since mortgage lending took off from a very low initial level in 2000, the number of housing loans that would be expected to be retired between 2008:9 and 2012:3 is a small fraction of the aggregate. And finally, we are able to match the aggregates series quite closely by accounting for the 2011 Early Repayment Program.

Table 32
Robustness of Main Results to Missing Data Adjustments

Panel A: Default

	ERP Adj. #1 (3-Banks)		ERP Adj. #2 (Refinance)	
(lr)2-3(lr)4-5	(1)	(2)	(3)	(4)
HH FC debt share × Post	8.25	6.13	7.93	4.23
	(1.17)	(0.75)	(1.09)	(0.75)
Full Settlement Controls		Yes		Yes
R^2	0.84	0.87	0.84	0.87
Observations	71064	71064	71064	71064

Panel B: New Auto Registrations

	ERP Adj. #1 (3-Banks)		ERP Adj. #2 (Refinance)	
(lr)2-3(lr)4-5	(1)	(2)	(3)	(4)
HH FC debt share × Post	-72.1	-45.7	-83.3	-32.2
	(18.2)	(8.83)	(14.8)	(8.33)
Full Settlement Controls		Yes		Yes
R^2	0.81	0.83	0.81	0.83
Observations	17766	17766	17766	17766

Panel C: Unemployment

	ERP Adj. #1 (3-Banks)		ERP Adj. #2 (Refinance)	
(lr)2-3(lr)4-5	(1)	(2)	(3)	(4)
HH FC debt share × Post	1.53	1.33	1.90	1.17
	(0.87)	(0.51)	(0.81)	(0.51)
Full Settlement Controls		Yes		Yes
R^2	0.60	0.65	0.60	0.65
Observations	17766	17766	17766	17766

Notes: The table presents estimate of the baseline results in section 5 of the paper with the adjusted household foreign currency debt share measures.

11.1.6 SETTLEMENT LOAN-TO-VALUE ESTIMATES

The Household Credit Registry does not report loan-to-value ratios at the loan level. However, individual banks do report the volume of yearly originations across loan-to-value bins by loan currency denomination to the National Bank of Hungary. Using this information, we compute the origination volume weighted average LTV by currency, bank, and year of origination, LTV_{cbt}. We then construct a settlement-level LTV prior to the depreciation as the loan volume weighted average of LTV_{cbt} from 2004 through 2008. We also construct the change in the settlement-level average LTV between 2004-05 and 2007-08 to capture changes in LTV at origination over the credit expansion. This measure allows us to control for LTV differences across settlements that are driven by variation across bank-currency-year of origination dimensions. However, it does not capture variation within these dimensions across settlements. For example, it would not capture variation in LTVs that would arise if a specific bank had different lending policies for foreign currency loans across regional bank branches.

11.2 WAGE ESTIMATES FROM THE STRUCTURE OF EARNINGS SURVEY

The Structure of Earnings Survey (SES) is conducted annually by the National Employment Service and samples 6 percent of Hungarian employees, recording information on their income in May. Firms with 5-20 employees are randomly sampled from the census of enterprises and report information on all employees. All large firms with at least 20 employees are required to

Table 33
Elasticity of Imputed ERP Debt Prepayment with Respect to Income and Education

Panel A: Income Elasticity				
	ERP Adj. #1 (Three-Banks)		ERP Adj. #2 (Refinance)	
(lr)2-3(lr)4-5	(1) Log ERP per Capita	(2) Log ERP	(3) Log ERP per Capita	(4) Log ERP
Log disp. inc. per cap.	0.41	0.68	1.95	1.89
	(0.069)	(0.072)	(0.076)	(0.079)
Log population		0.76		1.06
		(0.017)		(0.015)
R^2	0.015	0.50	0.30	0.75
Observations	2535	2535	2050	2050
Panel B: College Share Elasticity				
	ERP Adj. #1 (Three-Banks)		ERP Adj. #2 (Refinance)	
(lr)2-3(lr)4-5	(1) Log ERP per Capita	(2) Log ERP	(3) Log ERP per Capita	(4) Log ERP
Log college share	0.10	0.35	1.03	1.06
	(0.035)	(0.040)	(0.039)	(0.043)
Log population		0.73		0.97
		(0.019)		(0.015)
R^2	0.0037	0.50	0.32	0.75
Observations	2529	2529	2050	2050

Notes: This table presents regressions of the log of estimated debt prepaid through the ERP on disposable income measures (panel A) and the college share (panel B).

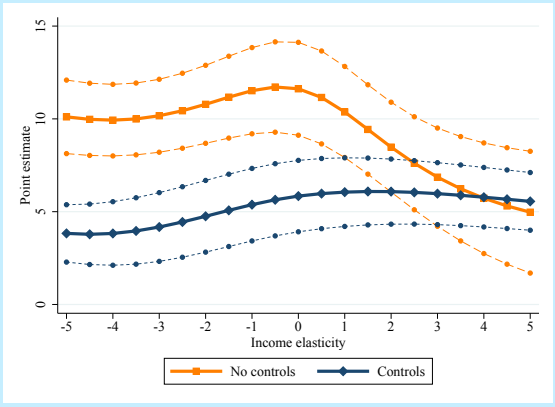
report information on a 10 percent random sample of employees based on employee date of birth. See Harasztosi and Lindner (2019) for a detailed description of the SES.

