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

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Abstract

This paper examines how an increase in household debt affects the local economy using a foreign currency debt crisis in Hungary as a natural experiment. We construct shocks to local household debt burdens by exploiting spatial variation in households' exposure to foreign currency debt during the large (over 30%) and unexpected depreciation of the Hungarian forint in late 2008. We first show that a shock to local household debt leads to a rise in default rates and a persistent decline in local durable and non-durable consumption. Next, we find that regions with greater exposure to foreign currency debt experience a persistent increase in local unemployment. Firm-level census data reveal that employment losses are driven by firms dependent on local demand. Exposed areas see a modest decline in wages, but no adjustment through reallocation toward exporting firms or migration. In addition to the direct effect of higher debt, we find evidence of local spillovers. Regional exposure to foreign currency debt predicts a decline in house prices and an increase in the probability of default for households with only domestic currency debt. Our results are consistent with demand and pecuniary externalities of household foreign currency debt financing.

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1 Introduction

How does elevated household debt affect the real economy in a crisis? The rapid global increase in household debt leading up to the Great Recession has revived interest this question. Recent research, building on Fisher (1933)'s *debt-deflation* hypothesis, argues that household debt is a powerful contractionary mechanism because it forces leveraged households to cut back on consumption and leads to fire-sales that depress wealth and borrowing capacity (e.g., Korinek and Simsek 2016). Since the Great Recession, concerns about the risks of elevated household debt have led many countries to implement macro-prudential policies that constrain household leverage.[1]

Despite the prominence of debt-deflation in models and financial regulation, there is limited empirical evidence that isolates the effects of household debt in a crisis. Several studies find that expansions in household debt predict more severe recessions (e.g., Jordà, Schularick, and Taylor 2014). However, estimating the causal effect of debt on real outcomes presents several empirical challenges. First, increases in household debt are often part of a broader cycle in real activity and credit conditions, making it difficult to disentangle whether debt itself causes more severe recessions. For example, in the years surrounding the Great Recession, household leverage is strongly correlated with the rise and subsequent collapse in house prices and credit availability, both across countries and across U.S. regions.[2] Second, testing the equilibrium effects of debt requires variation in household debt at a sufficiently aggregated level. For example, higher debt may raise individual labor supply, but this expansionary effect may be offset by declines in local demand and house prices.

In this paper, we provide causal evidence on the real economic effects of a sudden increase in household debt burdens using a foreign currency debt crisis in Hungary as a natural experiment. We exploit spatial variation in exposure to household foreign currency debt during the sharp depreciation of the Hungarian forint in the 2008 global financial crisis. Using this *household debt*

[1] Macro-prudential restrictions such as caps on loan-to-value or debt-to-income ratios were in place in over 41 countries in 2014, including China, South Korea, and the United Kingdom (Cerutti, Claessens, and Laeven 2017).

[2] Country-level data show that credit expansions predict house price declines, bank credit contractions, equity market crashes, distressed corporate balance sheets, and over-optimistic expectations (Schularick and Taylor 2012, Jordà, Schularick, and Taylor 2013, Baron and Xiong 2017, Krishnamurthy and Muir 2017, López-Salido, Stein, and Zakrajšek 2017, Mian, Sufi, and Verner 2017, IMF 2017). Dynan (2012) analyzes whether household debt overhang constrained consumption in the U.S. during the Great Recession, but notes that debt is strongly correlated with regional housing booms and busts, which Mian and Sufi (2014a) show have strong effects on local consumption and employment.

revaluation shock, we provide three main results. First, household debt revaluation increases household default rates and persistently depresses consumption. Second, the increase in household debt causes a significantly worse local recession. The worse recession is driven by a decline in demand through two channels: a direct effect of debt on demand and an indirect effect through a decline in house prices. Third, as a result, we find that the debt revaluation has negative spillovers on nearby households without foreign currency debt.

Household exposure to foreign currency debt in a currency crisis provides a novel way to assess the real economic effects of higher debt. Hungary provides an appealing setting for this analysis for two reasons. First, prior to the depreciation of the Hungarian forint in late 2008, 69% of household debt was denominated in foreign currency. Second, the depreciation of the forint was sharp and unexpected. The flight to safety from emerging markets in late 2008 caused the forint to depreciate by over 30%, raising aggregate household debt by 10% of disposable income. While we focus on Hungary, foreign currency retail lending, especially to households, was widespread throughout emerging Europe during the 2000s. It resulted in an unprecedented level of private sector currency mismatch, with non-financial foreign currency debt reaching 19% of GDP in 2007 for a sample of 10 new EU member states (Ranciere, Tornell, and Vamvakidis 2010).[3]

Hungary's foreign currency debt revaluation allows us to address the identification challenge that household debt usually varies as part of a broader credit and real economic cycle. We show that local exposure to household foreign currency debt is not correlated with household leverage in 2008 or growth in house prices, durable spending, and real activity prior to the currency crisis. Our empirical strategy, therefore, estimates the effect of higher household debt, holding fixed other related factors such as a house price boom and bust (e.g., Mian and Sufi 2011), over-optimistic beliefs about future growth or returns (e.g., Bordalo, Gennaioli, and Shleifer 2017, Kaplan, Mitman, and Violante 2017), or a housing supply overhang (e.g., Gao, Sockin, and Xiong 2017, Rognlie, Shleifer, and Simsek 2017). A distinct concern in our setting is that the exchange rate depreciation differentially affects local outcomes through channels other than household debt, such as expenditure switching or corporate foreign currency debt. However, the currency composition of household debt is not strongly related to local export intensity, industry composition, or corporate foreign

[3]This statistic is based on data from national central banks collected by Brown, Peter, and Wehrmuller (2009). Household foreign currency denominated debt was also important in previous emerging market crises. For example, prior to Argentina's crisis and devaluation in 2002, 80% of mortgages were denominated in U.S. dollars (IMF 2003).

currency financing. Instead, variation in household foreign currency exposure is mainly driven by the historical banking market structure and the initial depth of domestic banks.

To analyze the consequences of the household debt revaluation, 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: (i) measures of household spending, unemployment, and house prices, and (ii) firm-level census and credit registry data that include information on employment, bank lending relationships, and balance-sheet items, including the currency composition of firms' liabilities. Our data, therefore, provide a complete picture of private foreign currency financing, allowing us to compare the consequences of household versus firm foreign currency debt in a currency crisis.

We first show that household debt revaluation leads to a strong increase in household defaults and a decline in consumption. Using data across 3,124 local areas (cities or municipalities), we find that a 1% increase in debt leads to a 0.17 percentage point increase in default rates, a 2.7% decline in auto expenditure, a proxy for durable spending, and a 0.22% decline in electricity usage, a proxy for non-durable consumption. The strong consumption response to debt revaluation implies that households are not hedged against their foreign currency debt positions, opening up the possibility for demand externalities on local employment.

Next, we investigate how household debt revaluation affects local employment. Standard models have differing implications for the effect of debt revaluation on real activity. In an open economy model with household currency mismatch and nominal rigidity, debt revaluation triggers a decline in consumption and employment. The fall in employment is larger in economies with greater home bias. By contrast, in a model with flexible prices, debt revaluation lowers consumption, but increases employment, as households boost labor supply.

In the data, we find that regions with greater exposure to foreign currency debt experience a significant decline in local employment and a persistent rise in unemployment. The rise in unemployment is consistent with the importance of local household demand effects and is larger in more urban areas, where we expect less "leakage" of local demand to other regions. Exploiting firm-level census data, we show that the decline in employment is driven by non-exporting firms and firms in the non-tradable sector. These firms also experience significant drops in sales and output. By contrast, exporting firms are unaffected. In terms of magnitudes, we estimate that a

10 percentage point increase in household debt-to-income raises the local unemployment rate by 0.8 to 1.6 percentage points.

Why does household debt revaluation lead to persistently higher local unemployment? One potential reason is a lack of labor market adjustment through wage declines, migration, or reallocation to exporting firms. Indeed, we find that, concurrent with the decline in employment, areas with greater exposure to foreign currency debt see only a modest decline in wages and no increase in migration or reallocation toward exporting firms.

Another potential mechanism that amplifies the effects of higher debt burdens is house price declines, which reduce household wealth and borrowing capacity. We find that, despite experiencing similar house price growth before the depreciation, regions with more exposure to foreign currency debt experience a significant relative decline in house prices after the depreciation. House price declines, in turn, predict lower household consumption. 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). Liquidity constraints also amplify households' response to debt revaluation. Borrowers with foreign currency debt are more likely to default if their debt is of shorter maturity, holding fixed total debt.

The finding that debt revaluation causes a rise in unemployment and decline in house prices is consistent with theories where debt has negative demand and fire-sale externalities (e.g., Farhi and Werning 2016). An implication of these theories is that borrowing in foreign currency has negative spillover effects on other households in the crisis, including households that did not borrow in foreign currency. We find direct evidence of such spillovers in loan-level data. In particular, we find that borrowers who live in regions with greater exposure to foreign currency debt are more likely to default, conditional on borrowers' own foreign currency debt position. The effect of regional foreign currency exposure on the probability of default holds even for borrowers with only domestic currency debt.

The final part of the paper analyzes the connection between household foreign currency debt and a traditional channel of emerging market crises: corporate foreign currency indebtedness (Krugman 1999, Aghion, Bacchetta, and Banerjee 2000). Using firm-level data, we find that firms with foreign currency debt cut investment sharply after the depreciation, relative to unexposed firms. Surprisingly, however, these firms see *stronger* sales growth and similar employment growth. This

is explained by the fact that firms borrowing in foreign currency tend to be larger, more productive, and more likely to be exporters (see also Salomao and Varela 2016). As a result, local employment declines in the crisis can be more easily explained by households' foreign currency debt than firms' foreign currency debt, although there is evidence of an interaction between the two channels.

We take several steps to support our identifying assumption, namely that the debt revaluation shock is not correlated with unobserved shocks affecting local economic outcomes. The estimates are statistically and economically similar when controlling for initial household income, leverage, demographics, export exposure, and industry composition. In firm-level data, our results are robust to controlling for relationship-specific bank lending shocks (e.g., Chodorow-Reich 2014), industry-specific shocks, and firm characteristics including size, leverage, productivity, and ownership structure. Moreover, trends in all outcome variables are similar in the years leading up to the forint depreciation in the fall of 2008. Further, we find null effects using the 1998 Russian Sovereign Debt Crisis, which spilled over to other emerging markets, as a placebo sample. Our results are not explained by higher historical cyclicality in more exposed regions. Finally, we show that the estimates are similar when instrumenting for household foreign currency debt exposure using an instrument that exploits spatial variation in bank market shares and their propensity to lend in foreign or domestic currency. This allays the concern that foreign currency exposure is driven by currency-specific credit-demand factors that are correlated with business cycle risk.

Related Literature. This paper connects with literatures in finance, macroeconomics, and international finance. It contributes to a growing literature on household leverage and business cycles. Recent models emphasize that a combination of high household debt, deleveraging, and house price declines can trigger a recession in the presence of macroeconomic frictions, such as sticky prices, real rigidities, and monetary policy constraints (Hall 2011, Eggertsson and Krugman 2012, Guerrieri and Lorenzoni 2015, Midrigan and Philippon 2016, Huo and Ríos-Rull 2016). Mian, Rao, and Sufi (2013) and Baker (2016) show that leverage amplifies the consumption response to income and wealth shocks. By contrast, we trace the effect of a shock directly to household debt and study the impacts on local firms, house prices, and real allocations.

Our analysis is connected to recent papers that use variation in borrower payments from interest rate changes. Recent studies find that borrowers who experience interest rate reductions, through

interest rate resets or refinancing, have a lower probability of default and use additional funds to increase spending on durables (Tracy and Wright 2012, Fuster and Willen 2013, Di Maggio et al. 2017, Agarwal et al. 2015). In the framework of Auclert (2016), these papers study the interest rate exposure channel, whereas we estimate the Fisher channel through a revaluation of liabilities.[4] In addition, we focus mainly on local equilibrium effects, given the large foreign currency debt revaluation in Hungary, and show that foreign currency financing has negative spillover effects. Existing studies primarily focus on borrower-level responses.[5]

Another related line of papers evaluates the effects of debt reduction policies. Agarwal et al. (2016) find that U.S. regions exposed to mortgage modifications through HAMP saw fewer foreclosures, smaller house price declines, and a modest increase in durable spending.[6] Consistent with the theoretical analysis of Eberly and Krishnamurthy (2014), Ganong and Noel (2016) show that only reductions in current payments impact default and consumption at the individual level. In contrast to these studies that focus on debt reduction for heavily indebted borrowers, we focus on unanticipated increases in debt burdens for a broad population of debtors, starting from "normal" conditions. Therefore, we also contribute to the debate on mortgage contract design (Shiller and Weiss 1999, Mian and Sufi 2014a, Guren, Krishnamurthy, and McQuade 2017). Our findings show that low-interest foreign currency contracts, which tend to impose losses on borrowers in bad times (Lustig and Verdelhan 2007, Brunnermeier, Nagel, and Pedersen 2008), have adverse real economic effects and spillovers on other individuals.

Finally, this paper contributes to the international finance literatures on currency crises and adjustment to international wealth transfers. A large literature on balance-sheet effects in currency crises has focused on firm and bank foreign currency indebtedness.[7] To our knowledge, our paper is the first to analyze the effects of *household* foreign currency exposure, despite the prevalence of

[4] In Auclert (2016) the Fisher channel arises due to revaluation of nominal debt from inflation, whereas we examine revaluation of foreign currency debts from a depreciation.

[5] Di Maggio et al. (2017) and Agarwal et al. (2015) present evidence that higher zip code exposure to interest rate declines boosted local spending, employment, and house prices.

[6] Dobbie and Goldsmith-Pinkham (2015) present evidence that protection from unsecured creditors raised regional consumption and employment in the Great Recession.

[7] 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 (Caballero and Krishnamurthy 2003, Aguiar 2005, Gilchrist and Sim 2007, Kim, Tesar, and Zhang 2015, Du and Schreger 2015, Kalemli-Ozcan, Kamil, and Villegas-Sanchez 2016). Cross-country studies find that the country-level FC debt exposure increases the probability and severity of a sudden stop crisis (e.g., Calvo, Izquierdo, and Mejia 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.

household foreign currency debt throughout emerging Europe in the 2000s and in previous emerging market crises. In addition, whereas the extant empirical literature has documented a foreign currency balance-sheet effect at the firm level, we show that foreign currency exposure has local aggregate effects. More generally, our estimates isolate the effects of an outward transfer on wages and real allocations. Our paper, therefore, brings empirical evidence to the classic Transfer Problem debate (Keynes 1929, Ohlin 1929).

Outline. The remainder of the paper is structured as follows. Section 2 discusses the background of the foreign currency debt crisis in Hungary. Section 3 discusses the theoretical framework and empirical methodology. Section 4 describes the data. Sections 5 through 8 present the results, and Section 9 concludes.

2 The Hungarian Foreign Currency Debt Crisis

Hungary experienced a large expansion in household credit between 2000 and 2008. Figure 1(a) shows that over this period household debt to GDP increased by 28 percentage points.[8] The expansion was financed by two categories of loans: government-subsidized local currency (LC) housing loans and unsubsidized foreign currency (FC) loans.[9] In September 2008, 69% of outstanding housing debt was denominated in foreign currency, primarily Swiss franc, directly exposing household balance sheets to the large depreciation of the Hungarian forint starting in October 2008.

Household lending was initially spurred by a government housing program that provided interest rate subsidies on long-term LC mortgages. The subsidy program was introduced in 2000 to grant households access to housing finance at rates that were more affordable than the high market interest rates of over 10%. The subsidies fixed nominal interest rates for borrowers at levels similar to euro interest rates (4-6%), with the government financing the 5-6.5 percentage point spread relative to the market interest rate for domestic currency loans.[10]

[8] As a comparison, U.S. household debt increased by a similar amount relative to GDP, albeit from a much higher initial level of 66% in 2000.

[9] Unsubsidized local currency loans with market interest rates comprised less than 10% of local currency housing loans in September 2008.

[10] 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%. This placed all interest rate risk on the government budget. The subsidy scheme also provided a 40% personal income tax deduction on mortgage repayments. Vas and Kiss (2003) and Kiss and Vadas (2005) describe housing finance policies in Hungary.

Subsidized lending growth was driven primarily by three major domestic mortgage banks. The market for housing loans was highly concentrated, since average retail banking density following the transition from socialism was low and domestic mortgage banks had a tax advantage in originating subsidized loans (Rózsavolgyi and Kovács 2005). Therefore, domestic subsidized housing credit growth was strongest in regions with a higher historical density of domestic mortgage banks. However, the subsidies placed a significant burden on public finances and subsidies on new loans were sharply curtailed in early 2004.

The increased cost of LC loans for borrowers led foreign banks to enter the retail lending market and compete with domestic banks by offering low-interest-rate FC housing loans. Foreign banks competing for market share expanded FC credit aggressively, especially to areas with a lower density of domestic subsidized credit, both by opening new branches and through mortgage agents (Banai, Kiraly, and Nagy 2011). Foreign currency retail lending was prevalent throughout Europe prior to the 2008 financial crisis, especially in new EU member states.[11] Interest rates on Swiss franc and euro loans averaged 4% to 6%, which implied savings of about 5 percentage points relative to domestic currency loans at market rates, holding the exchange rate constant. Figure 1(b) shows an acceleration in FC credit growth in the middle of 2004.

The foreign currency credit expansion was propelled by a stable exchange rate. Figure 2(a) shows that the euro-forint exchange rate remained stable up to October 2008, as 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, so the Swiss franc-forint exchange rate mirrored the euro exchange rate prior to the crisis.[12] Further, Hungary ascended to the EU in May 2004 and initially targeted adopting the euro in 2007. Survey evidence shows that the expectation of adopting the euro boosted FC loan demand (Fidrmuc, Hake, and Stix 2013). Moreover, in a survey from November 2008, Pellényi and Bilek (2009) find that 87% of respondents with an FC loan did

[11] Lending to households in foreign currencies was widespread during the 2000s in Estonia, Latvia, Lithuania, Croatia, Serbia, Bulgaria, Poland, Romania, and Ukraine (Yesin 2013). Swiss franc mortgage lending was prevalent in Austria starting in the mid-1990s. Swiss franc and yen lending also occurred in Denmark, Spain, and the UK, especially prior to the 2008 financial crisis.

[12] Between January 1, 1999 and June 4, 2003, Hungary maintained a pre-announced ±2.25% crawling band around the euro. The band widened to ±15% in June 2003, but, in practice, fluctuations remained within ±5% (Ilzetzki, Reinhart, and Rogoff 2010). The forint primarily hovered at the strong end of the band up until 2008. Ilzetzki, Reinhart, and Rogoff (2010) classify the Swiss franc as fluctuating within a *de facto* ±2% moving band against the euro, and the Swiss franc-euro (or D-mark) volatility was low for several decades up to the Eurozone crisis (Beer, Ongena, and Peter 2010).

not expect exchange rate volatility at the late 2008 level. The mid-2008 Consensus Forecast also predicted that the forint-euro exchange rate would remain constant.

The depreciation of the forint in October 2008 was not caused by distress in household credit markets. This makes the Hungarian currency crisis a promising natural experiment to study the consequences of household debt revaluation. The National Bank of Hungary abandoned the crawling band in February 2008, and in October 2008, the flight to safety away from emerging markets led to a sharp depreciation of emerging market currencies, including the forint. The depreciation of the forint was particularly strong because of investor concerns about the Hungarian government's large external financing needs.[13] Between September 2008 and March 2009, the forint depreciated by 27.5% against the euro and 32.3% against the Swiss franc. The forint weakened further against the Swiss franc in 2010 and 2011, as the Swiss franc appreciated during the Eurozone crisis.

Figure 2(b) shows that this depreciation raised the value housing debt in terms of domestic currency by 5-9% of disposable household income in 2009 (2.5-4.5% of 2008 GDP), and 10% of disposable income by 2010 (5% of GDP), relative to a counterfactual where exchange rates had remained at their September 2008 values. Regional variation in the debt-revaluation shock depicted in Figure 2(b) is the fundamental shock we exploit in our empirical analysis.[14]

The depreciation was associated with a current account reversal and a severe recession. Figure 3 panel (a) shows that the current account reversed from a deficit of 8% of GDP to a small surplus. Real output contracted by 7.4% relative to its peak in 2008Q2 and remained depressed for several years, before beginning a moderate recovery in 2013. Private consumption fell more than output and had yet to recover to its pre-crisis level by early 2015. Durable expenditure, in particular, saw a complete collapse, falling an astonishing 36.7% from 2008 to 2010, a figure comparable to the decline in the U.S. Great Depression (Figure 3(c)).[15] The enormous decline in consumer spending stands out relative to other sudden stop episodes and provides suggestive evidence for the importance of household debt revaluation in this setting.[16]

[13] Hungary negotiated a $25 billion loan from the IMF and EU to meet the government's external financing gap in late October 2008.

[14] Starting in 2011, the newly elected conservative 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 loans into domestic currency in late 2014. Our analysis focuses on the period between 2008 and 2011, prior to when these policies were implemented.

[15] Durable spending in the U.S. fell 32.4% in the Great Depression according to Romer (1990).

[16] Mendoza (2010) shows that, in a sample of 33 emerging market sudden stop episodes, aggregate consumption typically falls slightly less than output.