We estimate composition adjusted wages at the settlement level in the following manner. In each year, we run the following regression separately for men and women

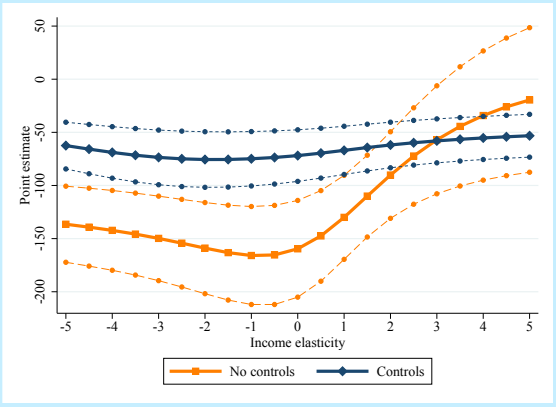
$$\ln(W_{it}) = \alpha_t + X_{it}\Gamma_t + \nu_{it},$$

where W_{it} is worker *i*'s nominal hourly wage (total wage compensation divided by total hours) and X_{it} is a vector of five-year age dummies (with 41-45 as the omitted category) and education dummies (with high school as the omitted category). We then exponentiate the residual plus the constant to obtain the composition adjusted wage, $\widetilde{W}_{it} = e^{\widehat{\nu}_{it}+\widehat{\alpha}_t}$ and compute the average of $\widetilde{W}_{it}$ in each settlement. This procedure yields estimated wage series for about one-third of the settlements in our sample that cover 87.8 percent of the population. With reported hours we also compute the average monthly hours in a settlement, conditional on employment.

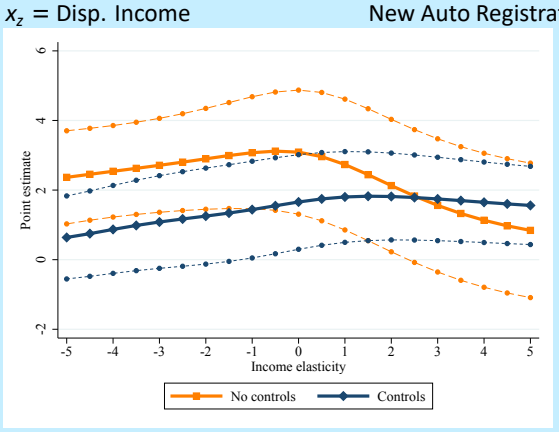
Figure 21
Impact of ERP Adjustment #3 on Baseline Model Estimates



Household Default Rate, x_z = Disp. Income



New Auto Registrations, x_z = Disp. Income



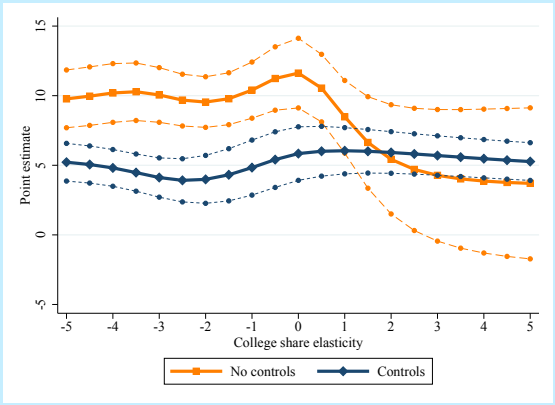
Unemployment Rate, x_z = Disp. Income

Notes: This figure illustrates how our main regression results are affected by adjusting the household FC debt share for debt prepaid through the ERP using the allocation rule in equation (10)*. Specifically, each point is a point estimate of* β *from*

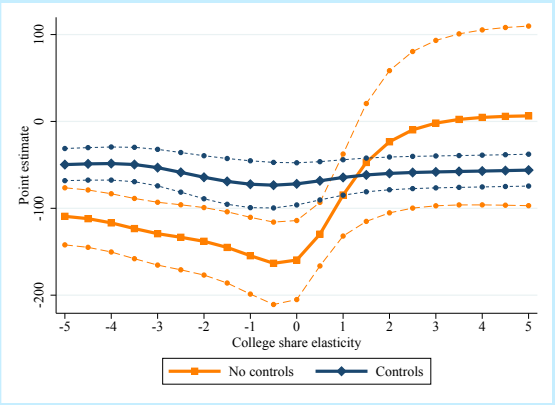
$$Y_{zt} = \alpha_z + \gamma_t + \beta(s_{z,08}^{FC,\epsilon} Post_t) + X_z Post_t \Gamma + \epsilon_{zt}.$$

The x-axis varies the elasticity ϵ_x*, which affects the allocation of prepaid debt and thus* $s_{z,08}^{FC,\epsilon_x}$*. Dashed lines represent 95 percent confidence intervals. The "No controls" estimate correspond to column 1 in Table 4, and the "Controls" estimate corresponds to our full set of controls in column 3 of Table 4.*

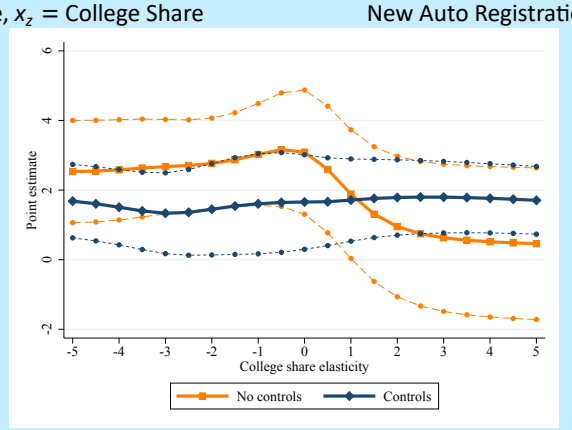
Figure 22
Impact of ERP Adjustment #3 on Baseline Model Estimates (cont.)



Household Default Rate, x_z = College Share



New Auto Registrations, x_z = College Share



Unemployment Rate, x_z = College Share

12 Consumption Response to Debt Revaluation

12.1 PERMANENT INCOME CONSUMER

A permanent income consumer of the form first studied by Hall (1978) has a consumption function

$$c_t = -rd_t + \frac{r}{1+r}\sum_{j=0}^{\infty}\frac{E_t[y_{t+j}]}{(1+r)^j}. \tag{11}$$

In this model, the d_t represents one period debt, y_t is income in period t, and E_t is the expectation conditional on information available in t. The consumer is assumed to have quadratic utility and a discount rate equal to the interest rate r. An unanticipated, zero probability debt revaluation shock Δd_t, thus leads to a decline in consumption of $r\Delta d_t$.

12.2 HAND-TO-MOUTH CONSUMER

A hand-to-mouth (HtM) consumer simply consumes her per period resources. Therefore, the consumption response to a debt revaluation is simply the change in per period debt service. As a result, the maturity of the debt exposed to revaluation affects the magnitude of the consumption response.

Consider an annuity loan of amount d, interest rate r, maturity m, and per period debt service of P. The value of the debt can then be written as a finite geometric series

$$d = \sum_{j=1}^{m}\frac{P}{(1+r)^j} = \frac{P}{1+r}\sum_{j=0}^{m-1}\frac{1}{(1+r)^j}, \tag{12}$$

which has the solution

$$d = P\frac{1-(1+r)^{-m}}{r}. \tag{13}$$

The per period debt payment is then

$$P = d\frac{r}{1-(1+r)^{-m}}. \tag{14}$$

As maturity goes to infinity, $m \to \infty$, the per period debt payment converges to $P = rD$. Therefore, with infinite maturity debt, the PI and HtM consumer have the same MPC out of an increase in debt of r. With debt due in one period, the payment is $P = (1+r)D$. The ratio between the payment on finite maturity debt and the payment on a perpetual debt is

$$\frac{P_m}{P_\infty} = \frac{1}{1-(1+r)^{-m}} \tag{15}$$

With an interest rate of 5 percent and a remaining maturity of 18 years, the average for housing loans prior to the 2008 forint depreciation, the payment is 1.7 times larger with finite maturity debt relative to infinite maturity debt. A HtM consumer would therefore have a 1.7 times stronger consumption response to an increase in monthly payments compared to the PI consumer. With an interest rate of 4 (7) percent this ratio is 1.97 (1.42).

13 Debt Revaluation in an Open Economy Model

13.1 MODEL SET-UP

This appendix presents a simple small open economy model that illustrates the contrasting expansionary and contractionary effects of an unanticipated household debt revaluation present in a broad class of neoclassical and New Keynesian models. We model a region as an island small open economy in a continuum of economies $i \in [0,1]$ following Galí and Monacelli (2005). To provide simple analytical results, we employ the recent continuous time formulation of Farhi and Werning (2017). We focus on an unanticipated exchange rate shock at time $t = 0$, which generates perfect foresight response from the initial steady state.

Households. Household preferences are given by

$$\int_0^\infty e^{-\rho t}\left[\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\varphi}}{1+\varphi}\right]dt,$$

where consumption is an aggregate of home and foreign goods

$$C_t = \left[(1-\alpha)^{\frac{1}{\eta}} C_{H,t}^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}} C_{F,t}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}.$$

Home goods are an aggregate of a continuum of varieties with elasticity of substitution ϵ

$$C_{H,t} = \left(\int_0^1 C_{H,t}(j)^{\frac{\epsilon-1}{\epsilon}} dj\right)^{\frac{\epsilon}{\epsilon-1}}.$$

The parameter α indexes the degree of home bias in consumption. The foreign good is an aggregate of goods from each country with elasticity of substitution γ. In turn, the consumption good produced by country i is an aggregate of varieties produced within i:

$$C_{F,t} = \left(\int_0^1 C_{i,t}^{\frac{\gamma-1}{\gamma}} di\right)^{\frac{\gamma}{\gamma-1}}, \qquad C_{i,t} = \left(\int_0^1 C_{i,t}(j)^{\frac{\epsilon-1}{\epsilon}} dj\right)^{\frac{\epsilon}{\epsilon-1}}.$$

Below we simplify and focus on the case where $\sigma = \eta = \gamma = 1$ (known as the Cole-Obstfeld case), but we keep the notation general for now.

We follow Farhi and Werning (2017) and assume incomplete markets.[40] Specifically, to be consistent with our empirical setting, the household has access to risk-free debt denominated in domestic and foreign currency. The budget constraint is

$$\mathcal{E}_t \dot{D}_t^* + \dot{D}_t = \mathcal{E}_t i_t^* D_t^* + i_t D_t + P_t C_t - W_t N_t - T_t - \Pi_t, \quad t \geq 0,$$

where D_t and D_t^* are debt denominated in domestic and effective foreign currency, and i_t and i_t^* are the home and foreign nominal interest rate.[41] In the initial steady state we have $\mathcal{E} = 1$ and $i = i^* = \rho$.