3 Theory and Empirical Framework

3.1 Theory

The debt-deflation channel is generally an endogenous transmission channel that amplifies shocks to the economy (King 1994). Our approach in order to isolate the debt-deflation channel is to obtain direct variation in real debt burdens using a foreign currency debt revaluation as a natural experiment. In this section, we outline the mechanisms through which a household debt revaluation can affect economic activity. We highlight that the debt revaluation shock provides a clean way to separate several classes of models.

Consistent with the foreign currency debt crisis in Hungary, we assume that domestic households can borrow and save in domestic and foreign currency risk-free debt. In the initial steady state, the nominal exchange rate equals one, and the household has $D^* > 0$ foreign currency debt, where debt is measured relative to steady state income.[17]

At time zero, there is an unanticipated, one-time exchange rate depreciation from one to $1+\Delta e > 1$. Because of currency mismatch on household balance sheets, total debt after the depreciation increases by $\Delta e D^*$. The domestic output response at time $t \geq 0$ to the exchange rate shock in the presence of household foreign currency debt can be written as:

$$y_t = \underbrace{\beta_t \Delta e D^*}_{\substack{\text{Debt} \\ \text{revaluation}}} + \underbrace{\gamma_t \Delta e.}_{\substack{\text{Expenditure} \\ \text{switching}}} \tag{1}$$

In appendix C we formally show that this equation can be derived from a New-Keynesian small open economy model in which we assume households have foreign currency debt exposure in the initial steady state. The model follows the framework of Galí and Monacelli (2005) and Farhi and Werning (2017) and provides expressions for β_t and γ_t as a function of the underlying parameters.

The exchange rate shock affects the economy through two channels. The first channel on the right-hand-side of (1) is the household debt revaluation channel. The debt-revaluation, in turn, can affect the economy through various mechanisms. One mechanism in expansionary. An increase in household debt lowers households' wealth and consumption, which leads households to boost labor

[17] Households in Hungary had substantial foreign currency *debt* but essentially no deposit "dollarization."

supply, raising output.[18]

At the same time, the increase in the households' real debt burden will depress consumption and therefore demand. The decline in demand for home goods is larger when the degree of home bias, households' propensity to consume home goods relative to foreign goods, is larger. Home bias is partly due to the presence of non-tradable goods, and below, we explicitly test whether the decline in demand has a stronger effect on firms producing non-tradable goods.

As a result of the opposing expansionary supply and contractionary demand effects, the sign of β_t in the short-run can be positive or negative. With flexible prices, the labor supply effect dominates, and an increase in debt boosts output in the short run, as in the model of Devereux and Smith (2007). In this case, β is (weakly) positive in the short run.[19] In contrast, in the presence of nominal rigidities, the rise in real debt burdens depresses output through a demand effect, and β is negative in the short run. Estimation of β_t, therefore, provides a clean test of flexible versus sticky price models.

An important implication of nominal rigidities is that the contractionary effect of a debt-induced decline in demand is not internalized by individuals when making financing decisions. This implies that there is a demand externality of borrowing decisions (Farhi and Werning 2016, Korinek and Simsek 2016). This is especially true for riskier forms of borrowing that impose greater losses in bad times, such as foreign currency borrowing in funding currencies, as households undervalue insurance against adverse shocks. By utilizing loan-level data, we will explicitly test for whether FC financing has negative impacts on other households, including households that did not borrow in FC.

In addition to nominal rigidities, the rise in debt may further depress consumption and thus output in the presence of financial constraints, such as a collateral constraint on housing debt. The rise in debt may increase defaults and foreclosures, leading to fire sales that depress local house prices. A decline in house prices amplifies the initial wealth loss for all households and can tighten collateral constraints, further lowering consumption (Kiyotaki and Moore 1997, Iacoviello 2005).

[18] The labor supply expansion channel holds for most standard preferences assumed in the literature. An exception is GHH (quasi-linear) preferences, which eliminate the wealth effect on labor supply.

[19] Similarly, Chari, Kehoe, and McGrattan (2005) and Lorenzoni (2014) show that a sudden stop can boost output by inducing households to expand labor supply. However, debt can also lower labor supply through a debt overhang effect (e.g. Dobbie and Song 2015, Donaldson, Piacentino, and Thakor 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.

A worse recession also depresses house prices, creating a two-way feedback between the demand and fire-sale channels. We explore this channel empirically below. Further, if households have a precautionary savings motive, the increase in debt would induce households to further reduce consumption to maintain a sufficient buffer of savings. Finally, real rigidities, such as frictions that inhibit a reallocation of employment towards exporting firms, strengthen the negative effects of debt on output (Huo and Ríos-Rull 2016).

The second channel in (1) is the standard expenditure switching channel. This is the traditional expansionary effect of the depreciated exchange rate, which increases demand for home goods. The response in (1) highlights that if households have currency mismatch, the expansionary effect of exchange rate appreciation is dampened and may even be reversed, posing a dilemma for monetary policy in a currency crisis. In this case, the exchange rate shock is contractionary on impact when FC debt exposure or the response to debt revaluation is sufficiently high.[20]

3.2 Empirical Specification and Identification

Equation (1) highlights that the debt revaluation channel cannot be identified by studying an aggregate economy with foreign currency debt in a currency crisis, as the exchange rate affects the economy directly through expenditure switching. More generally, the exchange rate shock can affect the economy through other channels, such as an increase in the cost of imported inputs (e.g., Rodnyansky 2017) or firm balance-sheet effects.

To address this identification issue, our empirical framework compares the evolution of regions in a currency union with varying exposure to foreign currency debt. In particular, comparing two regions subject to the same exchange rate, but with different exposures to FC debt, $D^{*,H} > D^{*,L}$, isolates the debt revaluation channel:

$$y_t^H - y_t^L = \beta_t \Delta e \left(D^{*,H} - D^{*,L} \right). \tag{2}$$

The identifying assumption underpinning this approach is that the exchange rate only differentially affects the two economies through the household debt revaluation channel.

[20] Empirically, the expenditure switching channel is likely substantially smaller than in models with producer currency pricing because about 90% of Hungarian exports are invoiced in euro or U.S. dollars (Boz, Gopinath, and Plagborg-Møller 2017).

Our empirical specification is motivated by equation (2). We compare the evolution of outcomes in regions with high exposure to foreign currency debt, relative to regions with low exposure, around the October 2008 depreciation of the Hungarian forint. The basic specification is:

$$\Delta_{08-10} y_z = \alpha + \beta \cdot (\text{FC Debt Revaluation})_{z08} + X'_{z08}\Gamma + \epsilon_z, \tag{3}$$

where $\Delta_{08-10} y_{zt}$ is the change in an outcome of interest in a local area z between 2008 and 2010, $(\text{FC Debt Revaluation})_{z08}$ is a measure of the household debt revaluation shock, and X_{z08} is a vector of controls. As we discuss below in Section 3.2.1, the variation in the debt revaluation shock we exploit is summarized by the local share of household debt denominated in foreign currency in September 2008, s^{FC}_{z08}. We therefore cast our discussion of identification in terms of the FC debt share.

We estimate (3) using 3124 local areas, known as *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).[21] Our preferred specification weights by settlement population in 2007, but we report robustness checks for alternative weighting schemes.

Equation (3) provides a consistent estimate β under the identifying assumption of parallel trends: the change in the outcome y_{zt} in a low s^{FC}_{z08} settlement is a valid counterfactual for high s^{FC}_{z08} areas, had those regions not been exposed to the depreciation through household FC debt, $\mathrm{E}[\epsilon_z \cdot s^{FC}_{z08} | X_{z08}] = 0$. The threat to identification is, therefore, a time-varying, region-specific shock that affects y_{zt} and is correlated with exposure to foreign currency debt. In particular, identification does not require that FC debt exposure is distributed randomly.

A potential concern with our empirical strategy is that households' decision to borrow in FC or LC may be correlated with exposure to business cycle or exchange rate shocks through other channels. The sign of a potential bias from using variation in s^{FC}_{z08} could be either positive or

[21] The procedure proposed by Ibragimov and Müller (2016) tests the null that a fine level of clustering is appropriate against the alternative of a coarser level of clustering. The test is based on comparing the sample variance of the sequence of estimates obtained by estimating the model separately on each of the j coarse clusters $(\{\hat{\beta}_j\}_{j=1}^q)$ against the variability of the $\hat{\beta}_j$'s implied by the null hypothesis, which is proportional to the asymptotic variance of the estimates. The idea is that correlations across the fine clusters but within the coarse clusters increase the variability of $\hat{\beta}_j$, so a relatively high variance of $(\{\hat{\beta}_j\}_{j=1}^q)$ is evidence against clustering at the fine cluster. We first test and reject the null for clustering at the settlement level (3124 areas) against the alternative of clustering on 175 subregions. We then fail to reject the null at the 10% level for clustering on 175 subregions against the alternative of clustering on 20 regions.

negative. Regions with a higher FC share could be more export-intensive, high-income areas with less exposure to business cycle risk, or areas where households receive a higher fraction of income in foreign currency, biasing our estimates toward zero. For example, Beer, Ongena, and Peter (2010) find that Swiss franc borrowers in Austria are typically high-income and financially sophisticated households. On the other hand, s_{z08}^{FC} may be correlated with exposure to negative business cycle shocks. For example, less financially sophisticated households that are more exposed to recession risk may select into FC loans because they do not adequately assess exchange rate risk.

An important supply-side determinant of the cross-regional variation in foreign currency debt share is the initial depth of domestic retail banks. Following the transition from communism, average retail banking depth and competition were low relative to other countries in the region, but varied substantially across regions.[22] Areas with a higher density of domestic banks experienced stronger growth in subsidized domestic currency household credit. Following the removal of domestic currency subsidies in 2004, foreign banks filled in to areas with lower branch density, offering foreign currency loans with significantly lower interest rates than market rates on domestic currency debt. Appendix Table A.1 confirms that areas with a lower 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.

Extant research on the determinants of FC borrowing in Hungary using household surveys finds that FC and LC borrowers are broadly similar along observable dimensions such as demographic characteristics and risk tolerance, although FC borrowers on average have slightly lower income than LC borrowers (Fidrmuc, Hake, and Stix 2013, Pellényi and Bilek 2009). To get a sense of the balancedness of s_{z08}^{FC} across observables at the settlement level, Table 2 presents regressions of s_{z08}^{FC} on various settlement-level characteristics.[23] Goldsmith-Pinkham, Sorkin, and Swift (2017) show that identification in Bartik-style instruments comes from exogeneity of the shares, so the correlation between the FC debt share and observables gives an indication of the potential for biased estimates.

Table 2 shows that the FC debt share is uncorrelated with export exposure, consistent with the

[22] Gál (2005) provides a detailed analysis of the geographic differences in the density of retail banking after the transition from socialism, 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 socialism.

[23] Figure A.1 visually presents binned bivariate means for the key tests in Table 2.

assumption that allows us to isolate the debt revaluation channel of the exchange rate shock. FC debt exposure is also balanced across debt to income, manufacturing and construction employment shares, growth in disposable income over 2004-08, the working age population share, labor productivity, and corporate FC indebtedness. Below, we also find that s_{z08}^{FC} is uncorrelated with the change in other outcomes, including house prices and durable spending prior to the depreciation. This allows us to disentangle the impact of higher debt from other housing-related factors that may contribute to a more severe recession. Consistent with the survey evidence, high s_{z08}^{FC} areas do tend to have lower disposable income per capita and lower population.

In the empirical exercises below, we report estimates for specifications that control for these settlement-level observables to capture any time-varying shocks that interact with these observables. In particular, we control for the 2008 debt to disposable income, log 2008 population, log 2008 disposable income per capita, the share age 18-59, the share age 60 or above, industry employment shares, export revenues as a share of total firm revenues, and export revenues relative to total firm revenues. We also control for the intensity of a public jobs program that was expanded in 2011.[24] In firm-level employment regressions, we include firm-level measures of productivity, size, firm leverage and firm FC indebtedness, ownership structure, two-digit industry fixed effects, and fixed effects for firm-bank relationships prior to the depreciation.

We take a number of additional steps to provide support for the parallel trends assumption. First, we present tests that control for time-varying regional shocks by including fixed effects for 20 regions. We also present robustness to controlling for 175 subregion-specific time trends. This ensures that the estimates are not driven by subregion-specific secular trends or shocks that may be spuriously correlated with FC debt exposure at a more aggregated regional level.

Further, we test whether the evolution of outcomes prior to the depreciation in the fall of 2008 was similar in regions with high and low FC shares by estimating specifications of the form

$$y_{zt} = \alpha_z + \gamma_t + \sum_{y \neq 2008} \beta_y (s_{z08}^{FC} \cdot \mathbf{1}_{y=t}) + \epsilon_{st}, \tag{4}$$

where $\mathbf{1}_{y=t}$ is an indicator that equals one in year t and zero otherwise. The sequence of coefficients

[24] The public jobs program lowered unemployment sharply 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.

$\{\beta_y\}$ shows the evolution of y_{zt} from 2008 in high FC share regions relative to low FC share regions. The finding that $\hat{\beta}_y$ is insignificant and close to zero in years leading up to the depreciation supports the parallel trends assumption. We also conduct placebo tests using the 1998 Russian Sovereign Debt Crisis that spilled over to emerging markets. Finally, to control for currency-specific credit demand factors, we present robustness tests using an instrument for s_{z08}^{FC} that exploits a bank's propensity to lend in foreign or domestic currency times the bank's presence in a given region.

3.2.1 Measuring Household Balance-Sheet Exposure to the Depreciation

Differences in the currency composition of debt portfolios generate differential shocks to debt burdens across local areas during a depreciation. From the law of motion for debt, the revaluation in household debt due to exchange rate changes can be related to debt currency composition and net new borrowing as:

$$\Delta d_t = \sum_{j \in C} \Delta e_t^j s_{t-1}^j + \eta_t. \tag{5}$$

Here Δd_t is the change in log total household debt, C is the set of all currencies including the local currency, Δe_t^j is the change in the log currency j exchange rate, $s_{t-1}^j = \frac{\mathcal{E}_{t-1}^j D_{t-1}^j}{D_{t-1}}$ is the share of debt denominated in currency j, $D_t = \sum_{j \in C} \mathcal{E}_t^j D_t^j$ is the LC value of all household debt, and η_t represents net new borrowing between period $t-1$ and t (new borrowing, amortization, and prepayment).[25]

For a uniform depreciation Δe across currencies j equation (5) becomes $\Delta d_t = \Delta e_t \cdot s_{t-1}^{FC} + \eta_t$, where s^{FC} is the overall share of debt in FC. As Figure 2 shows, the forint depreciated by a similar magnitude against the Swiss franc and the euro in the initial phase of the crisis between 2008 and 2010, as the Swiss franc was quasi-fixed against the euro. Further, in September 2008, 97%

[25] In particular, letting ND_t denote net new borrowing at the beginning of period t, this equation is derived as

$$\begin{aligned} D_t &= \sum_{j \in C} [\mathcal{E}_{t-1}^j D_{t-1}^j + (\mathcal{E}_t^j - \mathcal{E}_{t-1}^j) D_{t-1}^j + \mathcal{E}_t^j N D_t^j] \\ D_t - D_{t-1} &= \sum_{j \in C} \frac{\mathcal{E}_t^j - \mathcal{E}_{t-1}^j}{\mathcal{E}_{t-1}^j} \mathcal{E}_{t-1}^j D_{t-1}^j + N D_t \\ \frac{D_t - D_{t-1}}{D_{t-1}} &= \sum_{j \in C} \frac{\mathcal{E}_t^j - \mathcal{E}_{t-1}^j}{\mathcal{E}_{t-1}^j} s_{t-1}^j + \eta_t. \end{aligned}$$

Equation (5) approximates percent changes with log changes.

of FC debt was denominated in Swiss franc. A settlement's share of debt in FC as of 2008:9, s^{FC}_{z08}, captures most of the variation in exposure to the depreciation, so we use s^{FC}_{z08} as the baseline measure of exposure to the depreciation. We measure exposure as of September 2008, the last month before the depreciation, but results are very similar using earlier months in the summer of 2008 or instrumenting the 2008 FC debt share with the share in 2005 or 2006.

To obtain estimates that are more easily interpretable, we directly estimate the effect of the *household debt revaluation shock* from 2008:9 to t, $\Delta\tilde{d}_{z,08-t}$, using:

$$\Delta\tilde{d}_{z,08-t} = \frac{\sum_{j\in C}\left(\mathcal{E}^j_{t+h}D^j_{z08} - \mathcal{E}^j_{08}D^j_{z08}\right)}{D_{z08}}, \tag{6}$$

The debt revaluation shock can be related to the FC shares as: $\Delta\tilde{d}_{z,08-t} = \sum_{j\in C}[(\mathcal{E}^j_{t+h} - \mathcal{E}^j_{08})/\mathcal{E}^j_{08}]s^j_{z08}$. Thus, $\Delta\tilde{d}_{z,08-t}$ captures the valuation effect on household debt as the weighted average exchange rate depreciation applied to debt, with the currency shares as the weights.

We also present robustness tests using the household debt revaluation relative to income, which is defined as

$$\Delta\tilde{d}^{Inc}_{z,08-t} = \frac{\sum_{j\in C}\left(\mathcal{E}^j_{t+h}D^j_{z08} - \mathcal{E}^j_{08}D^j_{z08}\right)}{(\text{Household disp. income})_{z08}}. \tag{7}$$

Holding fixed the currency composition of debt, higher leverage yields a higher debt revaluation to income shock. The two measures of debt revaluation are positively correlated, with a correlation coefficient of 0.26. Finally, we also assess robustness using the fraction of loans on FC, the number of FC loans per adult, and the share of mortgage debt in FC (i.e. excluding home equity loans).

4 Data and Summary Statistics

We construct a dataset at the region 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* (a city or municipality). There are 3,152 settlements in Hungary with an average population of 3,168 in 2010. We also present results for 175 subregions that approximate local labor markets (Paloczi et al. 2016). We match this

regional dataset with firm-level data on employment and balance-sheet information, including firm FC liabilities and banking relationships. This section summarizes the key features of the data. Appendix B provides further details on the data sources and variable definitions.

4.1 Household Credit Registry

We use loan-level data from the Hungarian Household Credit Registry to measure household debt balances, new borrowing, and default at the loan and settlement level. The household credit registry contains all loans extended by all credit institutions to private individuals outstanding on or after March 2012. The credit registry records information on the loan type, loan amount, date of origination, maturity, monthly payments, default status, and currency.[26] The household credit registry also reports the identity of the lender and the borrower's settlement of residence.

In order to measure a settlement's FC debt exposure prior to the late 2008 forint depreciation, we reconstitute the credit registry going back to 2000. Specifically, we use an annuity model to estimate monthly payments and outstanding debt prior to 2012 for the population of outstanding loans at the start of the credit registry. The reconstructed credit registry accounts for 80.5% of aggregate housing debt in the Financial Accounts in September 2008. Moreover, the default rate for loans in the credit registry closely matches the aggregate default rate reported separately from bank balance sheets prior to and during the crisis. The annuity model also performs well at the loan level. For example, a cross-sectional loan-level regression of the actual balance on the modeled balance in 2012 yields an R^2 of 83%. We describe the annuity model in detail and further evaluate its accuracy in Appendix B.

Loans that are terminated (repaid, refinanced, canceled) before 2012 but were outstanding in September 2008 present a potential measurement error problem for the estimation of a settlement's FC debt exposure. In the fall of 2011, the newly elected Hungarian government implemented an Early Repayment Program that allowed borrowers with a foreign currency mortgage or home equity loan to repay the loan in full at a preferential exchange rate of 20-30% below the prevailing market rates. The program retired 21% of outstanding foreign currency debt.[27] Accounting for the 2011

[26] Default status is effectively available starting in 2008. The household credit registry was preceded by a negative registry that contained information on delinquency.

[27] It is widely believed that the program benefited wealthier and more creditworthy borrowers, since the program required full repayment of the loan and provided a limited 60 day window to participate.

Early Repayment Program raises the coverage of the credit registry in 2008:9 from 80.5% to 96% of housing debt in the flow of funds.

In Appendix B we use two approaches to adjust our outstanding settlement-level debt measures for loans that are prepaid through the Early Repayment Program. The first adjustment uses a separate dataset on the universe of loans for three of the largest banks in Hungary that have a combined market share of 24%. We use information from these three banks to approximate the amount of debt repaid through the 2011 ERP in each settlement for *all* other banks. 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 Early Repayment Program was in operation. Appendix B shows that all the main results in this paper are quantitatively similar when controlling for the 2011 Early Repayment Program using these adjustments. Furthermore, in our main analysis, we control for covariates that may potentially be associated with participation in the 2011 Early Repayment Program, including disposable income and demographic characteristics.

4.2 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.[28] To proxy for non-durable consumption, we use the quantity of electricity consumed by households. KSH also provides settlement-level information on household income, tax payments, population, and net migration.

Local unemployment rate data are based on the number of registered job seekers relative to working-age population from the National Employment Service (NFSZ). 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, Hurst, and Ospina (2016). We also use annual settlement and subregional 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, payrolls, total sales, export sales, and value-added growth at the firm level for all double-bookkeeping firms in Hungary. The median firm has one establishment (including the

[28] Auto registrations have been used as a proxy for durable spending in several recent papers including Mian and Sufi (2012) and Agarwal et al. (2016).

headquarters), and, on average, a firm has establishments in 1.66 settlements. We therefore define a firm's exposure to household FC debt by the settlement of the headquarters.[29] We clean the sample of firms following previous research on NAV data (e.g., Endrész and Harasztosi 2014). In particular, we 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 sample of 80,447 firms in 2008 that we follow through the crisis. Finally, we compute firm FC debt exposure by matching loan-level data from the Hungarian Firm Credit Registry.