Household optimality implies the following first order conditions for logged variables:

$$\begin{aligned} \sigma c_t + \varphi n_t &= w_t - p_t \\ \dot{c}_t &= \sigma^{-1}(i_t - \pi_t - \rho) \\ \dot{c}_t &= \sigma^{-1}(i_t^* - \pi_t - \rho + \dot{e}). \end{aligned}$$

[40] Galí and Monacelli (2005) focus on the symmetric complete markets case, which simplifies the analysis by removing net foreign assets as a state variable.

[41] There is a continuum of symmetric foreign countries. The foreign currency bond is denominated in the effective spot exchange rate $\mathcal{E} = \left(\int_0^1 \mathcal{E}_i^{1-\gamma} di\right)^{\frac{1}{1-\gamma}}$.

Firms. The production function of the firm producing variety j in the home country is $Y_t(j) = A_H N_t(j)$. Real marginal cost in terms of domestic prices is given by $MC_t = \frac{1+\tau}{A_H}\frac{W_t}{P_{H,t}}$, where τ is a employment subsidy that is set to offset the monopoly distortion. Log real marginal cost is thus

$$mc_t = -\nu + w_t - p_{H,t} - a_H, \quad \nu \equiv -\ln(1+\tau). \tag{16}$$

Firms set prices in producer currency in a staggered fashion and can reset prices with arrival rate ρ_δ.

Terms of Trade and Real Exchange Rate. It is useful to define and relate the terms of trade to the various price indexes in the economy. The consumer price index in the home country is $P_t = \left[(1-\alpha)P_{H,t}^{1-\eta} + \alpha P_{F,t}^{1-\eta}\right]^{\frac{1}{1-\eta}}$, where the home producer price index is the standard Dixit-Stiglitz aggregate over varieties j: $P_{H,t} = \left(\int_0^1 P_{H,t}(j)^{1-\epsilon}dj\right)^{\frac{1}{1-\epsilon}}$. Define the effective terms of trade as the price of foreign goods relative to the price of home goods, $S_t = \frac{P_{F,t}}{P_{H,t}}$, and the effective real exchange rate as $Q_t = \frac{\mathcal{E}_t P_t^*}{P_t} = \frac{P_{F,t}}{P_t}$, given producer currency pricing.

Home CPI can be log-linearized as

$$p_t = (1-\alpha)p_{H,t} + \alpha p_{F,t} = p_{H,t} + \alpha s_t \Rightarrow \pi_t = \pi_{H,t} + \alpha \dot{s}_t. \tag{17}$$

This allows us to relate the log terms of trade to the log real exchange rate

$$q_t = (1-\alpha)s_t.$$

Consumption Risk Sharing and Wealth Effects. We assume all foreign countries are symmetric. The Euler equation for the home country and country i imply an international risk sharing condition:

$$C_t = \Theta^i C_t^i Q_{i,t}^{\frac{1}{\sigma}}.$$

Taking logs and integrating over i gives us

$$c_t = \theta + c_t^* + \frac{1}{\sigma}q_t,$$

where $\theta = \theta^i = \int_0^1 \theta^i di$ and $c_t^* \equiv \int_0^1 c_t^i di$. θ is a term that depends on net foreign debt, and a debt revaluation that increases the home country's net foreign debt lowers θ.

Goods Market Clearing. Using the standard CES demand functions, the market clearing condition for variety j is

$$\begin{aligned} Y_t(j) &= C_{H,t}(j) + \int_0^1 C_{H,t}^i(j)di \\ &= (1-\alpha)\left(\frac{P_{H,t}(j)}{P_{H,t}}\right)^{-\epsilon}\left(\frac{P_{H,t}}{P_t}\right)^{-\eta} C_t + \alpha\int_0^1 \left(\frac{P_{H,t}(j)}{P_{H,t}}\right)^{-\epsilon}\left(\frac{P_{H,t}}{E_{i,t}P_{F,t}^i}\right)^{-\gamma}\left(\frac{P_{F,t}^i}{P_t^i}\right)^{-\eta} C_t^i di \end{aligned}$$

Inserting this into the domestic output aggregator $Y_t = \left(\int_0^1 Y_t(j)^{\frac{\epsilon-1}{\epsilon}}dj\right)^{\frac{\epsilon}{\epsilon-1}}$, we have

$$\begin{aligned} Y_t &= (1-\alpha)\left(\frac{P_{H,t}}{P_t}\right)^{-\eta} C_t + \alpha\int_0^1 \left(\frac{P_{H,t}}{E_{i,t}P_{F,t}^i}\right)^{-\gamma}\left(\frac{P_{F,t}^i}{P_t^i}\right)^{-\eta} C_t^i di \\ &= \left(\frac{P_{H,t}}{P_t}\right)^{-\eta}\left[(1-\alpha)C_t + \alpha C_t\int_0^1 \left(\frac{P_{F,t}^i E_{i,t}}{P_{H,t}}\right)^{\gamma-\eta} Q_{i,t}^{\eta-\frac{1}{\sigma}}\Theta_i^{-1}di\right]. \end{aligned}$$

Under the assumption that $\sigma = \gamma = \eta = 1$ the goods market clearing condition simplifies to

$$Y_t = C_t S_t^\alpha\left[(1-\alpha) + \alpha\Theta^{-1}\right], \tag{18}$$

which can be log-linearized as

$$y_t = c_t + \alpha s_t - \alpha\theta. \tag{19}$$

Using the risk sharing condition $c_t = \theta + c_t^* + q_t$ and the fact that $q_t = (1-\alpha)s_t$ yields

$$y_t = c_t^* + s_t + (1-\alpha)\theta. \tag{20}$$

An increase in θ increases demand for home output by $(1-\alpha)$, the share on home goods.