4.3 Summary Statistics and Variation in Household Foreign Currency Exposure

Panels A and B of Table 1 report summary statistics for the 3124 settlements (cities or municipalities) in our sample. The foreign currency debt share in September 2008, s_{z08}^{FC}, has a mean of 66% and a standard deviation of 8.7 percentage points. Figure 4(a) presents a map of the spatial variation in the household FC debt share, revealing that the share of household debt in foreign currency is not strongly clustered in specific regions.

Figure 4(b) provides a visual impression of the variation in FC debt exposure by computing the average s_{z08}^{FC} within 20 equal population bins. The lowest exposure bin has an FC debt share of 40%, while settlements in the highest bin have an average FC share of almost 90%. Foreign currency exposure generates an average debt revaluation shock, $\Delta_{08-10}\tilde{d}_z$, of 22%. The majority of household FC debt is denominated in Swiss franc, with an average across settlements of 97% in 2008:9.

Table 1 panel B shows that the household default rate rose by 4.1 percentage points on average, while the unemployment rate increased by 2.1 percentage points. The data also show a staggering 70% (120 log point) decline in auto spending over the same period, a 2% fall in electricity consumption, and a 15% decline in house prices. The mean level of settlement debt to disposable income is 50%. Panel C reports summary statistics for our sample of firms. Average employment growth from 2008 to 2010 was -12.9%. The average firm size is 34 employees, a quarter of firms are exporters, and 21% are in the manufacturing sector.

[29] The establishment address dataset was created by researchers at Central European University with funding provided from the European Union framework NETWORKS-283484. The original data were made available by Wolters Kluwer Kft. Results are similar if we only use single-establishment firms or if we take the establishment weighted average of household FC debt exposure.

5 Household Responses to Debt Revaluation

5.1 Household Balance Sheets and Default

We begin by documenting that settlements with more exposure to household FC debt experience significant financial distress following the depreciation of the Hungarian forint. Table 3 presents regressions of various measures of changes in household debt on the household FC debt share, s_{z08}^{FC}. Columns 1 and 2 show that the FC debt share is strongly correlated with the household debt revaluation shock measured between 2008:9 and 2010:9, $\Delta_{08-10}\tilde{d}_z$. The estimate implies that a settlement with full exposure to FC debt experiences a 26% revaluation in household debt, relative to a settlement with an FC debt share of zero. The R^2 of this regression is 0.95, which shows that the FC debt share captures most of the variation in the debt revaluation shock, as we discussed in Section 3.2.1.

In columns 3 through 5 we replace the debt revaluation shock with growth in overall household debt as the dependent variable. Columns 3 and 4 show that from 2008:9 to 2010:9, a settlement with an FC debt share of one experiences a 26 to 33% increase in debt relative to a settlement with only local currency debt. The similarity between the estimates in columns 1-2 and 3-4 implies regions with more exposure to foreign currency debt do not deleverage to a greater extent following the depreciation. Column 5 shows that the estimate increases to about 40% by 2011. Columns 6 and 7 replace the growth in debt with the change in debt relative to 2008 household disposable income. Consistent with an initial debt to income ratio of about 50% in 2008, foreign currency debt exposure raises debt to 2008 income by about half the percentage increase in debt.

Table 4 analyzes the effect of debt revaluation on the household default rate. Housing loans in Hungary are full recourse loans, and debt cannot be discharged in bankruptcy. Thus, a household's decision to default reflects limited ability, as opposed to willingness, to repay. Column 1 shows a regression of the change in the fraction of housing loans in arrears between 2008 and 2010 on household FC debt exposure. The estimate implies that taking the FC debt share from zero to one is associated 7.2 percentage point higher settlement housing default rate. The coefficient is large in magnitude. A one standard deviation increase in s_{z08}^{FC} implies a one-quarter of a standard deviation increase in the household default rate.

In columns 2-4 we add various controls that may affect the estimation. In particular, in columns

2 and 3 we progressively add controls for demographic characteristics, debt to income, log disposable income, export exposure, 18 one-digit industry employment shares, and fixed effects for 7 main regions (NUTS 2). The estimate falls by one-fifth, but remains significant at the 1% level. As we discuss in detail below, applying the test from Oster (2016) and Altonji, Elder, and Taber (2005) for coefficient stability, we can reject that the effect is driven by omitted variable bias.

Finally, columns 5 and 6 present the estimated effect in terms of the household debt revaluation shock, $\Delta_{08-10}\tilde{d}_z$. 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.[30] In terms of magnitudes, column 6 implies that a 10% increase in household debt raises the settlement default rate by 1.7 percentage points. In Section 7.3 we unpack this result using loan-level specifications. We find that more exposed areas experience a rise in defaults because (i) they have a greater share of FC loans, which have a higher default rate than LC loans, and (ii) loans in exposed regions are more likely to default, which indicates a role for negative local equilibrium effects.

Figure 5 presents the effect of FC debt exposure on the default rate over time. It plots the estimates of $\{\beta_y\}$ from estimating equation (4) for the settlement default rate on housing loans at a quarterly frequency. The omitted period is 2008Q1, the first period default information is available in the credit registry. The evolution of the default rate in high and low FC debt regions is similar up to the depreciation. Higher FC debt regions only begin experiencing high default rates starting in 2008Q4. The default rate rises differentially in more exposed settlements through 2014.

5.2 Durable Spending and Non-Durable Consumption

In Figure 3 we saw that real aggregate private consumption fell by over 10% from 2008 to 2010, and durable spending declined by 40%. Micro data on the number of auto registrations point to a 60% decline in new auto registrations in 2009 alone. In Table 5 we ask whether this dramatic decline in spending is related to the household debt revaluation across local areas.

Table 5A columns 1-4 report regressions of the change in log new auto registrations from 2008 to 2010 on the household FC debt exposure, s_{z08}^{FC}.[31] Between 2008 and 2010, settlements with only

[30] As can be inferred from Table 3, results are almost identical if we instead instrument the increase in household debt with the FC debt share.

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

FC debt see a 63% (99.5 log point) decline in auto spending relative to regions with no foreign currency debt. A one standard deviation increase in s_{z08}^{FC} is associated with one-fifth of a standard deviation lower auto expenditure. The estimated effect is robust to including baseline controls for demographic characteristics, income, and household debt to income, as well as controls for export exposure, industrial composition, and fixed effects for seven major regions. In columns 5 and 6 we replace the FC debt share with the household debt revaluation shock and find that a 1% debt revaluation lowers household durable spending by 2.7 to 3.5%.

Figure 6 panel (a) illustrates how FC debt exposure affects new auto registrations over time by plotting estimates of $\{\beta_y\}$ from equation (4). In the years leading up to the depreciation there is no differential change in auto spending in high relative to low s_{z08}^{FC} settlements. In particular, there is no evidence of differential "boom-bust" dynamics. The estimated effect on durable spending after the depreciation is therefore unlikely to be explained by a combination of: (i) a consumption boom reversal, (ii) an overhang of consumer durables in more exposed regions, and (iii) a reversal in optimistic growth expectations. In 2009, following the depreciation, auto spending falls sharply in regions with a higher FC share and continues to fall in 2010. Durable spending begins a slow recovery starting in 2012, but remains significantly below the pre-crisis level even by 2014. The persistent effect on durable expenditure is consistent with the fact that debt revaluation permanently lowers household wealth.

Table 5 panel B examines the effect of FC debt exposure on household electricity consumption, a proxy for non-durable consumption. Even for this subset of consumption that we expect to be relatively inelastic, we find a negative and significant estimate. The estimate on s_{z08}^{FC} ranges from -13.1% without controls to -7.3% with our full set of controls. The implied elasticity with respect to the household debt revaluation shock in columns 5-6 ranges between -0.22% and $-.47\%$.

Figure 6(b) shows the dynamic impact of FC debt exposure on non-durable consumption. Again, we can reject the notion that high FC debt exposure regions have differential consumption growth up to 2008. After the depreciation, non-durable spending falls from 2008 to 2009 and 2010. As with durable expenditure, the debt revaluation shock appears to permanently lower household consumption in more exposed regions.

are quantitatively similar when dropping small settlements with zero spending in either period or when using the symmetric growth rate, $\frac{C_{10z}-C_{z08}}{.5(C_{10z}+C_{z08})}$, which allows for the start or end value to be zero.

6 Impact of Debt Revaluation on Real Activity

6.1 Main Result

The rise in the real burden of debt for households with foreign currency exposure leads to a rise in default rates and a sharp decline in household spending. But how does the local economy absorb this shock? The evidence on default and consumption alone does not inform us about whether the debt revaluation shock had a negative impact on local economic activity. Households may respond to the rise in debt burdens by boosting search effort or hours in order to service higher debt payments. However, a positive effect on labor supply may be overwhelmed by a shortfall in local demand, especially in the presence of price and wage rigidities and reallocation frictions, leading to a decline in employment and a rise in unemployment.

Table 6 explores the effect of household debt revaluation on the settlement (city or municipality) unemployment rate. Column 1 reveals that settlements with higher exposure to household FC debt see a larger rise in unemployment from 2008 to 2010. The coefficient implies that a region with all debt denominated in FC experiences a 2.3 percentage point increase in unemployment from 2008 to 2010, relative to a region with only domestic currency debt. Columns 2 through 4 reveal that the estimate is unchanged when including various controls, including household income and leverage, export exposure controls, one-digit industry employment shares, and region fixed effects.

In terms of economic magnitudes, Table 6 columns 5 and 6 show that a 10% revaluation of household debt raises local unemployment by 0.7-0.9 percentage point. This result implies that a higher burden of debt leads to a significantly weaker local economy. The weaker local economy, in turn, exacerbates the burden of debt repayment.

Figure 7 presents the full dynamic impact of FC debt exposure on unemployment from estimating equation (4). Between 2003 and 2008, there is a precisely estimated zero relationship between s_{z08}^{FC} and the change in unemployment, consistent with parallel trends. Notably, parallel trends hold during 2005 and 2006, when the aggregate unemployment rate increased by 1.5 percentage points following the implementation of a fiscal consolidation program (Figure 3). After the depreciation in 2008Q4, the coefficient rises to 2.2 percentage points, and unemployment remains persistently higher in more exposed regions for several years. By 2014, six years after the shock, unemployment in exposed regions had still not completely recovered to its relative pre-crisis level.

6.2 Local Demand: Outcomes at Tradable and Non-tradable Firms

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 2014b). 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, sales, and output for non-exporting firms and firms in the non-tradable sector.

Table 7 panel A displays estimates of the effect of household FC debt exposure on firm-level employment growth:

$$g^{E}_{i,08-10} = \beta s^{FC}_{z08} + X_{i08}\Gamma^{firm} + X_{z08}\Gamma^{settlement} + \alpha_{industry} + \epsilon_{ib},$$

Following the employment dynamics literature (Davis and Haltiwanger 1999), we measure firm-level employment growth as the symmetric growth rate in employment between 2008 and 2010, $g^{E}_{i08-10} = \frac{100(E_{i10}-E_{i08})}{.5(E_{i10}+E_{i08})}$.[32]

In Table 7 column 1, we find that firms in settlements with greater exposure to the household debt revaluation shock experience a significant decline in employment.[33] Estimating the equation at the firm level allows us to control for detailed firm characteristics. Column 2 shows that the elasticity is stronger when including firm-level controls, our baseline settlement level controls, and two-digit NACE industry fixed effects. Firm-level controls are a firm's own FC debt share, a quadratic in 2008 log employment, 2008 log sales, leverage (debt-to-sales ratio) in 2008, and indicator variables for whether the firm is majority state or foreign owned. Two-digit industry fixed effects ensure that the estimate is not driven by industry-specific employment shocks that are correlated with regional variation in s^{FC}_{z08}.

[32] The symmetric growth rate is equivalent to the log difference up to a second order Taylor approximation, but is bounded between -200 and 200, which mitigates the influence of outliers.

[33] Table A.2 panel B shows the estimates are robust to using the debt revaluation relative to income as the right-hand-side variable. Table A.3 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. Table A.4 presents the same regression for firm-level data aggregated to the settlement level and finds similar results. Further, Figure A.2 present the settlement level employment estimates over time, showing that the employment decline is persistent and is not driven by pre-trends.

Table 7 columns 3-6 estimate the effect separately for non-exporters and exporters. The decline in employment is driven entirely 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 16% greater decline in employment, relative to a settlement where all debt is in LC. In contrast, employment at exporting firms is shielded from the variation in local demand induced by the debt revaluation. This test provides additional evidence that the household debt revaluation effect on employment is not spuriously driven by the exchange rate channel or another shock to exporters.

In columns 7 and 8 we focus on firms in the non-tradable sector, following Mian and Sufi (2014b). Specifically, we classify the restaurant and retail industries and four-digit NACE industries with below-median geographic Herfindahl indexes as non-tradable.[34] We also exclude firms that have positive exports in 2008, since these are less likely to cater primarily to local markets. Focusing on the subset of firms in the non-tradable sector yields an estimate on household FC debt exposure of -13.3% with controls, which is similar to the overall decline for non-exporters.

Table 7 panels B and C present the same regressions for domestic sales growth and output (real value-added) growth.[35] Household FC debt exposure predicts a decline in domestic sales and real value added, and the magnitudes are similar to the effect on employment. The effect on household FC debt exposure is larger among non-exporters and firms in the non-tradable sector, while s_{z08}^{FC} is not significantly correlated with sales growth or real output growth for exporters.

6.3 Interpretation

The decline in local employment and the rise in unemployment from the household debt revaluation is qualitatively consistent with the presence of price rigidities. To provide a sense of the potential aggregate effects of the debt revaluation channel, one can compute an aggregate partial equilibrium counterfactual in which all settlements have zero foreign currency liabilities. To do this, we sort settlements into 20 equal population bins and apply the estimated coefficient from Table 6 to the average foreign currency share in each bin and aggregate over all bins, $\sum_j \frac{1}{20}\hat{\beta} \cdot \overline{s}_j^{FC}$. This exercise

[34] This classification of the non-tradable industry for Hungarian firms in NAV follows Harasztosi and Lindner (2017). 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.

[35] Real value added is calculated as profits plus depreciation and labor costs, deflated by two-digit sectoral GDP deflators.

implies a 1.44 percentage point increase in unemployment relative to the counterfactual where all debt is denominated in local currency, which accounts for 69% of the increase in the registered unemployment rate between 2008 and 2010. We should emphasize that this exercise is only meant to provide a sense of the size of the estimates and is subject to a number of caveats because cross-sectional elasticities do not capture a variety of general equilibrium effects.

6.4 Robustness

Measurement of the Shock. Table 8 Panel A presents regressions of the 2008-10 change in unemployment on several alternative measures of FC debt exposure. Column 1 replaces the debt revaluation shock with the debt revaluation relative to income defined in equation (7). A 10% revaluation of household debt relative to disposable income raises the local unemployment rate by .79 percentage point.[36] While the FC debt share is negatively correlated with income, the debt revaluation relative to income is positively correlated with income. The fact that we find similar results with the latter measure rejects the notion that our results are driven by some unobservable recession shock that differentially affected poorer regions.

Our results are also robust to measuring household FC debt exposure using the fraction of loans in FC (column 2) and the number of FC loans relative to the working age population (column 3). 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 4 finds a null effect using the number of LC loans per adult. In column 5 we compute the FC debt share for mortgage loans and find a similar estimate as the overall housing FC debt share. The mortgage FC debt share measure excludes home equity loans, which account for 33% of total housing debt. Anecdotal evidence indicates that mis-selling of foreign currency mortgages was most prevalent for home equity loans. The mortgage FC debt share has the advantage that it is uncorrelated with 2008 household disposable income.

Heterogeneity by City Size and Aggregation. Panel B column 1 shows that the estimate falls by one-third when weighting settlements equally.[37] This is because the effect is stronger among larger, more densely populated settlements, which generally constitute their own labor markets (columns 2 and 3). Column 4 shows the effect is over two times larger for the 306 settlements

[36] Appendix Table A.2 confirms that all our main results are robust to using the debt revaluation relative to income as the shock.

[37] Recall that the baseline estimates are weighted by settlement population in 2007.

classified as main cities relative to the 50% smallest settlements by population. Larger cities are more closed economies and therefore subject to less "leakage" of local demand, as predicted by the model in section 3.1. Column 5 of Panel B addresses the concern that settlements may be too fine a unit of analysis to capture local labor market effects.[38] Specifically, we estimate our main specification using 175 subregions that correspond to commuting zones (Paloczi et al. 2016). The point estimate is quantitatively similar using this higher level of aggregation.

Specification Checks and Alternative Hypotheses. In Table 8 panel C we address the concerns that high s_{z08}^{FC} areas experience a worse recession because these regions: (i) are inherently more cyclical, (ii) have lower credit quality borrowers, (iii) are undergoing a negative secular trend in the labor market, or (iv) are part of larger regions that fare worse in the recession, perhaps for reasons other than household FC debt exposures. Specifically, we report several additional specification checks using a multi-period difference-in-differences specification on annual data for the period 2006-11:

$$u_{zt} = \alpha_z + \beta(s_{z08}^{FC} \cdot POST_t) + POST_t + (X_{z08}^{FC} \cdot POST_t)\Gamma + \epsilon_{zt},$$

where $POST_t$ is an indicator variable that equals 1 from 2009 onward. Column 1 notes that the effect of s_{z08}^{FC} is virtually unchanged using this expanded time period. Column 2 shows that the estimate is not affected by controlling for the unemployment rate in 2008 or average default rate in 2008. In column 3 we control the standard deviation of the unemployment rate between 1995 and 2007 as a proxy for historical cyclicality and find that the coefficient is unchanged.

Column 4 of panel C presents a test that controls for 175 subregion-specific time trends and finds the estimate is similar, consistent with parallel trends. Column 5 includes both subregion time trends and region by time fixed effects for 20 major regions (NUTS 3). The effect remains highly significant, albeit 25% smaller, which may be because exploiting variation within 20 NUTS 3 regions soaks up some labor-market level variation.

Selection on Unobservables. A general concern is that household FC debt exposure is correlated with unobserved characteristics that are associated with a worse recession. Under an assumption of

[38] Using an excessively fine level of regional aggregation will bias the results toward zero because of spillovers from more exposed to less exposed settlements. Lalive, Landais, and Zweimüller (2015) conduct a local labor markets analysis of unemployment insurance spillovers using a similar level of aggregation in Austria (2,361 communities).

proportionality between selection on observables and unobservables, we can partially address this concern using the test developed by Oster (2016) and Altonji, Elder, and Taber (2005). Appendix Table A.5 shows that, for all outcomes presented thus far, except non-durable consumption (i.e. defaults, new auto registrations, and unemployment), we can reject the notion that the estimates are driven by omitted variables based on the change in the coefficients and R^2 when moving from the specification without controls to one with controls.

Instrumenting with Banking Shift-Share Instrument. One concern is that the variation in FC debt exposure is partly driven by currency-specific credit-demand factors that are associated with a worse recession risk. To partially address this concern, we construct an instrument for FC debt exposure that exploits spatial variation in banks' market shares and their propensity to lend in domestic and foreign currency. First, for each year t we regress bank domestic and foreign currency per capita lending on settlement and bank fixed effects

$$L^j_{z,b,t} = \alpha^j_{z,t} + \gamma^j_{b,t} + \epsilon^j_{z,b,t}, \quad j \in \{LC, FC\}.$$

From this we obtain annual bank lending shocks in domestic and foreign currency, $\{\hat{\gamma}^{LC}_{b,t}, \hat{\gamma}^{FC}_{b,t}\}$ that are purged of settlement currency-specific demand factors. Next, we construct the instrument as

$$V_z = \frac{\sum_{t=2001}^{2008} \sum_b ms_{z,b,t-1} \hat{\gamma}^{FC}_{b,t}}{\sum_{j\in\{LC,FC\}} \sum_{t=2001}^{2008} \sum_b ms_{z,b,t-1} \hat{\gamma}^{j}_{b,t}}, \tag{8}$$

where $ms_{z,b,t-1}$ is bank b's market share in terms of total (LC and FC) household lending in settlement z in year $t-1$. The instrument therefore exploits variation in banks market shares and their propensity to lend in FC, relative to their propensity to lending in LC.

Table A.6 shows a strong first stage regression of s^{FC}_{z08} on V_z. Instrumenting s^{FC}_{z08} with V_z, we find that the main results are quantitatively similar using the variation in s^{FC}_{z08} that is driven by differential exposure to banks lending in domestic and foreign currency.[39]

[39] We should emphasize, however, that (8) is not immune to all currency-specific credit-demand-based identification concerns. In particular, the exclusion restriction would be violated if banks lending in foreign currency target regions with (unobserved) consumer characteristics that happen to be correlated with worse recession outcomes through other channels than household FC debt. Given that our data allow us to absorb many credit-demand-specific characteristics, we believe this is not a serious concern. Another potential violation of instrument validity is if banks lending in FC differentially reduce lending during the crisis. Below, we directly address the concern that our results are driven by a bank lending channel utilizing information on firm-bank relationships.