Net Exports. Define net exports in terms of domestic output as $nx_t = \left(\frac{1}{Y}\right)\left(Y_t - \frac{P_t}{P_{H,t}}C_t\right)$. Log-linearizing and using that $S^{\alpha} = P_t/P_{H,t}$ yields

$$nx_t = y_t - c_t - \alpha s_t = -\alpha\theta,$$

where the last equality uses (19) and hence the assumption of unitary elasticities of substitution. Therefore, when $\theta > 0$ ($\Theta > 1$) the home country can run trade deficits of $\alpha\theta$ in each period. The assumption of unit elasticities simplifies the analysis because it implies that the trade balance is constant.

IS Equation. Differentiating the market clearing condition (19) with respect to time under the assumption of unitary elasticities, we have

$$\dot{y}_t = \dot{c}_t + \alpha\dot{s}_t$$

Substituting out consumption from the Euler equation, $\dot{c}_t = i_t - \pi_t - \rho$, implies

$$\dot{y}_t = i_t - \pi_t - \rho + \alpha\dot{s}.$$

Finally, using (17), the dynamic IS equation is

$$\dot{y}_t = i_t - \pi_{H,t} - \rho.$$

Marginal Cost, Output, and Phillips Curve. To a first order approximation, we can relate domestic output to domestic productivity and employment as

$$y_t = a_H + n_t.$$

Using this and other relations, we can rewrite real marginal cost in (16) as

$$mc_t = -\nu + (w_t - p_t) + (p_t - p_{H,t}) - a_H \tag{21}$$

$$= -\nu + (1+\varphi)y_t + \alpha\theta - (1+\varphi)a_H \tag{22}$$

where we assume $\sigma = \gamma = \eta = 1$.

The natural level of output that obtains under flexible prices when $mc = -\mu = \ln\left(\frac{\epsilon}{\epsilon-1}\right)$, is thus

$$y_t^n = a_H + \frac{\nu - \mu}{1+\varphi} - \frac{\alpha\theta}{1+\varphi}. \tag{23}$$

The deviation from real marginal cost relative to the initial natural level (with $\theta = 0$) is

$$\widetilde{mc}_t = (1+\varphi)\tilde{y}_t + \alpha\theta. \tag{24}$$

Calvo price setting implies that domestic inflation dynamics are given by the New-Keynesian Phillips curve

$$\dot{\pi}_{H,t} = \rho\pi_{H,} - \lambda\widetilde{mc}_t, \quad \lambda = \rho_\delta(\rho + \rho_\delta) \tag{25}$$

which, using (24), can be rewritten as

$$\dot{\pi}_{H,t} = \rho\pi_{H,} - \kappa\tilde{y}_t - \lambda\alpha\theta, \quad \kappa = \lambda(1+\varphi). \tag{26}$$

Initial Flexible Price Steady State. In the initial steady state $\theta = 0$. Moreover, we assume $a_H = c^* = 0$. From (20) and (23), the natural level of output and terms of trade are simply $y^n = 0, s^n = 0$.

13.2 CONSEQUENCES OF A HOUSEHOLD DEBT REVALUATION

We assume that in the initial steady state the nominal exchange rate equals one, $E = 1$. The household is long in domestic currency assets and borrows in foreign currency, so debt in terms of output satisfies $\bar{D}^* + \bar{D} = 0$, $\bar{D}^* > 0$.[42] The economy is in the natural allocation with $\theta = 0$ and balanced trade.

At time zero there is Δe percent depreciation that raises debt to $\Delta e\bar{D}^* > 0$. This is the fundamental shock we study. The increase in debt implies that the economy must run trade surpluses. Under the assumption of unit elasticities of substitution, the trade balance is constant and equals $nx = -\alpha\theta$. The country budget constraint therefore implies that net foreign debt relative to initial output is $\Delta e\bar{D}^* = \int_0^\infty e^{-\int_0^t i_s ds} nx dt = \int_0^\infty e^{-\rho t} nx dt = \frac{nx}{\rho}$. As a result, the debt revaluation implies that the wedge in the risk sharing condition declines by

$$\theta = -\frac{\rho \Delta e D^*}{\alpha}.$$

This term has the intuitive property that the increase in debt is smoothed according to the rate at which the households can borrow ρ.