Missing Data. In Appendix B we address whether the results are affected by accounting for data missing in the credit registry because the credit registry records information starting in March 2012. We draw on two separate sources of information to approximate the debt repaid before 2012 through the 2011 Early Repayment Program. First, we use a separate loan-level dataset for three of the eight largest banks with a combined market share of 24% to impute the amount of debt prepaid at the settlement-bank level for the remaining banks. Adjusting s_{z08}^{FC} for the predicted repaid debt by settlement has a small but not statistically or economically significant effect on the main results (Table B.3 in the appendix). Second, adjusting the FC debt share using the newly originated local currency loans at the time of the 2011 program as a proxy for participation intensity in the 2011 ERP hardly changes the estimated coefficients.

Placebo Test: 1998 Russian Sovereign Debt Crisis. An important threat to identification is that areas with higher exposure to foreign currency debt are inherently more cyclical. We have seen that controlling for the historical volatility of unemployment does not affect the estimated effect of household foreign currency debt revaluation. Figure 8 uses the 1998 Russian Sovereign Debt Crisis as a placebo sample to further support the argument that regions with higher exposure to foreign currency debt are not generally more sensitive to business cycle shocks.

Russia's devaluation and sovereign default in August 1998 were followed by capital outflows and a rise in emerging market risk premia worldwide. Hungary experienced a rise in interest rates and pressure on the exchange rate, as well as a 31% fall in exports to Russia. Figure 3 shows that the financial and trade spillovers from the Russia crisis were associated with a 1.3 percentage point increase in the aggregate unemployment rate in 1998, followed by a strong recovery in 2000.

Figure 8 depicts estimates of our unemployment specification (4) for the period 1995-2001, before the introduction of household FC loans. If s_{z08}^{FC} were spuriously correlated with business cycle risk, then we would expect a positive coefficient in 1998, followed by a reversal. However, we find estimates that are close to zero and insignificant for all years between 1995 and 2001. There is no evidence that high s_{z08}^{FC} regions are generally more sensitive to business cycle risk.

7 Mechanisms

Several potential mechanisms can help explain the large local employment response to household debt revaluation. One mechanism is real rigidities that inhibit a reallocation of labor toward exporting firms, which are not constrained by local demand. 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 this section, we analyze the role of two other mechanisms: limited labor market adjustment and house price declines. We then examine direct evidence of financial spillovers.

7.1 Labor Market Adjustment: Wages and Migration

Table 9 presents evidence that there is limited labor market adjustment following the household debt revaluation shock. We focus on two margins of adjustment: (i) wage declines to restore local labor market equilibrium and (ii) an increase in net migration. Columns 1 and 2 compute wages as firm payrolls per worker in the firm-level census data (NAV). Columns 3 and 4 use settlement-level composition-adjusted residual wages estimated from the Structure of Earnings Survey.[40] Both sources suggest that there is limited downward adjustment in wages in the first two years (columns 1 and 3). By 2012 there is evidence of a decline in wages in more exposed regions. The estimates, however, are smaller and less significant without controls, as shown in appendix Table A.7. These results are broadly consistent with downward nominal wage rigidity generating higher unemployment following a negative demand shock, as in Schmitt-Grohé and Uribe (2016).

Columns 5 and 6 focus on net migration. We find no evidence of an increase in net migration from settlements with higher FC debt exposure between 2008 and 2010 or 2012. The estimates are statistically insignificant and close to zero. The lack of adjustment through migration accords with recent studies that find limited adjustment to local labor market shocks through interregional migration (e.g., Autor, Dorn, and Hanson 2013, Dix-Carneiro and Kovak 2017).

[40] 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 estimates based on payroll per worker are therefore more precise. 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 811 settlements, the sum of the weights (2007 population) amounts to over 82.4% of the overall 2007 population.

7.2 House Price Declines

House price declines can amplify the local economic effects of a shock to borrower debt burdens through declines in wealth and by tightening collateral constraints. Table 10 explores whether the shock to the real burden of household debt affects settlement-level house prices. Column 1 shows that regions with more exposure to FC debt see a greater decline in house prices from 2008 to 2010. The effect is significant at the 1% level and robust to including a variety of controls (columns 2-3). Column 5 shows that the effect implies that a 10% revaluation of household debt is associated with a 5.8% decline in local house prices.

Figure 9 presents the full dynamic effect of FC debt exposure on house prices starting from 2005, the first year for which we have house price data. There is no evidence of differential house price dynamics in high FC debt exposure regions relative to low exposure regions between 2005 and 2008. The worse recession in high s_{z08}^{FC} regions is not driven by a boom and bust in house prices. The absence of a boom also indicates that, relative to low s_{z08}^{FC} areas, expectations about future rents were not more optimistic in high s_{z08}^{FC} areas. Figure 9 also shows that the decline in house prices starting in 2009 is gradual and persistent, compounding the loss to household wealth.

The evidence in Table 10 indicates that debt revaluation depresses local house prices, potentially through the rise in default rates and the resulting fire sales of foreclosed homes (Campbell, Giglio, and Pathak 2011, Mian, Sufi, and Trebbi 2015). A large empirical and theoretical literature demonstrates that house price declines lead to large declines in household consumption. Columns 6 and 7 presents evidence that, in our setting, the decline in house prices in turn depressed household consumption further. We regress durable spending growth on house price growth over 2008-10 and find a positive and significant relation between house price growth and spending growth between 2008-10 (columns 6 and 7). Since other common shocks are likely to affect house prices and spending in the same direction, the elasticity in column 6 is likely to be an upper bound of the elasticity of consumption expenditure with respect to house prices. Nevertheless, the evidence on house price declines is consistent with a reinforcing interaction between fire-sale and demand externalities.

7.3 Financial Spillovers: Evidence from Defaults

Models of aggregate demand and fire-sale externalities demonstrate that household financing decisions can have negative spillover effects on other agents through demand and asset price channels (Farhi and Werning 2016, Korinek and Simsek 2016). We have seen that borrowing in FC leads to a decline in local employment, a rise in unemployment, a decline in house prices, and, to some extent, a decline in wages. The negative effects of foreign currency debt revaluation on demand and asset prices therefore lower other households' income and borrowing capacity.

In this section, we explore whether the negative consequences of local foreign currency exposure imply spillovers on other households using loan-level data on defaults. In Table 4 we saw that debt revaluation predicts a rise in defaults at the settlement level. There are two possible channels for the increase in defaults. First, FC loans have a higher probability of default because these borrowers directly experience a rise in debt. Therefore, areas with a higher share of FC debt will have higher average default rates. Second, borrowers are more likely to default when many nearby households have FC exposure because the revaluation of household debt burdens imposes negative demand and fire-sale externalities on other agents.

Loan-level data allow us to disentangle these channels. In Table 11 we investigate whether aggregate local FC debt exposure matters for default rates, or whether default is entirely predicted by loan-level currency denomination. We estimate loan-level default models of the form

$$\Delta_{08-10}\text{Default}_{i,b,z} = \beta_0 + \beta_1 FC_i + \beta_2 s^{FC}_{z,-b,08} + X^L_i \Gamma^L + X^B_b \Gamma^B + X^S_z \Gamma^S + \epsilon_{iz}, \tag{9}$$

where $\Delta_{08-10}\text{Default}_{i,b,z}$ is the change in loan i's default status between 2008 and 2010, 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, and X^L, X^B, and X^S are loan-, borrower-, and settlement-level controls. Columns 1-3 in Table 11 show that FC loans on average have a 2.6 percentage point higher probability of default than LC loans, and borrowers with higher total leverage and shorter maturity loans are more likely to default.

Next, we ask whether a loan 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, for example, through the negative effect of FC debt on local employment.

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 supports the hypothesis that borrowing in FC imposes negative externalities on individuals who do not borrow in FC. The effect on $s^{FC}_{z,-b,08}$ is slightly stronger for FC borrowers, who are likely to be more vulnerable to an adverse local debt revaluation shock because the exchange rate depreciation simultaneously deteriorates their own balance sheets.[41]

8 Are the Results Driven by Firm Foreign Currency Debt or a Bank Lending Channel?

We have seen that the estimated effect of household debt revaluation on the local economy is not explained by a boom and bust cycle in house prices or the supply of durables, international trade shocks, higher regional cyclicality in previous cycles, or exposure to industry-specific shocks. In this section, we analyze the relation between household FC debt and two traditional channels of weak economic performance in emerging market crises: firm FC debt and a contraction in bank lending.

8.1 Firm Foreign Currency Debt

Since the Latin American and East Asian crises of the 1990s, numerous studies have found that firm FC indebtedness leads to a fall in business investment and a higher probability of bankruptcy after a devaluation.[42] Prior to the forint depreciation in 2008Q4, 48% of Hungarian corporate liabilities were denominated in FC, primarily in euro. An alternative hypothesis is that regions

[41] 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.

[42] An exception is Bleakley and Cowan (2008), who find that Latin American firms with dollar debt have a performance similar to those with peso debt after peso depreciations. Firms in their sample tend to match the currency denomination of their liabilities with the exchange rate sensitivity of their profits.

with more household FC debt exposure also have higher corporate FC debt exposure and that the worse outcomes are caused by a deterioration in firm balance sheets.

We address this concern directly by matching the Hungarian Firm Credit Registry to our firm-level panel. The firm credit registry allows us to measure foreign currency liabilities for each firm in September 2008.[43] We also construct the fraction of corporate debt in FC in a settlement prior to the depreciation by aggregating corporate balance sheets to the settlement level.

In Table 2 we saw that the household and firm FC debt shares are uncorrelated across space. One concern is that these settlement-level aggregates mask a positive correlation between FC exposures of households and smaller firms. Table A.8 presents the correlation separately for small, medium, and large firms. The data show a zero correlation between household and firm exposures across the firm size distribution. The zero cross-sectional correlation indicates that household and firm FC debt exposure prior to the forint depreciation are not explained by a common FC credit supply expansion.

Two additional facts are consistent with the absence of a cross-sectional relation between household and firm FC debt exposures. First, household FC lending was isolated to the 2004-08 period, while FC lending to firms had been commonplace since the mid-1990s. In 1995 the fraction of firm liabilities denominated in foreign currency was already above 40% (Bodnar 2009). Thus, the expansion in household FC credit occurred a decade after firms began borrowing in FC.

Second, as we saw in Table 2, household FC debt exposure is unrelated to regional export intensity, manufacturing employment share, and average productivity. Yet these are precisely the factors that best explain firm FC financing. Appendix Table A.10 presents firm-level regressions relating firm FC exposure in 2008 to a variety of firm-level characteristics. Firms borrowing in foreign currency are larger and more productive, have a higher share of revenues from exports and stronger employment growth from 2003-2008, and are more likely to be in the manufacturing sector.[44] Foreign currency revenues are an important factor behind FC financing, and three-fourths of firm FC debt is in euro, the dominant export destination and invoicing currency. In contrast,

[43] We do not have firm-level information on foreign exchange derivative positions. In practice, the use of derivatives to hedge short FC positions is limited to the largest firms (Endrész and Harasztosi 2014). The use of derivatives would mitigate the concern that our main results are explained by firm currency mismatch.

[44] Salomao and Varela (2016) and Varela (2016) find similar drivers of selection into FC borrowing for Hungarian firms. In a broader sample of 25 transition economies, Brown, Ongena, and Yesin (2011) show that firm FC revenues are the primary driver of FC borrowing for small firms.

97% of household FC liabilities are denominated in Swiss franc.

Our estimated local economic effects of household debt revaluation are not confounded by corporate FC debt. However, weak firm balance sheets may have played an independent or reinforcing role in the currency crisis. Table 12 presents regressions of the change in firm-level outcomes from 2008 to 2010 on a firm's FC debt share and the local household FC debt share, both measured in 2008.

There is a strong balance-sheet channel from FC debt exposure to firm investment. Columns 1 and 2 in Table 12 find that firms with a higher fraction of debt denominated in FC reduce their investment between 2008-10, and this result is robust to a rich set of controls.[45] However, in contrast to the negative investment effect, firms with a higher fraction of debt in FC do *not* experience weaker sales and employment growth (columns 3 through 6). In several specifications the effect of firm FC debt on sales and employment is positive and significant. One explanation for the limited employment effect is that firms with FC debt are more productive and hedged against the depreciation through their exports. They therefore temporarily cut back on investment following a balance-sheet shock, but retain their employees in anticipation of stronger growth in the future.

Household FC debt exposure, meanwhile, predicts a decline in all measures of firm performance. Nevertheless, there is suggestive evidence of an interaction effect between household and firm FC exposure. As argued by Giroud and Mueller (2017), firms with balance-sheet distress may be more likely to lay off workers following a negative product demand shock. In our data, FC indebted firms do reduce employment more in regions with more household FC debt exposure (column 7). The interaction is not statistically significant, but implies a 25% larger decline in employment for FC indebted firms.[46]

8.2 Bank Lending Channel

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. Nevertheless, banks

[45] For detailed studies on firm FC exposures and investment following the 2008 forint depreciation, see Endrész and Harasztosi (2014) and Salomao and Varela (2016). These studies find similar effects of foreign currency exposure on firm investment.

[46] Table A.11 in the appendix confirms that results in Table 12 are similar using the FC debt to assets ratio. Moreover, sorting firms by the FC debt-to-assets ratio yields a stronger interaction effect.

may have restricted lending to firms because of a rise in funding costs and losses on household loans. Another threat to identification is that the worse outcomes in regions with higher FC debt exposure is driven by a contraction in the local supply of bank credit to firms.

Several facts cast doubt on the bank lending channel interpretation of the household debt revaluation effect. First, the effect is stronger among non-exporters and non-tradable sector firms, which are firms that are less reliant on bank credit. Consistent with patterns documented by Chen, Hanson, and Stein (2017) for the United States, 62.7% of exporters in our sample have bank credit in 2008, while only 45.3% of non-exporters and 44.8% of non-tradable firms have a bank loan in 2008. Second, the firm-level tests in Table 7 control for foreign firm ownership, which has been used in previous work as a proxy for access to bank credit in a crisis (Kalemli-Ozcan, Kamil, and Villegas-Sanchez 2016). Moreover, Chodorow-Reich (2014) finds that credit market disruption most strongly affects small firms. But Table A.9 shows that the impact of household debt revaluation on firm employment is similar across the firm size distribution.

Table 13 goes one step further by explicitly controlling 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 2005 and 2008.[47] We estimate employment growth specifications at the firm-bank relationship level and incorporates bank fixed effects. Since we have multiple observations for firms with more than one banking relationship, we re-weight observations by a firm's number of relationships. Moreover, we allow for residual correlation across firms within subregions and banks by dually clustering on subregion and bank (Thomson 2011, Cameron, Gelbach, and Miller 2011).

Table 13 shows that including bank fixed effects does not substantially change the estimated effect of household FC debt exposure. For example, with controls, including a firm's own FC debt share, the coefficient declines slightly from -14.3% to -12.6%. Therefore, we can rule out the concern that the local economic impact of household debt revaluation is driven by a simultaneous contraction in bank credit.[48]

[47] Ongena, Schindele, and Vonnak (2017) demonstrate a strong bank lending channel of monetary policy for these firm-bank pairs.

[48] A more subtle concern is that banks with negative shocks are systematically sorted into regions with negative employment shocks. In this case, controlling for bank fixed effects is not sufficient. To assess this concern, we estimate firm-level regressions of firm employment growth on settlement fixed effects and bank fixed effects at the firm-bank relationship level, re-weighting by the inverse of the number of relationships. We then compute the average of the bank fixed effects for each settlement, $\bar{\alpha}_z$. The correlation of this average bank fixed effect

9 Conclusion

In this paper, we provide new evidence that household leverage is a strong contractionary channel during crises, consistent with the debt-deflation hypothesis. We trace the effects of a sudden, large-scale revaluation of household foreign currency debt burdens on households default and consumption, local economic activity, and house prices. The existing literature has analyzed the consequences of a build-up in debt over the credit cycle. By instead studying a sharp increase in the value of foreign currency debt in a currency crisis, we isolate the effect of household debt from other factors that co-move with leverage over the credit cycle, such as house prices, housing supply, bank credit supply, and firm balance sheet conditions.

Exploiting spatial variation in exposure to foreign currency debt, we find that a revaluation in household debt burdens sharply reduces local consumption, house prices, employment, and firm output. Employment and output losses are driven by firms that are reliant on local demand. These results are consistent with demand and fire-sale externalities of foreign currency financing. Highlighting the externalities associated with foreign currency debt, we find that local exposure to foreign currency debt increases a borrower's default probability, conditional on the borrower's own foreign currency debt status.

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. Interestingly, prior to the 2008 depreciation, over 90% of domestic currency loans in Hungary were government subsidized. Since these loans partly substitute for foreign currency credit, our results suggest that the subsidy program had (unintended) macro-prudential benefits.

Second, our results imply that monetary policy faces a dilemma in a crisis in economies with foreign currency debt, as in 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. By using information on the foreign currency exposures of both households and firms, our results indicate that the debt revaluation channel

with the settlement fixed effect $\hat{\gamma}_z$ is -0.074, which suggests that banks associated with firms that have worse employment outcomes are not clustered in regions with worse employment growth. This strengthens the validity of the within-bank test in Table 13.

is particularly strong when households have foreign currency debt.

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Table 1: Summary Statistics

	N	Mean	Std. dev.	10th	90th
A: Foreign Currency Exposure					
HH FC debt share, s_{z08}^{FC}	3124	0.66	0.09	0.56	0.77
HH debt revaluation, $\Delta_{08-10}\tilde{d}_z$	3124	22.04	2.37	19.38	24.95
HH debt to inc. revaluation, $\Delta_{08-10}\tilde{d}_z^{Inc}$	3124	12.44	3.39	8.46	17.06
Fraction of housing loans in FC, 2008:9, f_{z08}^{FC}	3124	0.64	0.08	0.56	0.75
Number of FC housing loans to w.a. pop.	3124	0.07	0.02	0.05	0.09
Number of LC housing loans to w.a. pop.	3124	0.04	0.01	0.02	0.05
CHF and JPY share of FC debt, x_{z08}^{CHF}	3091	0.97	0.03	0.95	1.00
B: Settlement Variables					
Default rate change, 2008-10	3108	4.14	2.53	2.42	6.45
Unemployment rate change, 2008-10	3124	2.06	1.48	0.82	3.51
Log new auto reg. change (x100), 2008-10	3124	-120.39	45.00	-177.31	-83.30
Log electricity cons. change (x100), 2008-10	3124	-1.92	8.06	-10.07	3.09
Log house price index change (x100), 2008-10	2528	-12.51	22.51	-35.67	3.32
Debt to disp. income, 2008	3124	0.51	0.17	0.34	0.68
Disp. income per capita, 1000 HUF, 2008	3124	654.63	162.99	428.08	852.72
Share of population age 18-59, 2008	3124	0.61	0.03	0.59	0.64
Share of population age 60+, 2008	3124	0.22	0.03	0.18	0.25
C: Firm-Level Variables					
Employment growth, 08-10	80447	-16.63	49.46	-97.44	33.33
Investment growth, 08-10	80447	-39.11	140.03	-200.00	191.52
Inv. to capital ratio change, 08-10	80447	-22.62	82.27	-112.34	38.01
Employment, 2008	80447	22.37	212.82	3.00	31.00
Firm has positive FC debt	80447	0.18	0.39	0.00	1.00
Foreign currency share of firm debt, 2008:9	80447	0.11	0.29	0.00	0.62
Exporter, 2008	80447	0.20	0.40	0.00	1.00
Export share of sales, 2008	80447	0.05	0.19	0.00	0.10
Manufacturing	80447	0.18	0.38	0.00	1.00
State owned	80447	0.00	0.06	0.00	0.00
Foreign owned	80447	0.08	0.28	0.00	0.00

Notes: This table presents summary statistics for the main variables used in the empirical analysis. Panels A and B report summary statistics for the 3124 settlements (cities or municipalities) in our sample, and panel C presents summary statistics for our sample of 80,447 firms in our firm-level census sample (NAV).

Table 2: Correlates of Household Foreign Currency Debt Exposure

Right-hand-side variable, x_z	Coefficient	S.E.	R^2	N
Export sales share, 2008	-.021	0.029	0.004	2708
Export sales per capita, 2008	-.078	0.410	0.000	2718
Debt to disposable income, 2008	-.038	0.026	0.004	3124
Log disposable income per capita, 2008	-.062**	0.014	0.041	3124
Disposable income growth, 2004-08	-.075	0.060	0.002	3117
Log population, 2008	-.006**	0.002	0.028	3124
Share of population age 18-59, 2008	-.052	0.119	0.000	3124
Log sales-employment ratio, 2008	-.006	0.008	0.003	2718
Corporate FC indebtedness, 2008, $s_{z08}^{FC,Firm}$	-.011	0.022	0.001	2718
Manufacturing employment share, 2008	.021	0.020	0.004	2718
Construction employment share, 2008	-.002	0.036	0.000	2718
Agriculture employment share, 2008	.042+	0.023	0.005	2718

Notes: The table presents regressions of the September 2008 household foreign currency debt share on various settlement level characteristics:

$$s_{z08}^{FC} = \alpha + \beta x_z + u_z.$$

The table shows that settlements (cities or municipalities) with higher share of debt in foreign currency have similar levels of debt-to-income, corporate FC debt exposure, manufacturing and construction employment shares, and export exposure measured in 2008. At the same time, these areas have significantly lower income and population. Standard errors are clustered at the subregion level. +,*,** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table 3: Foreign Currency Debt Exposure and the Increase in Household Debt

	Debt revaluation shock, $\Delta_{08-10}\tilde{d}_z$		Overall household debt growth			Change in debt to 2008 income	
	(1) 2008-10	(2) 2008-10	(3) 2008-10	(4) 2008-10	(5) 2008-11	(6) 2008-10	(7) 2008-11
HH FC debt share, s_{z08}^{FC}	26.22**	26.45**	25.98**	32.85**	38.51**	16.80**	21.32**
	(0.424)	(0.460)	(4.673)	(5.038)	(5.558)	(2.563)	(3.220)
Controls		Yes		Yes	Yes	Yes	Yes
R^2	0.949	0.950	0.00788	0.0247	0.0321	0.443	0.480
Observations	3124	3067	3124	3067	3067	3067	3036

Notes: This table shows that household foreign currency debt exposure predicts a large and significant rise in debt following the depreciation of the Hungarian forint. Specifically, we report regressions of the form,

$$\Delta_{08-t}(\text{Household Debt}) = \alpha + \beta s_{z08}^{FC} + \epsilon_z,$$

for various measures of the change in household debt. Columns 1 and 2 report the regression of the household debt revaluation shock from 2008 to 2010 on the household foreign currency debt share measured as of September 2008. Columns 3-5 use the overall change in debt between 2008 and 2010 or 2011 as the dependent variable. This measure accounts for new originations. Columns 6-7 use the change in debt relative to 2008 household disposable income. Standard errors are clustered at the subregion level. +,*,** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table 4: Household Debt Revaluation and Local Default Rates

	$\Delta_{08-10}\text{Default}_z$					
	(1)	(2)	(3)	(4)	(5)	(6)
HH FC debt share, s_{z08}^{FC}	7.20**	6.03**	6.30**	5.03**		
	(0.90)	(0.75)	(0.73)	(0.76)		
HH debt revaluation, $\Delta_{08-10}\tilde{d}_z$					0.22**	0.17**
					(0.029)	(0.026)
Baseline Controls		Yes	Yes	Yes		Yes
Export Exposure Controls			Yes	Yes		Yes
Industry Employment Shares			Yes	Yes		Yes
Region FE (7 units)				Yes		Yes
R^2	0.062	0.15	0.18	0.22	0.044	0.22
Observations	3108	3051	2678	2678	3109	2678

Notes: This table shows that settlements with higher exposure to household foreign currency debt experience a larger increase in household default rates between 2008 and 2010. Columns 1 through 4 report regressions of the form

$$\Delta_{08-10}\text{Default}_z = \alpha + \beta s_{z08}^{FC} + \Gamma X_z + \epsilon_z,$$

where the left-hand side is the change in the settlement default rate on housing loans. The default rate is measured as the fraction of loans in arears in a settlement (city or municipality). Columns 5 and 6 replace the independent variable with the household debt revaluation shock, defined in equation (6) as the change in debt induced by exchange rate depreciations. Baseline controls are household disposable income, household debt to income, log population, and working age and retired population shares. Export exposure controls are the export share of firm revenues and total firm export revenues per capita. Industry employment share controls are defined using 18 one digit NACE industries (e.g., agriculture, mining, manufacturing, construction, wholesale and retail trade). Columns 4 and 6 include fixed effects for the 7 NUTS level 2 regions. Controls are measured in 2008. Observations are weighted by 2007 population. Standard errors are clustered at the subregion level (175 units) based on the Ibragimov and Müller (2016) test. +,*,** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table 5: Household Debt Revaluation and Household Spending

Panel A: New Auto Registrations Growth, 2008-10

	(1)	(2)	(3)	(4)	(5)	(6)
HH FC debt share, s_{z08}^{FC}	-99.5**	-69.9**	-78.3**	-74.0**		
	(19.5)	(15.3)	(14.4)	(12.1)		
HH debt revaluation, $\Delta_{08-10}\tilde{d}_z$					-3.47**	-2.70**
					(0.64)	(0.44)
Baseline Controls		Yes	Yes	Yes		Yes
Export Exposure Controls			Yes	Yes		Yes
Industry Employment Shares			Yes	Yes		Yes
Region FE (7 units)				Yes		Yes
R^2	0.037	0.22	0.28	0.33	0.034	0.33
Observations	3124	3067	2679	2679	3124	2679

Panel B: Household Electricity Usage Growth, 2008-10

	(1)	(2)	(3)	(4)	(5)	(6)
HH FC debt share, s_{z08}^{FC}	-13.1**	-8.44*	-9.25*	-7.25**		
	(4.33)	(3.76)	(3.70)	(2.78)		
HH debt revaluation, $\Delta_{08-10}\tilde{d}_z$					-0.47**	-0.22*
					(0.15)	(0.086)
Baseline Controls		Yes	Yes	Yes		Yes
Export Exposure Controls			Yes	Yes		Yes
Industry Employment Shares			Yes	Yes		Yes
Region FE (7 units)				Yes		Yes
R^2	0.020	0.14	0.19	0.33	0.019	0.32
Observations	3124	3067	2679	2679	3124	2679

Notes: This table presents evidence that areas with higher exposure to foreign currency debt experience larger declines in durable spending and non-durable consumption. Panel A uses the log of the number of new auto registrations plus one as a proxy for durable spending. Panel B uses the log of electricity consumption (in megawatt hours) as a measure of non-durable consumption. Standard errors are clustered at the subregion level (175 units) based on the Ibragimov and Müller (2016) test. +,*,** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table 6: Impact of Household Debt Revaluation on Local Unemployment

	Δ_{08-10}Unemployment rate$_z$					
	(1)	(2)	(3)	(4)	(5)	(6)
HH FC debt share, s_{z08}^{FC}	2.34**	2.66**	2.76**	2.76**		
	(0.62)	(0.65)	(0.67)	(0.66)		
HH debt revaluation, $\Delta_{08-10}\tilde{d}_z$					0.079**	0.089**
					(0.023)	(0.025)
Baseline Controls		Yes	Yes	Yes		Yes
Export Exposure Controls			Yes	Yes		Yes
Industry Employment Shares			Yes	Yes		Yes
Region FE (7 units)				Yes		Yes
R^2	0.019	0.043	0.066	0.11	0.017	0.10
Observations	3124	3067	2679	2679	3152	2679

Notes: This table shows that areas with larger exposure to foreign currency debt prior to the forint depreciation experience a larger rise in the local unemployment rate. Specifically, we present regressions of the form

$$\Delta_{08-10}\text{Unemployment rate}_z = \alpha + \beta s_{z08}^{FC} + \Gamma X_z + \epsilon_z.$$

The unemployment rate is defined as the number of registered unemployed workers divided by the working age population. Columns 5 and 6 replace the household foreign currency debt share with the household debt revaluation shock defined in equation (6) as the right-hand-side variable. Standard errors are clustered at the subregion level (175 units) based on the Ibragimov and Müller (2016) test. +,*,** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table 7: Impact of Household Debt Revaluation on Tradable and Non-tradable Firms

Panel A: Employment Growth, 2008-10

	All Firms		Non-Exporters		Exporters		Non-Tradable	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
HH FC debt share, s_{z08}^{FC}	-9.35*	-14.3**	-10.0*	-16.2**	-0.49	-3.57	-6.91	-13.3*
	(3.81)	(3.37)	(4.02)	(3.65)	(5.31)	(5.45)	(6.58)	(6.31)
Firm-level controls		Yes		Yes		Yes		Yes
Settlement controls		Yes		Yes		Yes		Yes
2-Digit Industry FE		Yes		Yes		Yes		Yes
R^2	0.00016	0.066	0.00018	0.072	0.00000051	0.044	0.000096	0.065
Observations	80447	80447	64422	64422	16025	16025	20306	20306

Panel B: Domestic Sales Growth, 2008-10

	All Firms		Non-Exporters		Exporters		Non-Tradable	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
HH FC debt share, s_{z08}^{FC}	-5.34	-13.8**	-7.34	-14.8**	10.6	1.21	-8.86	-14.7+
	(4.34)	(4.14)	(4.75)	(4.72)	(9.74)	(9.38)	(8.03)	(8.21)
Firm-level controls		Yes		Yes		Yes		Yes
Settlement controls		Yes		Yes		Yes		Yes
2-Digit Industry FE		Yes		Yes		Yes		Yes
R^2	0.000029	0.023	0.000058	0.027	0.000093	0.032	0.000098	0.019
Observations	80290	80290	64422	64422	15868	15868	20306	20306

Panel C: Real Value-Added Growth, 2008-10

	All Firms		Non-Exporters		Exporters		Non-Tradable	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
HH FC debt share, s_{z08}^{FC}	-9.96*	-17.9**	-11.5*	-19.8**	-1.37	-6.04	-12.6	-20.9*
	(4.59)	(4.32)	(5.01)	(4.94)	(7.14)	(7.14)	(8.54)	(8.63)
Firm-level controls		Yes		Yes		Yes		Yes
Settlement controls		Yes		Yes		Yes		Yes
2-Digit Industry FE		Yes		Yes		Yes		Yes
R^2	0.00011	0.021	0.00014	0.022	0.0000025	0.031	0.00018	0.013
Observations	80447	80447	64422	64422	16025	16025	20306	20306

Notes: This table shows that firms in areas with higher exposure to household foreign currency debt experience larger declines in employment, domestic sales, and real value added, and this result is strongest for non-exporting firms and firms in non-tradable industries. Each panel presents regressions of the growth in a firm-level outcome from 2008 to 2010 on household FC debt exposure. Employment growth is defined as the symmetric growth rate in employment. Export status is defined as whether a firm has positive export revenues in 2008. 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 (2017)'s implementation of the Mian and Sufi (2014b) classification for Hungary. Standard errors are clustered at the subregion level (175 units). +,*,** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table 8: Impact of Household Debt Revaluation on Local Unemployment: Robustness

	(1)	(2)	(3)	(4)	(5)
Panel A: Alternative Measures of Household FC Debt Exposure					
HH debt to inc. revaluation, $\Delta_{08-10}\tilde{d}_z^{Inc}$	0.079**				
	(0.024)				
Fraction of loans in FC, f_{z08}^{FC}		3.41**			
		(0.70)			
FC loans per adult (std.)			0.61**		
			(0.090)		
LC loans per adult (std.)				-0.099	
				(0.10)	
FC debt share, mortgages only					1.95**
					(0.51)
Controls	Yes	Yes	Yes	Yes	Yes
R^2	0.032	0.049	0.067	0.021	0.040
Observations	3067	3067	3067	3067	3023
Panel B: Weights, Subsamples, and Subregional Aggregation					
HH FC debt share, s_{z08}^{FC}	1.75**	1.61**	2.26**	3.85**	1.90*
	(0.51)	(0.59)	(0.74)	(1.37)	(0.74)
Controls	Yes	Yes	Yes	Yes	Yes
Sample	Full	50% smallest	50% largest	Largest cities	175 subreg.
Weights	None	None	None	None	Pop.
R^2	0.055	0.061	0.056	0.067	0.073
Observations	3067	1534	1533	306	175
Panel C: Additional Specification Checks, Estimation Period: 2006-2011					
HH FC debt share, $s_{z08}^{FC} \times POST_t$	2.03**	2.21**	2.01**	1.89**	1.47**
	(0.57)	(0.58)	(0.57)	(0.40)	(0.37)
Unemployment rate in 2008 $\times$ $POST_t$		-0.092**			
		(0.020)			
Default rate in 2008:9 $\times$ $POST_t$		0.017			
		(0.026)			
SD of unemp. rate, 1995-2007 $\times$ $POST_t$			-0.19*		
			(0.094)		
$POST_t$	2.13+	3.40**	2.63*	2.90**	1.25
	(1.11)	(1.16)	(1.16)	(1.03)	(0.97)
Controls×POST	Yes	Yes	Yes	Yes	Yes
Settlement FE	Yes	Yes	Yes	Yes	Yes
Subregion time trends				Yes	Yes
Region (20 units)-POST FE					Yes
R^2	0.63	0.63	0.63	0.71	0.73
Observations	18402	18402	18402	18402	18402

Notes: This table shows that the effect of household foreign currency debt exposure on local unemployment is robust to a variety of specification and sample checks. The dependent variable in panels A and B is the change in the local unemployment rate from 2008 to 2010. In panel C we estimate a difference-in-differences specification using annual data from 2006 to 2011, where $POST_t$ equals 1 in years 2009 onward. This specification allows us to control for 175 subregion specific time trends. Standard errors are clustered at the subregion level (175 units) based on the Ibragimov and Müller (2016) test. +,*,** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table 9: Labor Market Adjustment: Wages and Migration

	Payroll Per Worker Growth		Nominal Wage Growth		In-Migration Rate Change	
	(1) 08-10	(2) 08-12	(3) 08-10	(4) 08-12	(5) 08-10	(6) 08-12
HH FC debt share, s_{z08}^{FC}	-4.48^{+}	-8.42*	-0.18	-13.6	0.55^{+}	0.44
	(2.55)	(3.59)	(7.12)	(8.24)	(0.31)	(0.37)
Unit of Obs.	Firm	Firm	Settle-ment	Settle-ment	Settle-ment	Settle-ment
Settlement Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes				
2-Digit Industry FE	Yes	Yes				
R^2	0.031	0.036	0.0047	0.036	0.11	0.20
Observations	79974	67389	811	811	2943	2924

Notes: This table presents estimates of the effect of household FC debt exposure on wage growth and in-migration change. There is moderate evidence of a gradual downward adjustment in wages following the debt revaluation shock, but no evidence of an increase in migration. Payroll per worker is total payroll expenses divided by number of employees in the firm-level census data (NAV). Nominal wage growth refers to the change in log residualized hourly wages multiplied by 100, estimated from the worker-level Structure of Earnings Survey. The in-migration rate change is the change in the in-migration to population ratio. Changes are computed between 2008-2010 and 2008-2012 as indicated. Standard errors are clustered at the subregion level (175 units). +,*,** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table 10: Household Debt Revaluation, House Prices, and Spending

	House Price Growth, $\Delta_{08-10}\ln(P_z^H)$					$\Delta_{08-10}\ln(C_z^{Dur})$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
HH FC debt share, s_{z08}^{FC}	-33.2**	-26.8**	-18.5**				
	(6.25)	(6.39)	(6.14)				
HH debt revaluation, $\Delta_{08-10}\tilde{d}_z$				-1.06**	-0.58*		-3.11**
				(0.22)	(0.23)		(0.59)
House price growth, 2008-10						0.21**	0.16*
						(0.069)	(0.065)
Baseline Controls		Yes	Yes		Yes	Yes	Yes
Export Exposure Controls		Yes	Yes		Yes	Yes	Yes
Industry Employment Shares		Yes	Yes		Yes	Yes	Yes
Region FE (7 units)			Yes		Yes		
R^2	0.031	0.10	0.12	0.022	0.12	0.30	0.32
Observations	1932	1856	1856	1933	1856	1856	1856

Notes: This table shows that settlement foreign currency debt exposure leads to a decline in local house prices. In turn, house price growth is correlated with consumption growth, which suggests that house price declines amplify the effect of foreign currency exposure by further depressing consumption. The dependent variable in columns 1-5 is settlement house price growth from 2008 to 2010. House price index series are available for two-thirds of the settlements in Hungary. The dependent variable in columns 6 and 7 is the change in log new auto registrations. Standard errors are clustered at the subregion level (175 units). +,*,** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table 11: Financial Spillovers: Loan-Level Evidence from Defaults

	LC and FC Housing Loans				LC Borrower	FC Borrower
	(1)	(2)	(3)	(4)	(5)	(6)
Foreign currency loan, FC_i	2.63**	2.21**	11.9**	2.59**		
	(0.16)	(0.17)	(0.97)	(0.16)		
Local HH FC debt share, $s^{FC}_{z,-b,08}$				3.08**	3.32**	3.55**
				(0.80)	(1.02)	(0.98)
$FC_i \times$ High Leverage Indicator$_b$		0.87**				
		(0.17)				
$FC_i \times$ Maturity (years)$_i$			-0.52**			
			(0.039)			
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	0.012	0.013	0.058	0.012	0.013	0.0065
Observations	650193	650193	650175	650193	215394	434799

Notes: This table presents loan-level regressions of the change in default status from 2008 to 2010 on an indicator for whether a loan is in foreign currency (FC_i) and foreign currency exposure in the borrower's settlement of residence, excluding borrower b ($s^{FC}_{z,-b,08}$):

$$\Delta_{08-10}\text{Default}_{i,b,z} = \beta_0 + \beta_1 FC_i + \beta_2 s^{FC}_{z,-b,08} + X^L_i \Gamma^L + X^B_b \Gamma^B + X^S_z \Gamma^S + \epsilon_{iz}$$

Columns 1-3 show that foreign currency loans are more likely to default, and this effect is stronger for borrowers with higher leverage and shorter maturity loans. Column 4 shows that both the loan's own currency denomination and local foreign currency debt exposure predict an increased probability of default. Columns 5 and 6 split the sample into local and foreign currency borrowers and show that higher local exposure to foreign currency debt predicts an increased probability of default for both local and foreign currency borrowers. Local currency borrowers are defined as borrowers who have no individual exposure to FC debt. Loan controls are a loan type fixed effect (mortgage or HE) and a quadratic in log loan size. Borrower controls are the total number of mortgage and HE loans, log total borrower debt in 2008, and five-year age bin fixed effects. Settlement controls are log population, debt-to-income, disposable income per capita, fraction of the population age 18 to 59 and fraction age 60 or more, export revenue share, exports per capita, one-digit industry employment shares, and fixed effects for seven major regions. Controls are measured in 2008. Standard errors are clustered at the subregion level (175 units). +,*,** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table 12: Firm FC Debt, Household FC Debt, and Firm-Level Outcomes from 2008 to 2010

	Inv.-Capital Change, 08-10		Sales Growth, 08-10		Employment Growth, 08-10		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Firm FC debt share	-10.0**	-11.4**	1.76*	2.64**	4.05**	0.77	
	(1.27)	(1.34)	(0.68)	(0.68)	(0.50)	(0.48)	
HH FC debt share, s_{z08}^{FC}		-7.05		-13.4**		-14.1**	-13.4**
		(4.39)		(4.11)		(3.36)	(3.71)
s_{z08}^{FC} × Firm has FC debt							-3.48
							(5.42)
Firm has FC debt							3.39
							(3.57)
Firm Controls		Yes		Yes		Yes	Yes
Settlement Controls		Yes		Yes		Yes	Yes
2-Digit Industry FE		Yes		Yes		Yes	Yes
R^2	0.0012	0.0084	0.000065	0.028	0.00055	0.066	0.066
Observations	80447	80447	80447	80447	80447	80447	80447

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 from 2008 to 2010. The dependent variables are the change in the investment to lagged capital ratio (columns 1-2), firm sales growth (columns 3-4), and employment growth (columns 5-7). Growth rates are computed using the symmetric growth rate to mitigate the influence of outliers and allow for zeros. Firms with a higher fraction of FC debt experience falling investment, but stronger sales growth and no difference in employment growth. Household foreign currency debt exposure robustly predicts falling sales and employment. Appendix Table A.11 shows that these results are similar when measuring firm foreign currency exposure using FC debt to assets ratio. Standard errors are clustered at the subregion level (175 units). +,*,** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table 13: Controlling for Bank Credit Supply Shocks

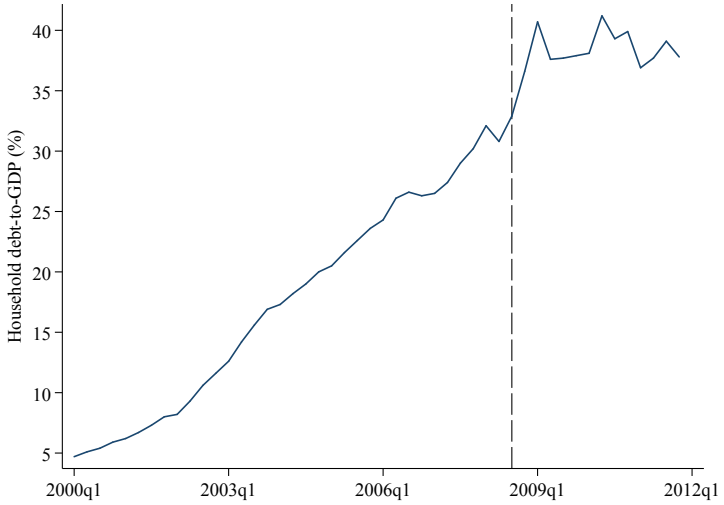
	Firm Employment Growth, 2008-10			
	(1)	(2)	(3)	(4)
HH FC debt share, s_{z08}^{FC}	-9.35*	-7.24^{+}	-14.3**	-12.6**
	(4.13)	(3.83)	(3.84)	(3.75)
Bank FE		Yes		Yes
Firm-level controls			Yes	Yes
Settlement controls			Yes	Yes
2-Digit Industry FE			Yes	Yes
R^2	0.00016	0.0040	0.066	0.069
N Firms	80447	80447	80447	80447
Observations	121084	121084	121084	121084