How does the exchange rate shock and associated debt revaluation affect output and prices? We can trace the effect by solving the following system:

$$\dot{\pi}_{H,t} = \rho \pi_{H,t} - \kappa y_t + \lambda \rho \Delta e D^* \tag{27}$$

$$\dot{y}_t = i_t - \pi_{H,t} - \rho \tag{28}$$

$$y_0 = -\frac{1-\alpha}{\alpha} \rho \Delta e D^* + \Delta e. \tag{29}$$

Equation (27) is the standard New-Keynesian Phillips curve, adjusted for the wealth effect of the debt revaluation. Equation (28) is the dynamic IS curve. Given that we think of the home economy as an independent region within a currency union, we assume that $i_t = \rho$, so that domestic monetary policy does not react to the shock. Equation (29) is the initial goods market clearing condition. The nominal exchange rate enters the initial condition, as it jumps by Δe, depreciating the terms of trade, but prices are sticky and hence evolve smoothly.[43]

Analytical Solution. We can write the system in (27)-(28) as $\dot{X}_t = AX_t + B_t$ and apply the transformation $Z_t = V^{-1}X_t$, where $V^{-1}AV = D$. Here V is the matrix of eigenvectors of A, and D is the diagonal matrix of eigenvalues of A:

$$A = \begin{bmatrix} \rho & -\kappa \\ -1 & 0 \end{bmatrix}, \quad D = \begin{bmatrix} \overline{\nu} & 0 \\ 0 & \nu \end{bmatrix}, \quad V = \begin{bmatrix} -\overline{\nu} & -\nu \\ 1 & 1 \end{bmatrix}, \quad \overline{\nu} = \frac{\rho + \sqrt{\rho^2 + 4\kappa}}{2}, \quad \nu = \frac{\rho - \sqrt{\rho^2 + 4\kappa}}{2}$$

The system we want to solve is then $\dot{Z} = DZ + V^{-1}B$, or

$$\dot{z}_1 = \overline{\nu} z_1 + \frac{\lambda \rho \Delta e D^*}{\nu - \overline{\nu}} \tag{30}$$

$$\dot{z}_2 = \nu z_2 + \frac{\lambda \rho \Delta e D^*}{\overline{\nu} - \nu} \tag{31}$$

$$\tag{32}$$

The general solution is

$$z_{1t} = b_1 e^{\overline{\nu} t} - \frac{\lambda \rho \Delta e D^*}{\nu - \overline{\nu}} \frac{1}{\overline{\nu}} \tag{33}$$

$$z_{2t} = b_2 e^{\nu t} - \frac{\lambda \rho \Delta e D^*}{\overline{\nu} - \nu} \frac{1}{\nu}, \tag{34}$$

[42] The assumption that $\bar{D}^* + \bar{D} = 0$ is without loss of generality, as we can always redefine the initial natural allocation as one with a different wedge in the consumption risk sharing condition.

[43] Empirically, the terms of trade moves significantly less than one for one with exchange rate shock. A weaker quantitative effect of the exchange rate channel through expenditure switching strengthens our identifying assumption, as it implies that the expenditure switching channel will also matter less for output in the cross-section of regions.

where b_1 and b_2 are constants. We set $b_1 = 0$ for the saddle path stable solution. Using $X_t = VZ_t$, we can obtain the solution in terms of the original variables

$$X_t = \begin{bmatrix} -\nu e^{\nu t} b_2 \\ b_2 e^{\nu t} - \frac{\lambda \rho \Delta e D^*}{\nu - \bar{\nu}} \left(\frac{1}{\bar{\nu}} - \frac{1}{\nu} \right) \end{bmatrix} \tag{35}$$

To obtain b_2, we use the initial condition (29)

$$b_2 = -\frac{1-\alpha}{\alpha} \rho \Delta e D^* + \Delta e + \frac{\lambda \rho \Delta e D^*}{\nu - \bar{\nu}} \left(\frac{1}{\bar{\nu}} - \frac{1}{\nu} \right)$$

The output response to the exchange rate shock is then:

$$\begin{aligned} y_t &= \left(-\frac{1-\alpha}{\alpha} e^{\nu t} - (1 - e^{\nu t}) \frac{\lambda}{\nu - \bar{\nu}} \left(\frac{1}{\bar{\nu}} - \frac{1}{\nu} \right) \right) \rho \Delta e D^* + \Delta e \cdot e^{\nu t} \\ y_t &= \left(-\frac{1-\alpha}{\alpha} e^{\nu t} + (1 - e^{\nu t}) \frac{1}{1+\varphi} \right) \rho \Delta e D^* + \Delta e \cdot e^{\nu t} \\ y_t &= \beta_t \Delta e D^* + \gamma_t \Delta e \end{aligned} \tag{36}$$

and the response of domestic inflation is

$$\pi_{H,t} = -\nu e^{\nu t} \left(-\frac{1-\alpha}{\alpha} \rho D^* \Delta e - \frac{\rho \Delta e D^*}{1+\varphi} + \Delta e \right).$$

The debt revaluation channel tends to lower inflation and depreciate the terms of trade, as demand falls and labor supply expands.

The first channel on the right-hand-side of (36) is the household debt revaluation channel. The debt-revaluation can have opposing expansionary supply and contractionary demand effects, captured by the different terms entering β_t. An increase in household debt lowers households' wealth and consumption, which leads households to boost labor supply, raising output. With flexible prices, this labor supply effect dominates, and an increase in debt boosts output in the short run. At the same time, the increase in the households' real debt burden will depress consumption and therefore demand. With nominal rigidities, the demand channel dominates in the short run, and the rise in real debt burdens depresses output through a demand effect. Estimation of β_t, therefore, provides a test of flexible versus sticky price models.