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

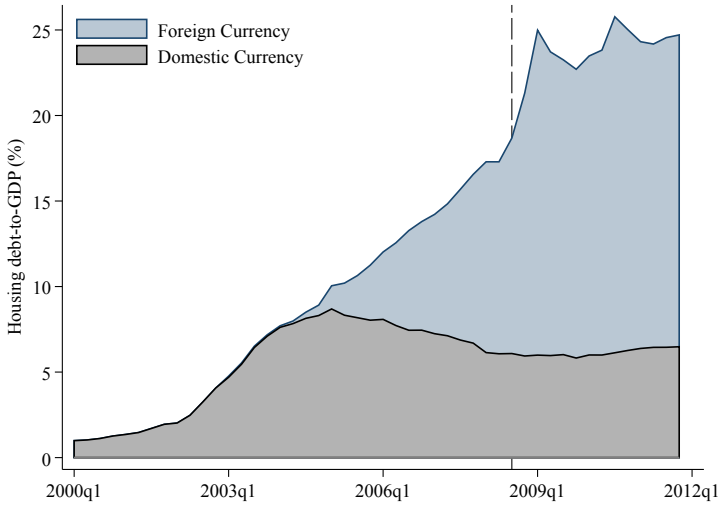
$$g_{08-10,ib}^{E} = \alpha_{bank} + \beta s_{z08}^{FC} + X_{i08}\Gamma^{i} + X_{z08}\Gamma^{z} + \epsilon_{ib},$$

where the unit of observation is a firm-bank relationship in 2008. The dependent variable is symmetric firm employment growth between 2008 and 2010. α_{bank} is a bank fixed effect that absorbs bank-specific shocks. To recover the firm-level estimates, the observations are re-weighted by the inverse of a firm's total number of relationships. Two-thirds of firms have only one relationship, and the mean number of relationships per firm is 1.51. Standard errors are dually clustered on bank ID and subregion (175 units). +,*,** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Figure 1: Household Credit Expansion in Domestic and Foreign Currency



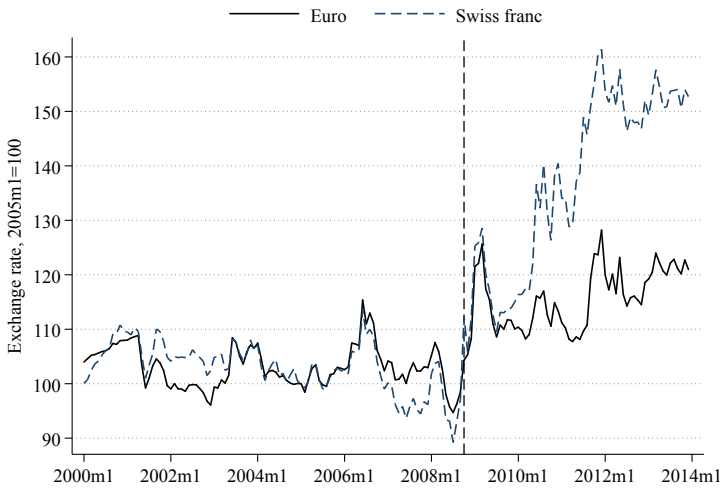
(a) Household debt-to-GDP ratio (%)



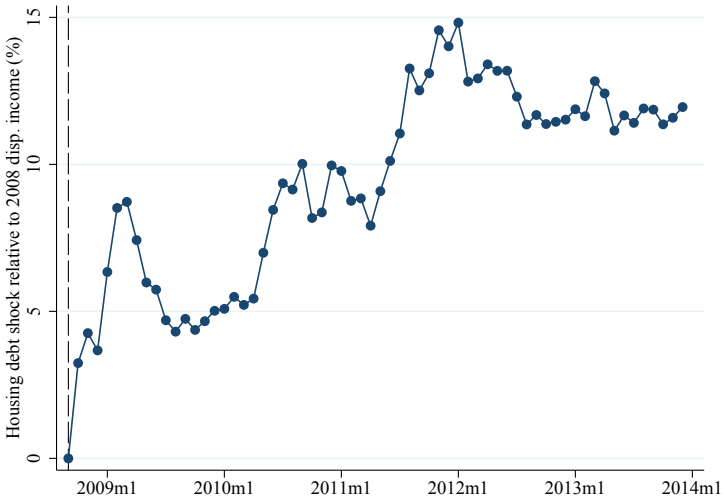
(b) Housing debt in domestic and foreign currency

Notes: Panel (a) shows the increase in total household debt-to-GDP from the BIS's "Long series in credit to the private sector" database. Panel (b) depicts the evolution of mortgage and home equity debt in domestic and foreign currency from the National Bank of Hungary. The vertical dashed line represents September 2008, the month prior to the forint depreciation.

Figure 2: Household Debt Revaluation Shock Induced by the Forint Depreciation



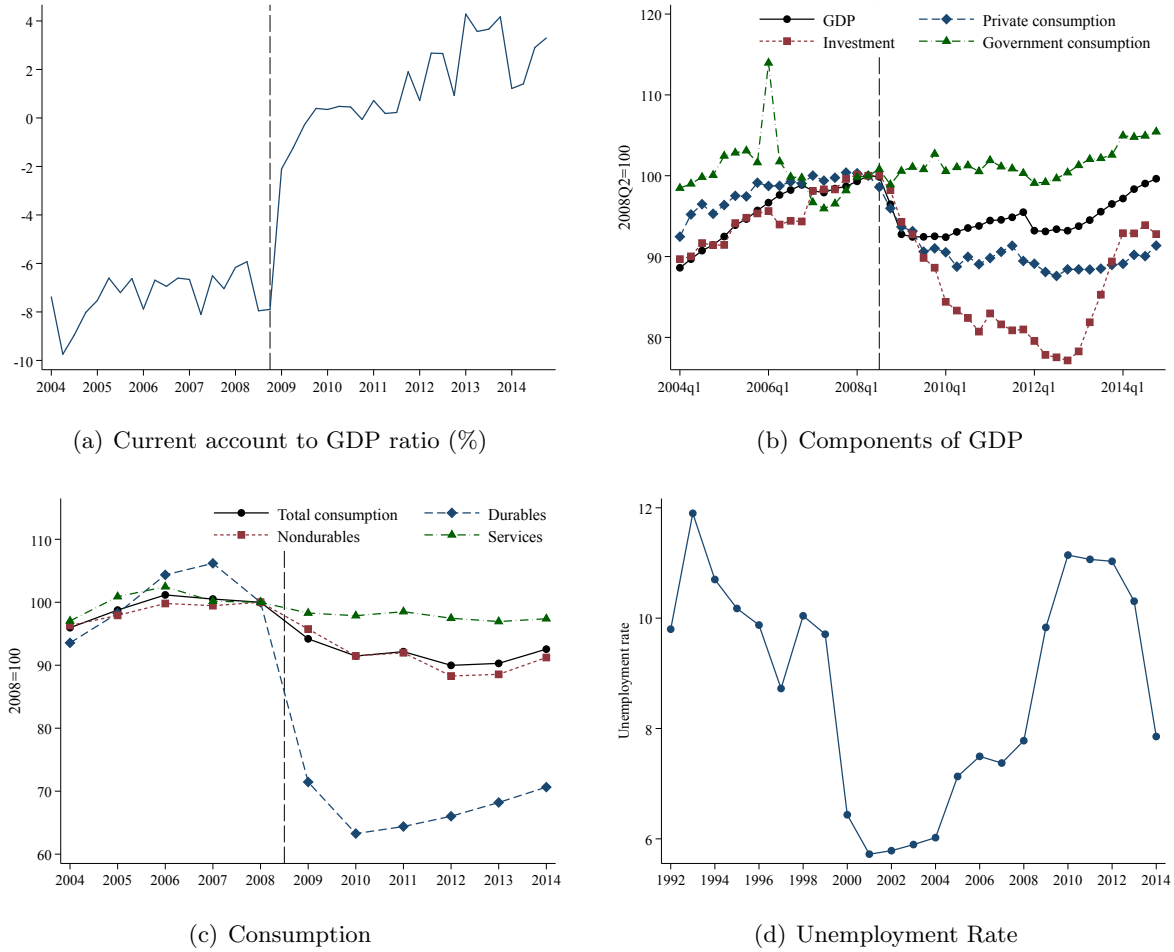
(a) Nominal exchange rate relative to euro and Swiss franc



(b) Household debt-revaluation induced by the depreciation, as a percentage of disposable income

Notes: Panel (a) shows the evolution of the forint-euro and forint-Swiss franc exchange rates. The figure shows that a *de facto* ±5% crawling band target up to 2008:2 was followed by a sudden depreciation in October 2008. The forint depreciated further relative to the Swiss franc during the European debt crisis in 2010. Panel (b) presents the *household debt-revaluation shock* induced by the depreciation computed as the difference between the value of 2008:9 outstanding housing debt at market exchange rates and housing debt assuming exchange rates remain at their 2008:9 value, scaled by 2008 disposable income. The forint depreciation led to an unanticipated increase in housing debt of 5-10% in 2009 and 10% by mid-2010.

Figure 3: Macroeconomic Background



(a) Current account to GDP ratio (%)

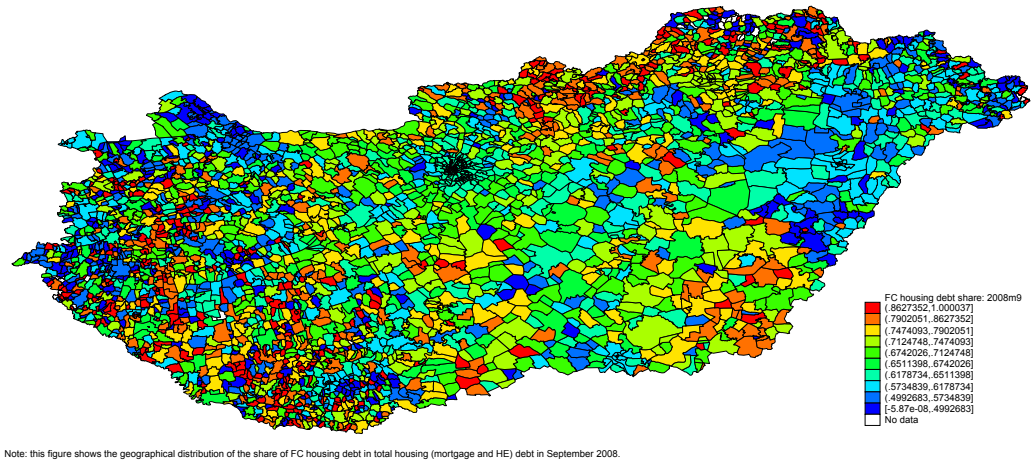
(b) Components of GDP

(c) Consumption

(d) Unemployment Rate

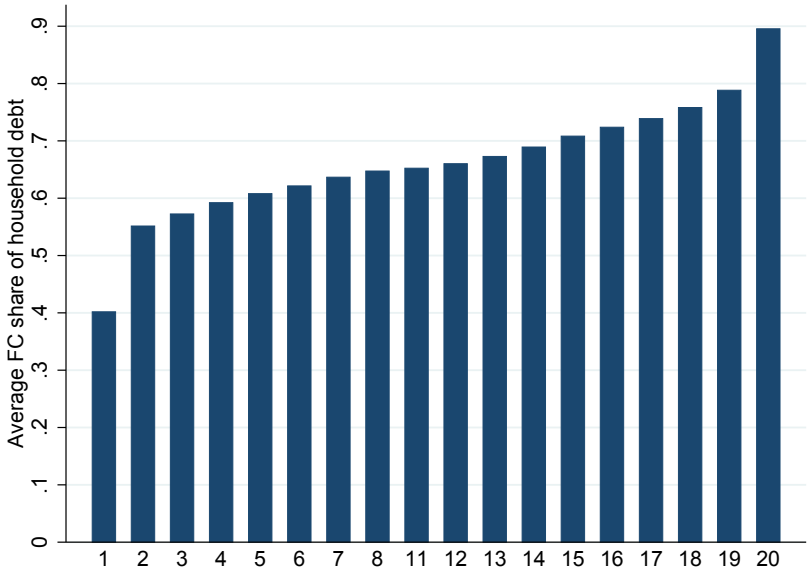
Notes: This figure presents the evolution of key macroeconomic aggregates up to and after the forint depreciation, which started in October 2008.

Figure 4: Distribution of Household Foreign Currency Debt Exposure



Note: this figure shows the geographical distribution of the share of FC housing debt in total housing (mortgage and HE) debt in September 2008.

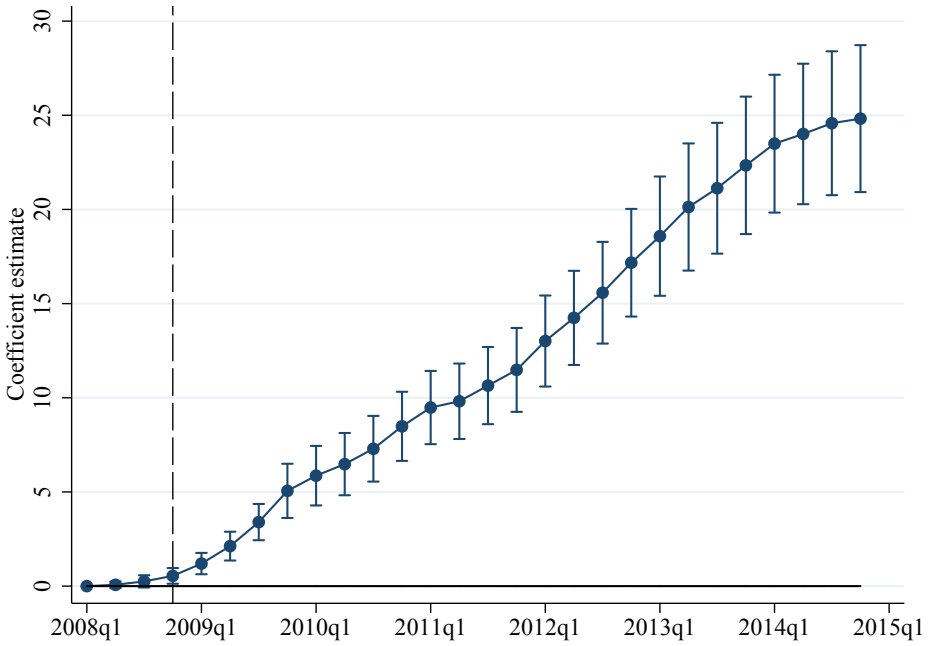
(a) Geographic Distribution of Household FC Debt Exposure



(b) Variation in FC Debt Exposure

Notes: Panel (a) presents a map of the household FC debt share across 3124 settlements in Hungary. The map shows that there is variation both within and across regions in the share of household debt denominated in FC. Panel (b) sorts settlements into 20 equal population bins by the household foreign currency debt share measured in September 2008, s_{08}^{FC}, and presents the average of s_{08}^{FC} within each bin. The figure shows there is substantial variation in exposure going from the lowest to the highest quantiles.

Figure 5: Household Foreign Currency Debt Exposure and Local Default Rates

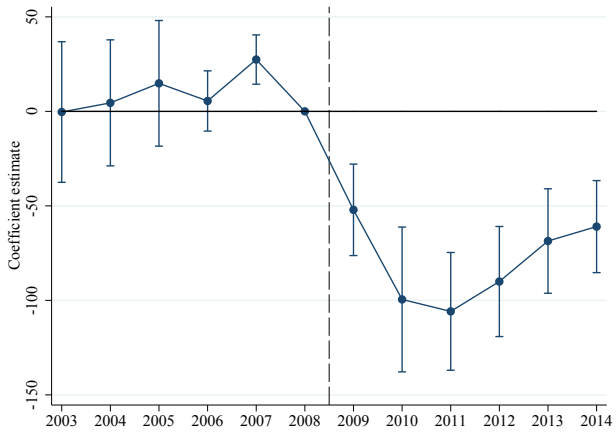


Notes: This figure presents estimates of $\{\beta_q\}$ from

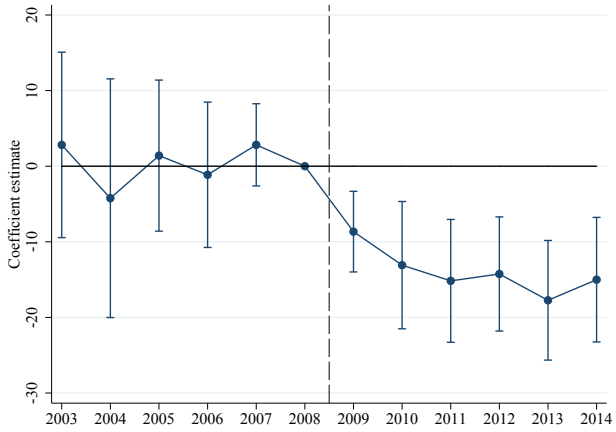
$$\text{Default}_{zt} = \alpha_z + \gamma_t + \sum_{q \neq 2008Q1} \beta_q (s_{z08}^{FC} \cdot \mathbf{1}_{q=t}) + \epsilon_{zt}.$$

The outcome variable is the settlement default rate on housing loans, defined as the fraction of housing loans in default. Coefficients are multiplied by 100. The estimation period is 2008Q1, as this is the first period that default status is available. For reference, the aggregate default rate on housing loans increased from 0.9% in 2008:9 to 4.7% in 2010:9 and 13.9% in 2014:9. Error bars represent 95% confidence intervals from standard errors clustered at the subregion level based on the Ibragimov and Müller (2016) test for the appropriate level of clustering.

Figure 6: Foreign Currency Debt Exposure and Household Spending



(a) Durable spending (new auto registrations)



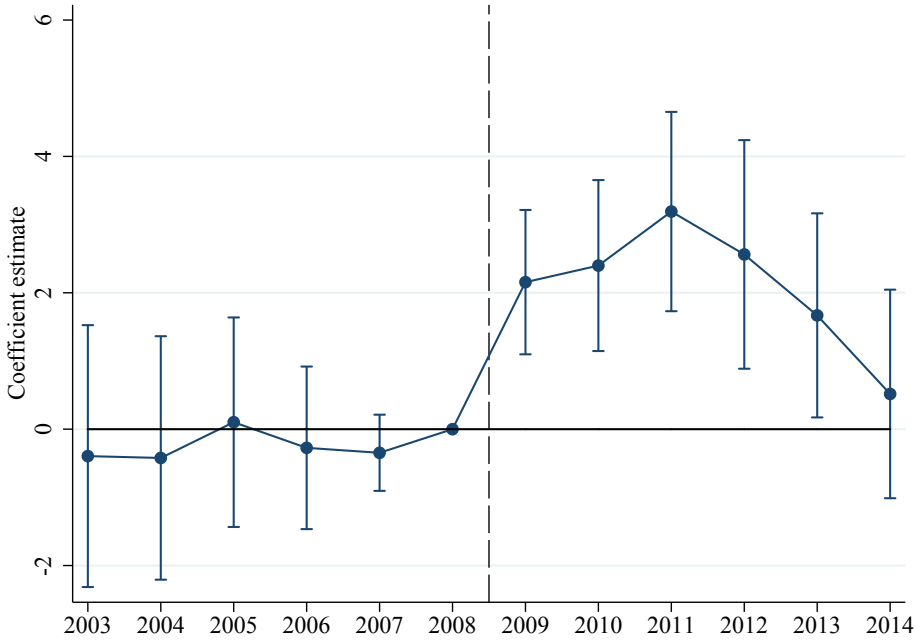
(b) Non-durable consumption (electricity usage)

Notes: This figure presents estimates of

$$\ln(C_{zt}) = \alpha_z + \gamma_t + \sum_{y \neq 2006} \beta_y (s_{z08}^{FC} \cdot \mathbf{1}_{y=t}) + \epsilon_{st}$$

for durable spending (new auto registrations), durable financing (new auto lending), and non-durable consumption (household electricity consumption). Coefficients are multiplied by 100. Error bars represent 95% confidence intervals from standard errors clustered at the subregion level based on the Ibragimov and Müller (2016) test for the appropriate level of clustering.

Figure 7: Foreign Currency Debt Exposure and Unemployment



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

$$u_{zt} = \alpha_z + \gamma_t + \sum_{y \neq 2006} \beta_y (s^{FC}_{z08} \cdot \mathbf{1}_{y=t}) + X_{zt}\Gamma + \epsilon_{st},$$

where u_{zt} is the settlement unemployment rate. The specification controls for a public jobs program that expanded in 2011. Error bars represent 95% confidence intervals from standard errors clustered at the subregion level based on the Ibragimov and Müller (2016) test for the appropriate level of clustering.

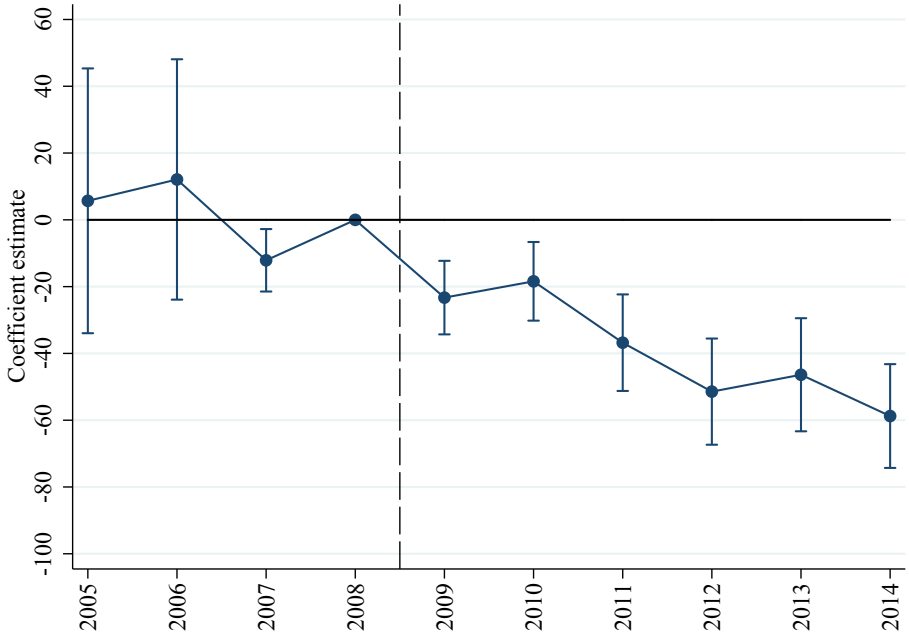
Figure 8: Placebo Test: 1998 Russian Financial Crisis

Notes: This figure uses the second half of the 1990s as a placebo sample. Figure 3 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,

$$u_{zt} = \alpha_z + \gamma_t + \sum_y \beta_y \{ s_{z08}^{FC} \cdot \mathbf{1}_{y=t} \} + \epsilon_{zt}.$$

For the late 1990s placebo sample the coefficients $\{\hat{\beta}_y\}$ are precisely estimated and not significantly different from zero.

Figure 9: Foreign Currency Debt Exposure and House Prices



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

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

where $\ln(P_{zt}^H)$ is (100 times) the log of the settlement home price index. The specification includes controls corresponding to of Table 10 column 3 interacted with year dummies, as Table 10 reveals that the estimates are sensitive to the inclusion of these controls (see Figure A.3 for the estimates without controls). Error bars represent 95% confidence intervals computed from standard errors clustered at the subregion level. House prices are only available for 187 major settlements prior to 2007, so the estimated effect from 2005 and 2006 to 2008 is more uncertain.

A Appendix Tables and Figures

Table A.1: Initial Banking Density and Household Foreign Currency Debt

	(1) DTI 2008	(2) LC DTI 2008	(3) FC DTI 2008	(4) HH FC debt share, s_{z08}^{FC}
Log banking density in 1995	-0.064	0.042	-0.12*	-0.12**
	(0.064)	(0.032)	(0.055)	(0.038)
Baseline 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	0.30	0.31	0.24	0.30
Observations	2679	2679	2679	2679

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). Standard errors are clustered at the subregion level (175 units). +,*,** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table A.2: Robustness: Household Debt Revaluation to Income Shock

Panel A: Settlement Level Outcomes

	Change from 2008 to 2010				
	(1) Default	(2) Auto Reg.	(3) Auto Fin.	(4) Non-dur. Cons.	(5) Unemp. Rate
HH debt to inc. revaluation, $\Delta_{08-10}\tilde{d}_z^{Inc}$	0.099**	-2.50**	-0.67+	-0.30*	0.072**
	(0.026)	(0.54)	(0.34)	(0.12)	(0.022)
Baseline Controls	Yes	Yes	Yes	Yes	Yes
Export Exposure Controls	Yes	Yes	Yes	Yes	Yes
Industry Employment Shares	Yes	Yes	Yes	Yes	Yes
R^2	0.20	0.32	0.054	0.33	0.095
Observations	2678	2679	2615	2679	2679

Panel B: Firm Level Outcomes

	Change from 2008 to 2010					
	(1) Empl.	(2) Domestic Sales	(3) Real Val. Added	(4) Empl. Non-Exp.	(5) Empl. Exporters	(6) Empl. Non-trad.
HH debt revaluation	-0.46**	-0.57**	-0.71**	-0.50**	-0.14	-0.49*
rel. to income, $\Delta_{08-10}\tilde{d}_z^{Inc}$	(0.14)	(0.15)	(0.16)	(0.14)	(0.23)	(0.21)
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Settlement Controls	Yes	Yes	Yes	Yes	Yes	Yes
2-Digit Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.066	0.023	0.021	0.072	0.044	0.065
Observations	80447	80290	80447	64422	16025	20306

Notes: Panel A shows that the main settlement level results are robust to using the household debt revaluation to income shock defined in equation (7). Panel B reports firm level regressions of the main firm level outcomes on the household debt revaluation to income measure. Standard errors are clustered at the subregion level (175 units). +,*,** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table A.3: Firm Employment Regressions Controlling for Lagged Employment Growth

	All Firms	Non-Exporters	Exporters	Non-Tradable
	(1)	(2)	(3)	(4)
HH FC debt share, s_{z08}^{FC}	-15.9**	-16.8**	-8.53	-15.5**
	(3.20)	(3.37)	(5.38)	(5.85)
Lagged firm empl. growth, 2006-08	-0.011**	-0.026**	0.064**	-0.015+
	(0.0037)	(0.0042)	(0.0077)	(0.0081)
Firm-level controls	Yes	Yes	Yes	Yes
Settlement controls	Yes	Yes	Yes	Yes
2-Digit Industry FE	Yes	Yes	Yes	Yes
R^2	0.063	0.069	0.049	0.064
Observations	71075	56139	14936	17837

Notes: This table shows that the firm employment growth estimates in Table 7 are robust to controlling for firm-level lagged employment growth. Lagged employment growth is computed from 2006 to 2008. Standard errors are clustered at the subregion level (175 units). +,*,** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table A.4: Settlement Level Employment Regressions

	Total Employment		Non-Exporters		Exporters		Non-Tradable	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
HH FC debt share, s_{z08}^{FC}	-11.0+	-15.0*	-14.5+	-17.3*	-1.47	0.40	-11.8+	-14.8*
	(6.33)	(5.82)	(7.74)	(6.77)	(9.40)	(9.82)	(7.02)	(7.10)
Baseline Controls		Yes		Yes		Yes		Yes
Export Exposure Cont.		Yes		Yes		Yes		Yes
Industry Empl. Shares		Yes		Yes		Yes		Yes
R^2	0.0020	0.042	0.0028	0.032	0.000016	0.032	0.00095	0.017
Observations	2673	2673	2673	2673	2673	2673	2673	2673

Notes: The table presents employment growth regressions with firm level data aggregated to the settlement level. The specification is:

$$g_{z,08-10}^{E} = \beta_0 + \beta s_{z08}^{FC} + X_{z08}\Gamma + \epsilon_z,$$

where $g_{z,08-10}^{E}$ is settlement symmetric employment growth from 2008 to 2010. Standard errors are clustered at the subregion level (175 units). +,*,** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table A.5: Robustness to Omitted Variables Bias

Specification	Estimate w\o cont.	Estimate w\cont.	$\dot{R}^2$	$\tilde{R}^2$	$2.2 \cdot \tilde{R}^2$	Identified Set	
Default	7.2	5.03	0.06	0.22	0.48	5.03	1.40
Auto registration	-99.5	-74	0.04	0.33	0.73	-74.00	-39.54
Electricity cons.	-13.1	-7.25	0.02	0.33	0.73	-7.25	0.22
Unemployment	2.34	2.76	0.02	0.11	0.24	2.76	3.37
Default spillover	5.38	3.88	0.01	0.16	0.35	3.88	2.02
House prices	-33.2	-18.5	0.03	0.12	0.26	-18.50	5.28

Notes: This table presents the identified sets computed using the methodology developed by Oster (2016) and Altonji et al. (2005). The identified set is computed at $\left[\tilde{\beta} - \delta(\dot{\beta} - \tilde{\beta})\frac{R^2_{max} - \tilde{R}^2}{\tilde{R}^2 - \dot{R}^2}, \tilde{\beta}\right]$, where $\dot{\beta}$ and $\dot{R}^2$ are from the short regression, $\tilde{\beta}$ and $\tilde{R}^2$ are from the long regression, and $\delta = 1$ and $R^2_{max} = 2.2\tilde{R}^2$, based on the recommendation in Oster (2016). For all outcomes except non-durable (electricity) consumption and house prices, we can reject that the estimates are driven by omitted variable bias under an assumption of proportional selection on observables and unobservables.

Table A.6: Banking Shift-Share Instrument

Panel A: Settlement Level Outcomes

	First stage	IV: Change from 2008 to 2010				
	(1)	(2)	(3)	(4)	(5)	(6)
	s_{z08}^{FC}	Default	Auto spending	Electr. usage	Unem. rate	House prices
Shift-share FC debt shock, V_{z08}	0.73**					
	(0.047)					
s_{z08}^{FC}		5.04**	-131.1**	2.72	4.11**	-16.7
		(1.19)	(25.1)	(4.69)	(1.04)	(10.4)
Baseline 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
Region FE (7 units)	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.47	0.22	0.31	0.32	0.097	0.11
Observations	2677	2677	2677	2677	2677	2334

Panel B: Firm Level Outcomes

	IV: Change from 2008 to 2010					
	(1)	(2)	(3)	(4)	(5)	(6)
	Empl.	Domestic Sales	Real Val. Added	Empl. Non-Exp.	Empl. Exp.	Empl. Non-trad.
HH FC debt share, s_{z08}^{FC}	-14.4**	-16.4**	-23.5**	-16.2**	-1.21	-6.48
	(4.94)	(5.54)	(6.31)	(5.58)	(9.67)	(8.62)
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Settlement Controls	Yes	Yes	Yes	Yes	Yes	Yes
2-Digit Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.066	0.022	0.021	0.072	0.044	0.065
Observations	80447	80290	80447	64422	16025	20306

Notes: This table shows that the main results are robust to instrumenting the household FC debt share with an instrument constructed using banks' local market shares and their propensity to lend in domestic and foreign currency, defined in equation (8). Standard errors are clustered at the subregion level (175 units). +,*,** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table A.7: Labor Market Adjustment: Wages and Migration without Controls

	Payroll Per Worker Growth		Nominal Wage Growth		In-Migration Rate Change	
	(1) 08-10	(2) 08-12	(3) 08-10	(4) 08-12	(5) 08-10	(6) 08-12
HH FC debt share, s_{z08}^{FC}	-4.85^{+}	-5.26	2.68	-2.33	1.02**	2.01**
	(2.49)	(3.97)	(6.59)	(8.68)	(0.36)	(0.49)
Unit of Obs.	Firm	Firm	Settl.	Settl.	Settl.	Settl.
R^2	0.0045	0.0064	0.00026	0.00016	0.0049	0.015
Observations	79974	67389	811	811	2943	2924

Notes: This table presents the regressions in Table 9 without control variables. Standard errors are clustered at the subregion level (175 units). +,*,** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table A.8: Household and Firm FC Debt Exposure by Firm Size

	All Firms	Small (3 to 9)	Medium (10 to 50)	Large ($\geq$ 51)
	(1)	(2)	(3)	(4)
HH FC debt share, s_{z08}^{FC}	0.0094	0.028	-0.019	-0.051
	(0.034)	(0.032)	(0.042)	(0.11)
R^2	0.0000048	0.000051	0.000017	0.000092
Observations	80447	54273	21371	4803

Notes: The dependent variable is the firm level foreign currency debt share in 2008. Standard errors are clustered at the subregion level (175 units). +,*,** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table A.9: Effect of Household Debt Revaluation on Employment Growth: Effects by Firm Size

	Small (3 to 9)		Medium (10 to 50)		Large ($\geq$ 51)	
	(1)	(2)	(3)	(4)	(5)	(6)
HH FC debt share, s_{z08}^{FC}	-8.57^{+}	-12.8**	-10.8^{+}	-18.2**	-10.4	-14.4^{+}
	(5.01)	(4.63)	(5.57)	(5.06)	(8.47)	(8.29)
Firm-level controls		Yes		Yes		Yes
Settlement controls		Yes		Yes		Yes
2-Digit Industry FE		Yes		Yes		Yes
R^2	0.00013	0.071	0.00023	0.075	0.00027	0.055
Observations	54273	54273	21371	21371	4803	4803

Notes: This table reports firm level regressions by firm size of symmetric employment growth from 2008 to 2010 on the local household FC debt share. Standard errors are clustered at the subregion level (175 units). +,*,** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table A.10: Determinants of Firm Foreign Currency Financing

Right-hand-side variable	Coefficient	S.E.	R^2	N
Log employment, 2008	0.039**	.002	0.019	80447
Log sales per worker, 2008	0.026**	.001	0.011	80447
Employment growth, 2004-08	0.016**	.002	0.001	62219
Export sales share, 2008	0.140**	.014	0.008	80447
Exporter	0.076**	.008	0.011	80447
Manufacturing	0.052**	.003	0.005	80447

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

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

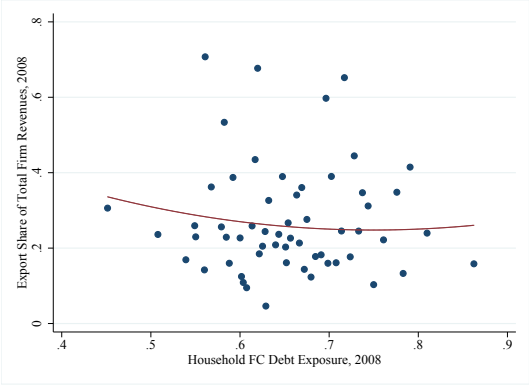
Firms with a higher share of debt in foreign currency tend to be larger, faster growing, more export intensive, and more likely to be in manufacturing. Standard errors are clustered at the subregion level (175 units). +,*,** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table A.11: Firm FC Debt, Household FC Debt, and Firm Level Outcomes from 2008 to 2010: Robustness using Firm FC Debt to Assets

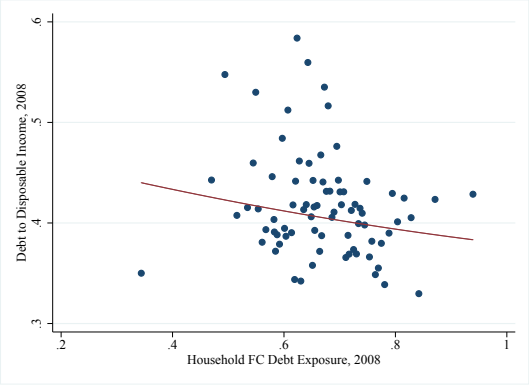
	Inv.-Capital Change, 08-10		Sales Growth, 08-10		Employment Growth, 08-10		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Firm FC debt to assets	-15.0**	-15.6**	1.55	3.06**	4.57**	0.94	9.37+
	(1.21)	(1.23)	(1.04)	(0.91)	(0.65)	(0.63)	(5.51)
HH FC debt share, s_{z08}^{FC}		-7.39+		-13.3**		-14.1**	-12.2**
		(4.45)		(4.12)		(3.35)	(3.60)
s_{z08}^{FC} × Firm FC debt to assets							-12.9
							(8.47)
Firm Controls		Yes		Yes		Yes	Yes
Settlement Controls		Yes		Yes		Yes	Yes
2-Digit Industry FE		Yes		Yes		Yes	Yes
R^2	0.0020	0.0089	0.000037	0.028	0.00051	0.066	0.066
Observations	80447	80447	80447	80447	80447	80447	80447

Notes: Standard errors are clustered at the subregion level (175 units). +,*,** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

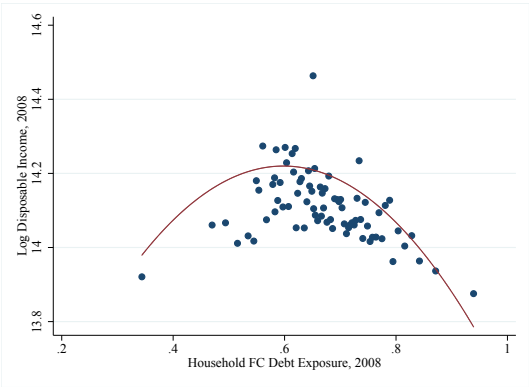
Figure A.1: Correlation of Household Foreign Currency Exposure with Key Observables



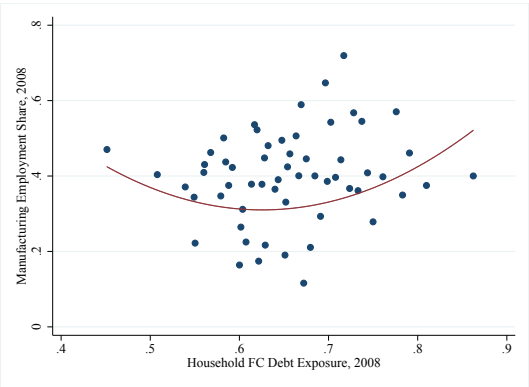
(a) Export exposure



(b) Debt to disposable income



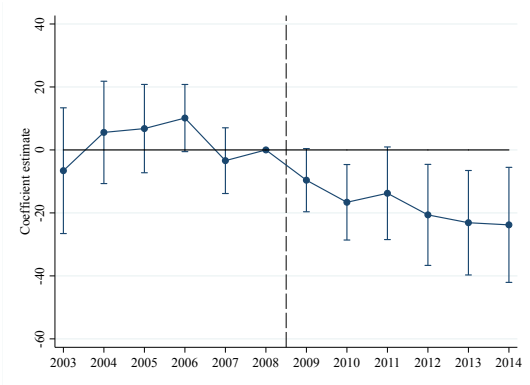
(c) Disposable income per capita



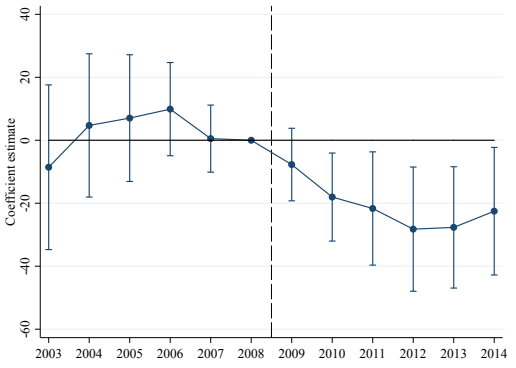
(d) Manufacturing employment share

Notes: These figures present binned bivariate means at the settlement level of key observables against the September 2008 household foreign currency debt share, s_{z08}^{FC}.

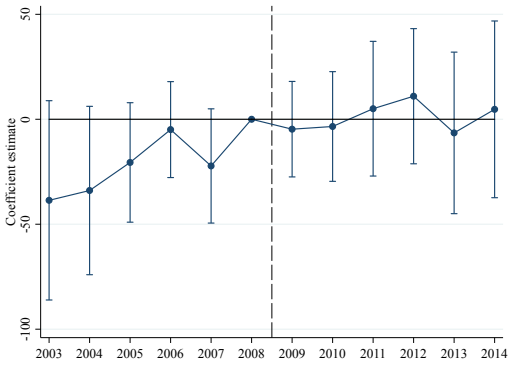
Figure A.2: Foreign Currency Debt Exposure and Settlement Employment



(a) Total Employment



(b) Employment: Non-Exporters



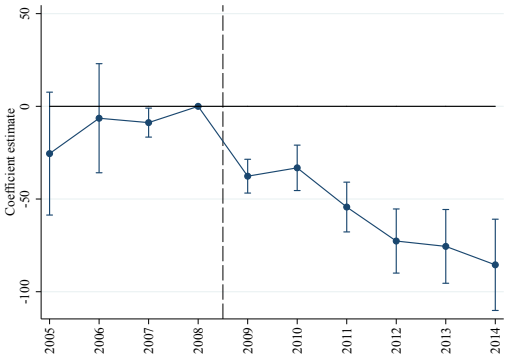
(c) Employment: Exporters

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

$$\ln(E_{zt}) = \alpha_z + \gamma_t + \sum_{y \neq 2008} [\beta_y(s_{z08}^{FC} \cdot \mathbf{1}_{y=t}) + \delta_y(X_{z08} \cdot \mathbf{1}_{y=t})] + \epsilon_{st},$$

where $\ln(E_{zt})$ is (100 times) the log of settlement total employment (panel a), employment in non-exporting firms (panel b), and employment in exporting firms (panel c). Settlement level employment is computed by aggregating firm employment in the firm-level census data (NAV) to the settlement level. Controls, X_{z08}, are the full set of controls in Table A.4. Error bars represent 95% confidence intervals computed from standard errors clustered at the subregion level.

Figure A.3: Foreign Currency Debt Exposure and House Prices without Controls



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

$$\ln(P_{zt}^H) = \alpha_z + \gamma_t + \sum_{y \neq 2008} \beta_y (s_{z08}^{FC} \cdot \mathbf{1}_{y=t}) + \epsilon_{st},$$

where $\ln(P_{zt}^H)$ is (100 times) the log of the settlement home price index. Error bars represent 95% confidence intervals computed from standard errors clustered at the subregion level. House prices are only available for 187 major settlements prior to 2007, so the estimated effect from 2005 and 2006 to 2008 is more uncertain.

B Data Appendix

B.1 Household Credit Registry

The Hungarian Household Credit Registry records information on all loans granted to households starting in March 2012. This allows us to observe loan information for all loans that are outstanding in March 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 2000:1 using information on the originated amount, loan type, currency, and variable interest rate at the bank-product level, where product includes loan type (mortgage, home equity loan, auto loan, etc.), maturity, and currency.[49]

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 $\tilde{P}_{it}$ and $\tilde{D}_{it}$. These are computed as

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

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

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.[50]

B.1.1 Accuracy of the Imputation within the Credit Registry

As an first test of the accuracy of the annuity model, Figure B.1 plots binned bivariate means of the imputed and actual loan balances in 2012:12. Panel (a) plots the binned means for all mortgage and home equity loans in our sample, and panels (b)-(d) presents subsamples by loan type and 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 B.2 reports regressions of the true loan balance on the imputed balance in 2012:12. The table shows that the R^2 in the regression of the true balance on the imputed balance in 83% for all loans, and lies between 80-96% for various subsets

[49] 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.

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

of loans. The coefficient on the slope is naturally biased downward from unity because of classical measurement error in B_{it}, and similarly the coefficient on the constant is biased upward since the average loan balance is positive.