The second channel on the right-hand-side of equation (36) is the standard expenditure switching channel. The depreciation lowers the relative price of home goods and thus increases the demand for home goods. The response in (36) highlights that if households have currency mismatch, the expansionary effect of exchange rate depreciation is dampened and may even be reversed, posing a dilemma for monetary policy in a currency crisis.

14 Financial Spillovers and Unobserved Selection

This section presents a simple statistical model of individual-level default. The model illustrates how comparison of the coefficient on *FC* from equation (7) *with* and *without* controlling for s^{FC} provides information on the degree of local-level unobserved selection.[44]

14.1 SET-UP

Consider a borrower i in local area z. Borrower-level FC debt exposure, FC_i, can equal zero or one. Assume borrower-level FC debt exposure is driven by three factors. The first factor is unobserved credit risk q_z at the local (settlement) level. The second factor is a random local-level foreign currency exposure shifter, r_z. The difference between q_z and r_z is that, unlike q_z, r_z does not independently affect the probability of default. The third factor is an individual level iid shock. Local-level FC debt exposure, excluding borrower i, is given by

$$s_{z,-i} = \frac{1}{N_i - 1} \sum_{j \in z, j \neq i} FC_j,$$

where N_i is the number of borrowers in a settlement. Finally, assume the probability of default is generated by the following model

$$Y_{iz} = \beta_{FC} FC_i + \beta_s s_{z,-i} + \beta_q q_z + \epsilon_{iz}, \tag{37}$$

where ϵ_{iz} is an iid shock. Thus, default is determined by individual FC exposure (FC_i), local FC exposure ($s^{FC}_{z,-i}$), and by unobserved credit risk (q_z) that is correlated with FC_i and $s_{z,-i}$. In this set-up, we abstract from individual-level selection based on the result that FC and LC borrowers are approximately similar at the individual level (see Section 4.3).

14.2 SHORT AND INTERMEDIATE REGRESSIONS

Consider first estimating the short regression, corresponding to column 1 in Table 7:

$$Y_{iz} = \beta_0 + \beta_{FC} FC_i + \epsilon_{iz} \tag{38}$$

which yields

$$\widetilde{\beta}_{FC} = \frac{\widehat{\mathrm{cov}}(Y, FC)}{\widehat{\mathrm{var}}(FC)},$$

where we omit subscripts to lighten the notation, and all variables are demeaned. We use $\widehat{\mathrm{var}}$ and $\widehat{\mathrm{cov}}$ to refer to sample variances and covariances and var and cov to refer to their population values. Estimating the intermediate regression

$$Y_{iz} = \beta_0 + \beta_{FC} FC_i + \beta_s s_{z,-i} + \epsilon_{iz} \tag{39}$$

yields an estimate on *FC* of

$$\widehat{\beta}_{FC} = \frac{\widehat{\mathrm{var}}(s)\widehat{\mathrm{cov}}(FC, Y) - \widehat{\mathrm{cov}}(FC, s)\widehat{\mathrm{cov}}(s, Y)}{\widehat{\mathrm{var}}(FC)\widehat{\mathrm{var}}(s) - \widehat{\mathrm{cov}}(FC, s)^2}.$$

Our object of interest is the difference between the short and intermediate regression coefficients:

$$\widetilde{\beta}_{FC} - \widehat{\beta}_{FC} = \frac{\widehat{\mathrm{cov}}(Y, FC)}{\widehat{\mathrm{var}}(FC)} - \frac{\widehat{\mathrm{var}}(s)\widehat{\mathrm{cov}}(FC, Y) - \widehat{\mathrm{cov}}(FC, s)\widehat{\mathrm{cov}}(s, Y)}{\widehat{\mathrm{var}}(FC)\widehat{\mathrm{var}}(s) - \widehat{\mathrm{cov}}(FC, s)^2}. \tag{40}$$

We will show that this object contains information on the importance of local-level unobserved selection driven by q.

[44] We thank David Matsa for pointing us in this direction.

14.3 EVALUATION OF $\widetilde{\beta}_{FC} - \widehat{\beta}_{FC}$

The common denominator of (40) can be written as

$$D = \widehat{\text{var}}(FC)\left[\widehat{\text{var}}(FC)\widehat{\text{var}}(s) - \widehat{\text{Cov}}(FC,s)\widehat{\text{Cov}}(FC,s)\right] \tag{41}$$

The numerator then becomes:

$$\begin{aligned} N &= \widehat{\text{Cov}}(Y,FC)\widehat{\text{var}}(FC)\widehat{\text{var}}(s) - \widehat{\text{Cov}}(Y,FC)\widehat{\text{Cov}}(FC,s)\widehat{\text{Cov}}(FC,s) \\ &\quad - \widehat{\text{var}}(FC)\widehat{\text{var}}(s)\widehat{\text{Cov}}(FC,Y) + \widehat{\text{var}}(FC)\widehat{\text{Cov}}(FC,s)\widehat{\text{Cov}}(Y,s) \\ N &= \widehat{\text{Cov}}(FC,s)\left[\widehat{\text{var}}(FC)\widehat{\text{Cov}}(Y,s) - \widehat{\text{Cov}}(FC,s)\widehat{\text{Cov}}(Y,FC)\right]. \end{aligned}$$