B.1.2 Missing Loans and Comparison with the Flow of Funds

A more serious 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 B.2 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). The flow of funds is constructed from bank balance sheet data and measures all outstanding debt by loan type and currency.

Figure B.2 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% of total outstanding housing debt and 73.0% of foreign currency housing debt in 2008:9 (panels (a) and (b)). Panel (b) shows that we match the aggregate level of local currency debt almost perfectly. The shortfall in our imputed series thus comes from missing FC debt. As a result, panel (d) shows that in 2008m9 the aggregate share of foreign currency debt is 62.7% in the imputed series compared to 69.1% in the flow of funds.

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.

B.1.3 Early Repayment Program of 2011

The primary reason for the FC housing debt shortfall in the Credit Registry relative to the flow of funds is that 21.3% of outstanding FC debt (15.9% 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%, with the majority of losses imposed on lenders.[51] 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 B.2).

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.[52] 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 we control flexibly 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 sections 5 and 6,

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

[52] 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.

the estimates are similar when controlling flexibly for income, which indicates that any systematic mis-measurement of s_{z08}^{FC} induces at most a modest bias in the estimates.

In addition, we take two different approaches to *explicitly correct* our measure of FC exposure for loans that are not in the Credit Registry because of the 2011 ERP.

ERP Adjustment #1. 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% of total consumer lending, and this database captures 34.4% 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, $\overline{x}^{3b}$ be the overall fraction that is repaid for the three banks, and $\overline{x}_b$ 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

$$x_{bz} = x_z^{3b}\left(\frac{\overline{x}_b}{\overline{x}^{3b}}\right). \tag{10}$$

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 $\hat{D}_{bz}^{prepaid} = \frac{x_{bz}}{1-x_{bz}} D_{bz}^{FC}$. With the imputed prepayment $\hat{D}_{zb}^{prepaid}$ we calculate the implied debt level in 2008:9 assuming a representative Swiss franc loan for each bank-settlement that was originated in 2007:3, in the middle of the FC credit boom.[53] Summing over all banks in z gives us a measure of the 2008:9 loan balance for ERP participants in settlement z, $\hat{D}_{z08}^{prepaid}$. We then simply adjust the foreign currency share of total housing debt for this term:

$$\tilde{s}_{z08}^{FC} = \frac{\sum_c \mathcal{E}_{08}^c D_{z08}^{*c} + \mathcal{E}_{08}^{chf} \hat{D}_{z08}^{prepaid}}{D_{z08} + \sum_{c \in C} \mathcal{E}_{08}^c D_{z08}^{*c} + \mathcal{E}_{08}^{chf} \hat{D}_{z08}^{prepaid}}. \tag{11}$$

ERP Adjustment #2. 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 in LC loans accounted for 33.0% of the participation in the 2011 ERP (approximately HUF 349.4 bn),[54] so the volume of refinancing provides an alternative indication of how intensively

[53] We choose 2007:3 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 of the bank-product interest rate for the representative loan.

[54] 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% to reflect the 27.5% discount on the market exchange rate.

households participated in the program.

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 2008:9 that were refinanced in the ERP.[55] 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 the first adjustments. With an estimate of the prepaid debt in settlement z we model the loan balance in 2008:9 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.

Performance of ERP Adjustments. Table B.2 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 1058bn compared the target of HUF 1135bn, or 3.7bn euros. Recall that method #2 mechanically matches the aggregate.

Figure B.3 shows the impact of the ERP adjustment on aggregate FC debt. With the imputation we account for 95% of total debt in 2008:9 (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 is explained by the ERP.

We also obtained data on the total prepayment for each bank in our sample, and Figure B.4(a) plots the predicted prepayment for method #1 against the true value for the eight major banks in Hungary, (i.e. $\hat{D}_b^{prepaid} = \sum_z \hat{D}_{zb}^{prepaid}$ and $D_b^{prepaid}$). Our simply non-parametric in method #2 yields an R^2 of 90.1%.

Figure B.5 compares the original and ERP-adjusted foreign currency debt shares, s^{FC} and $\tilde{s}^{FC}$. As expected, the adjustment raises the FC share in on 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).

Effect of Controlling for the Early Repayment Program on the Main Results. Table B.3 presents robustness tests for the main results using the two adjusted foreign currency exposure variables. For convenience we also report the baseline results. The point estimates are quantitatively quite similar to the baseline estimates, moving by at most 20%. The estimates for the adjusted variable tend to be slightly lower, although in some cases the estimates rise. While the standard errors increase, the main results retain their high statistical significance.

B.1.4 Short Maturities and Repayment

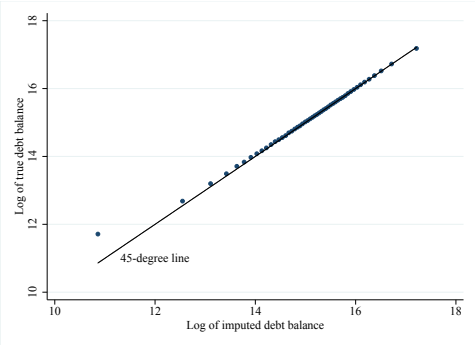
Another potential source of measurement error is that loans may have short maturities or come due before March 2012, but be outstanding around the depreciation. We do not believe this is a serious concern from the perspective of our study for the following reasons. First, our study focuses on housing-related obligations (mortgage and home equity loans), and these are typically long-dated. Aggregate credit series from MNB reveal that the fraction of housing loans with maturity shorter than 5 years in September 2008 is 1.69%, and the average of this fraction from January 2000 to September 2008 is 2.41%. 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

[55] The volume of new issuance in surrounding months is low, so this is a reasonable approximation.

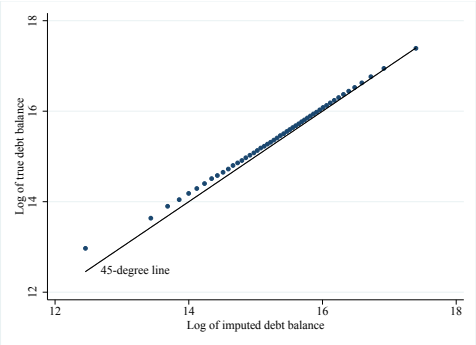
initial level in 2000, the number of housing loans that would be expected to be retired between 2008:9 and 2012:3 is a small fraction of the aggregate. And finally, we are able to match the aggregates series quite closely once accounting for the 2011 Early Repayment Program.

Figure B.1: Validation of Imputation Procedure: Binned Bivariate Means of Imputed and Actual Loan Balance in 2012

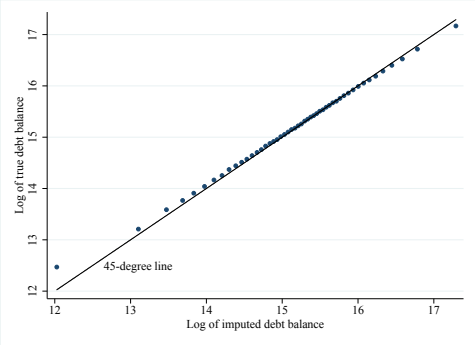
This figure plots binned bivariate means (binscatter) of imputed and actual loan balances in 2012:12 using 50 quantiles. The imputed loan balance is modeled using an annuity formula using loan-level information on the originated amount, time of origination, and bank-by-product specific interest rate 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.



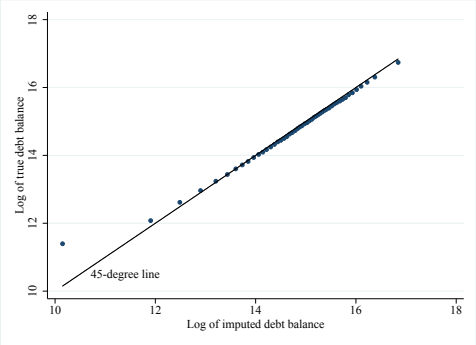
(a) All currencies



(b) Swiss franc loans



(c) Euro loans



(d) Forint loans

Table B.1: Regressions of True Loan Balance in 2012:12 on Imputed Balance

	Dependent variable: true balance in 2012:12, $\ln(D_{it})$						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Imputed balance, $\ln(\widetilde{D}_{it})$	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

Standard errors in parentheses.

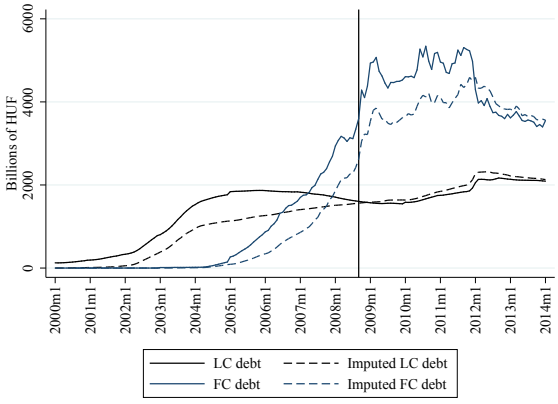
Table B.2: Aggregate Prepayment in 2011 Early Repayment Program

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

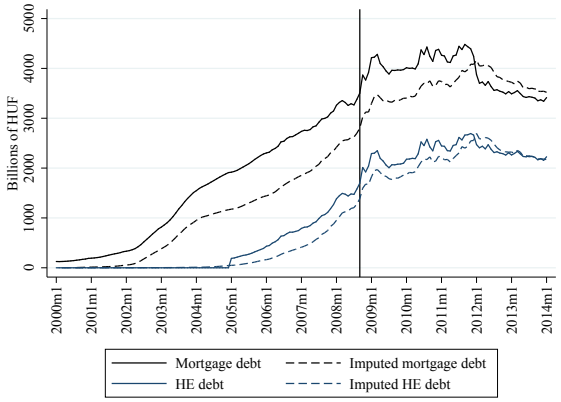
Figure B.2: Comparison of Imputed Aggregate Debt and Flow of Funds

This figure compares outstanding housing credit aggregates from flow of funds 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%) fraction of outstanding balances in 2008:9. However, prepayments from the 2011 Early Repayment Program means that we fail to account for about 23% 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% compared to a true value of 69.1% in 2008:9).

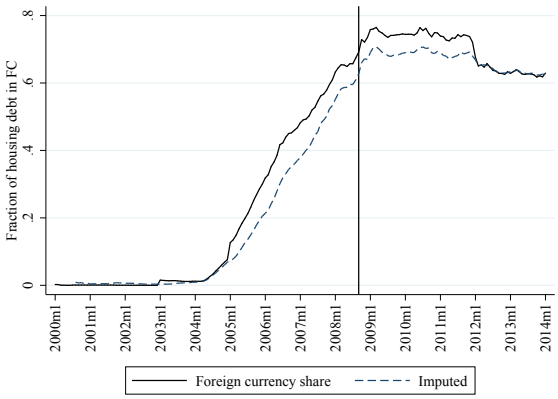
(a) All housing loans



(b) Aggregate separately by currency



(c) Aggregate separately by loan type



(d) Foreign currency share of housing debt

Figure B.3: Early Repayment Program Adjustment and Aggregate FC Debt

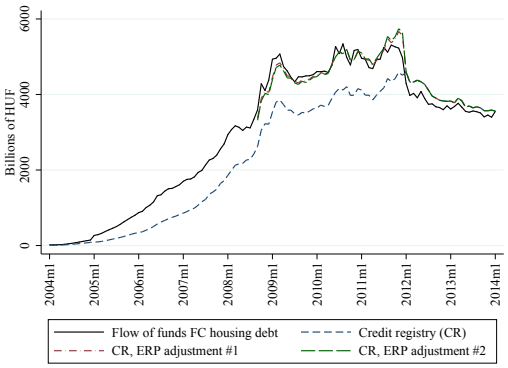
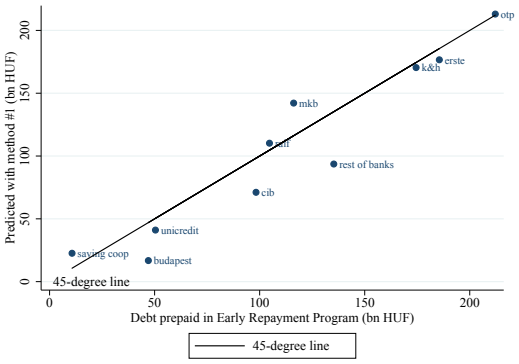


Figure B.4: Method #1 Predicted and Actual 2011 Early Repayment Program Debt Reduction by Bank



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 agains the predicted amount using Method #1.

Figure B.5: Original and ERP Adjusted FC Debt Shares

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_{z08}^{FC}).

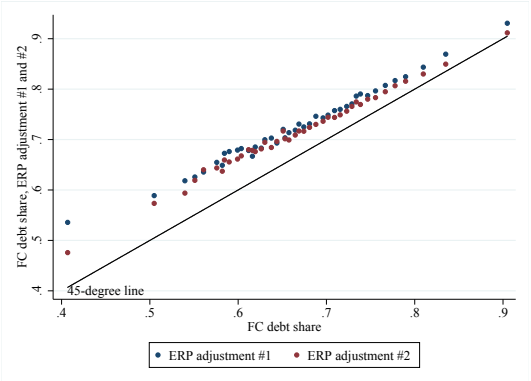


Table B.3: Robustness of Main Results to Missing Data Adjustments

Panel A: Default Rate Change, 2008-10

	(1)	(2)	(3)	(4)
HH FC debt share, ERP adj. #1	6.69**	6.23**		
	(1.07)	(0.88)		
HH FC debt share, ERP adj. #2			7.19**	7.81**
			(1.05)	(0.87)
Full Settlement Controls		Yes		Yes
R^2	0.039	0.17	0.041	0.19
Observations	3108	2678	3108	2678

Panel B: Durable Spending Growth, 2008-10

	(1)	(2)	(3)	(4)
HH FC debt share, ERP adj. #1	-74.5**	-56.9**		
	(18.6)	(16.8)		
HH FC debt share, ERP adj. #2			-66.2**	-74.8**
			(21.7)	(16.7)
Full Settlement Controls		Yes		Yes
R^2	0.017	0.27	0.013	0.27
Observations	3124	2679	3124	2679

Panel C: Non-Durable Spending Growth, 2008-10

	(1)	(2)	(3)	(4)
HH FC debt share, ERP adj. #1	-13.8**	-9.70*		
	(4.23)	(3.87)		
HH FC debt share, ERP adj. #2			-11.9**	-9.94*
			(4.34)	(3.89)
Full Settlement Controls		Yes		Yes
R^2	0.019	0.19	0.013	0.19
Observations	3124	2679	3124	2679

Panel D: Unemployment Rate Increase, 2008-10

	(1)	(2)	(3)	(4)
HH FC debt share, ERP adj. #1	1.51*	2.22**		
	(0.61)	(0.69)		
HH FC debt share, ERP adj. #2			2.52**	2.68**
			(0.69)	(0.72)
Full Settlement Controls		Yes		Yes
R^2	0.0067	0.053	0.017	0.059
Observations	3124	2679	3124	2679

Panel E: House Price Growth, 2008-10

	(1)	(2)	(3)	(4)
HH FC debt share, ERP adj. #1	-32.7**	-25.5**		
	(6.91)	(7.55)		
HH FC debt share, ERP adj. #2			-25.3**	-24.3**
			(7.78)	(7.44)
Full Settlement Controls		Yes		Yes
R^2	0.024	0.096	0.013	0.095
Observations	1932	1856	1932	1856

Standard errors in parentheses clustered at the subregion level.

+,*,** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

B.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% 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 report information on a 10% random sample of employees based on employee date of birth. See Harasztosi and Lindner (2017) 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), 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, $\tilde{W}_{it} = e^{\hat{\nu}_{it}+\hat{\alpha}_t}$ and compute the average of $\tilde{W}_{it}$ in each settlement. This procedure yields estimated wage series for about one-third of the settlements in our sample that cover about 82% of the population. With reported hours we also compute the average monthly hours in a settlement, conditional on employment.

C Debt Revalaution in an Open Economy Model

C.1 Model Set-Up

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.[56] 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.[57] 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:

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

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

$$mc_t = -\nu + w_t - p_{H,t} - a_H, \quad \nu \equiv -\ln(1+\tau). \tag{12}$$

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

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

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

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 $\mathcal{Q}_t = \frac{\mathcal{E}_t P_t^*}{P_t} = \frac{P_{F,t}}{P_t}$, given producer currency pricing.

Home CPI can be log-linearized as

$$p_t = (1-\alpha)p_{H,t} + \alpha p_{F,t} = p_{H,t} + \alpha s_t \Rightarrow \pi_t = \pi_{H,t} + \alpha \dot{s}_t. \tag{13}$$

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:

$$C_t = \Theta^i C_t^i \mathcal{Q}_{i,t}^{\frac{1}{\sigma}}.$$

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

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

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

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

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

$$Y_t = C_t S_t^{\alpha} \left[(1-\alpha) + \alpha \Theta^{-1} \right], \tag{14}$$

which can be log-linearized as

$$y_t = c_t + \alpha s_t - \alpha\theta. \tag{15}$$

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

$$y_t = c_t^* + s_t + (1-\alpha)\theta. \tag{16}$$

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 (15) 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 (15) 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 (13), 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 (12) as

$$mc_t = -\nu + (w_t - p_t) + (p_t - p_{H,t}) - a_H \tag{17}$$

$$= -\nu + (1+\varphi)y_t + \alpha\theta - (1+\varphi)a_H \tag{18}$$

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

$$y_t^n = a_H + \frac{\nu - \mu}{1+\varphi} - \frac{\alpha\theta}{1+\varphi}. \tag{19}$$

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

$$\tilde{mc}_t = (1+\varphi)\tilde{y}_t + \alpha\theta. \tag{20}$$

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

$$\dot{\pi}_{H,t} = \rho\pi_{H,} - \lambda\tilde{mc}_t, \quad \lambda = \rho_\delta(\rho + \rho_\delta) \tag{21}$$

which, using (20), can be rewritten as

$$\dot{\pi}_{H,t} = \rho\pi_{H,} - \kappa\tilde{y}_t - \lambda\alpha\theta, \quad \kappa = \lambda(1+\varphi). \tag{22}$$

Initial Flexible Price Steady State. In the initial steady state $\theta = 0$. Moreover, we assume $a_H = c^* = 0$. From (16) and (19), the natural level of output and terms of trade are simply $y^n = 0, s^n = 0$.

C.2 Consequences of a Household Debt Revaluation

As discussed in section 3.1, we assume that in the initial steady state the nominal exchange rate equals one, $\mathcal{E} = 1$. The household is long in domestic currency assets and borrows in foreign currency, so debt in terms of output satisfies $\bar{D}^* + \bar{D} = 0$, $\bar{D}^* > 0$.[58] The economy is in the natural

[58] 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.

allocation with $\theta = 0$ and balanced trade.

At time zero there is $\Delta e\%$ 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 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:

$$\dot{\pi}_{H,t} = \rho \pi_{H,t} - \kappa y_t + \lambda \rho \Delta e D^* \tag{23}$$

$$\dot{y}_t = i_t - \pi_{H,t} - \rho \tag{24}$$

$$y_0 = -\frac{1-\alpha}{\alpha} \rho \Delta e D^* + \Delta e. \tag{25}$$

Equation (23) is the standard New-Keynesian Phillips curve, adjusted for the wealth effect of the debt revaluation. Equation (24) 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 (25) 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.[59]

Analytical Solution. We can write the system in (23)-(24) 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:

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

[59] Empirically, the terms of trade moves significantly less than one for one with exchange rate shock (Boz et al. (2017)). 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.

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

$$\dot{z}_1 = \overline{\nu} z_1 + \frac{\lambda \rho \Delta e D^*}{\nu - \overline{\nu}} \tag{26}$$

$$\dot{z}_2 = \nu z_2 + \frac{\lambda \rho \Delta e D^*}{\overline{\nu} - \nu} \tag{27}$$

$$\tag{28}$$

The general solution is

$$z_{1t} = b_1 e^{\overline{\nu} t} - \frac{\lambda \rho \Delta e D^*}{\nu - \overline{\nu}} \frac{1}{\overline{\nu}} \tag{29}$$

$$z_{2t} = b_2 e^{\nu t} - \frac{\lambda \rho \Delta e D^*}{\overline{\nu} - \nu} \frac{1}{\nu}, \tag{30}$$

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

$$X_t = \begin{bmatrix} -\nu e^{\nu t} b_2 \\ b_2 e^{\nu t} - \frac{\lambda \rho \Delta e D^*}{\nu - \overline{\nu}} \left(\frac{1}{\overline{\nu}} - \frac{1}{\nu} \right) \end{bmatrix} \tag{31}$$

To obtain b_2, we use the initial condition (25)

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

The output response to the exchange rate shock is then of the form provided in the main text (1)

$$\begin{aligned} y_t &= \left(-\frac{1-\alpha}{\alpha} e^{\nu t} - (1 - e^{\nu t}) \frac{\lambda}{\nu - \overline{\nu}} \left(\frac{1}{\overline{\nu}} - \frac{1}{\nu} \right) \right) \rho \Delta e D^* + \Delta e \cdot e^{\nu t} \\ y_t &= \left(-\frac{1-\alpha}{\alpha} e^{\nu t} + (1 - e^{\nu t}) \frac{1}{1+\varphi} \right) \rho \Delta e D^* + \Delta e \cdot e^{\nu t} \\ y_t &= \beta_t \Delta e D^* + \gamma_t \Delta e \end{aligned} \tag{32}$$

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.