Combining these yields

$$\widetilde{\beta}_{FC} - \widehat{\beta}_{FC} = \frac{\widehat{\text{Cov}}(FC,s)}{\widehat{\text{var}}(FC)} \times \underbrace{\frac{\widehat{\text{var}}(FC)\widehat{\text{Cov}}(Y,s) - \widehat{\text{Cov}}(FC,s)\widehat{\text{Cov}}(Y,FC)}{\widehat{\text{var}}(FC)\widehat{\text{var}}(s) - \widehat{\text{Cov}}(FC,s)\widehat{\text{Cov}}(FC,s)}}_{A} \tag{42}$$

Now consider taking the number of borrowers in z and the number of local areas z to infinity, $N_i, N_z \to \infty$. Consider the term denoted by A. Using that

$$\begin{aligned} \widehat{\text{cov}}(Y,s) &\to_p \beta_{FC}\text{cov}(FC,s) + \beta_s\text{var}(s) + \beta_q\text{cov}(q,s) \\ \widehat{\text{cov}}(Y,FC) &\to_p \beta_{FC}\text{var}(FC) + \beta_s\text{cov}(s,FC) + \beta_q\text{cov}(q,FC), \end{aligned}$$

we have that

$$A \to_p \beta_s + \frac{\beta_q\left(\text{var}(FC)\,\text{Cov}(q,s) - \text{Cov}(FC,s)\,\text{Cov}(q,FC)\right)}{\text{var}(FC)\text{var}(s) - \text{Cov}(FC,s)\,\text{Cov}(FC,s)}.$$

Substituting back into (42), we obtain

$$\widetilde{\beta}_{FC} - \widehat{\beta}_{FC} \to_p \frac{\text{Cov}(FC,s)}{\text{var}(FC)} \times \left(\beta_s + \frac{\beta_q\left(\text{var}(FC)\,\text{Cov}(q,s) - \text{Cov}(FC,s)\,\text{Cov}(q,FC)\right)}{\text{var}(FC)\text{var}(s) - \text{Cov}(FC,s)\,\text{Cov}(FC,s)}\right).$$

Using that $\text{cov}(q,s) = \text{cov}\left(q, (N_i-1)^{-1}\sum_{j\neq i} FC_j\right) = \text{cov}(q,FC)$, this simplifies to

$$\widetilde{\beta}_{FC} - \widehat{\beta}_{FC} \to_p \beta_s\frac{\text{Cov}(FC,s)}{\text{var}(FC)} + \beta_q\frac{\text{Cov}(FC,q)}{\text{var}(FC)}\left(\frac{\text{Cov}(FC,s)\text{var}(FC) - \text{Cov}(FC,s)\,\text{Cov}(FC,s)}{\text{var}(FC)\text{var}(s) - \text{Cov}(FC,s)\,\text{Cov}(FC,s)}\right)$$

Focusing on the final term in parentheses, the law of total covariance implies

$$\begin{aligned} \text{cov}(FC,s) &= [\text{cov}(FC_i, FC_j|s)] + \text{cov}((FC_i|s),(FC_j|s)), \quad j \neq i \\ &= 0 + \text{cov}(s,s) \\ &= \text{var}(s). \end{aligned}$$

This implies that

$$\frac{\text{Cov}(FC,s)\text{var}(FC) - \text{Cov}(FC,s)\,\text{Cov}(FC,s)}{\text{var}(FC)\text{var}(s) - \text{Cov}(FC,s)\,\text{Cov}(FC,s)} = 1$$

.

Therefore,

$$\widetilde{\beta}_{FC} - \widehat{\beta}_{FC} \to_p \underbrace{\beta_s\frac{\text{Cov}(FC,s)}{\text{var}(FC)}}_{(i)} + \underbrace{\beta_q\frac{\text{Cov}(FC,q)}{\text{var}(FC)}}_{(ii)}. \tag{43}$$

14.4 INTERPRETATION

Equation (43) is the key result of this exercise. It implies that the difference between the short and intermediate regressions estimates of β_{FC} captures the sum of: (i) the systematic relation between *FC* and *s*, times the effect of *s* on *Y*, and (ii) the relation between *FC* and the unobserved selection *q*, times the effect of *q* on *Y*.

The coefficient on FC_i would, therefore, be expected to decline for two reasons when controlling for *s*. The first is mechanical. FC will be correlated with *s* because individual foreign currency exposure is partly determined by local factors. The second is more concerning. If unobserved selection is an important driver of *FC* and the outcome *Y*, the coefficient will decline because controlling for *s* captures this unobserved selection. However, if the difference $\widetilde{\beta}_{FC} - \widehat{\beta}_{FC}$ is small, then it suggests that unobserved selection is not a major concern, i.e. that $\beta_q \frac{\mathrm{Cov}(FC,q)}{\mathrm{var}(FC)}$ is relatively small. This also implies that the short regression provides an estimate that is approximately unbiased.

To provide a sense of the potential magnitude of term (ii) in (43), we can calculate the remaining terms under several assumptions. In our data, $\widehat{\mathrm{var}}(FC) = 0.23$ and $\widehat{\mathrm{cov}}(FC, s) = 0.005$. Assuming that $\beta_s = 3.99$ (as in Table 7), this implies that $\beta_q \mathrm{cov}(FC, q) = -.011$. This exercise implies that omitted credit quality is not biasing the estimate of β_{FC} (and hence β_s) upward.

MNB Working Papers 2020/2

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