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Essays on Household Credit Markets and Business Cycles

Verner, Emil

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Essays on Household Credit Markets and Business Cycles

Emil Verner

A Dissertation
Presented to the Faculty
of Princeton University
in Candidacy for the Degree
of Doctor of Philosophy

Recommended for Acceptance
by the Department of
Economics
Adviser: Atif Mian

June 2018

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Abstract

What is the role of household credit markets in the business cycle? Do credit market conditions and household debt positions amplify fluctuations in employment and output, or are they passive reflections of the state of the real economy? Should public policy intervene in credit markets when household leverage grows rapidly, or are credit market outcomes efficient from a macroeconomic perspective? This collection of essays empirically investigates the interplay between household credit markets and the real economy.

Chapter 1, co-authored with Győző Gyöngyösi, examines the household *debt-deflation* channel of recessions. The chapter isolates the effect of a sudden increase in real household debt burdens by exploiting variation across individuals and regions in exposure to foreign currency debt during the Hungarian currency crisis of 2008. The sudden revaluation of household debt burdens caused by the exchange rate depreciation translates into an increase in default rates, a collapse in consumption, and a significantly worse local recession. The chapter presents evidence of negative spillover effects on local firms and households that did not borrow in foreign currency, consistent with negative financial externalities of debt financing.

Chapter 2, co-authored with Atif Mian and Amir Sufi, analyzes the consequences of household credit expansions using panel data for 30 mostly advanced economies over the past 40 years. Expansions in household credit are associated with a boom and subsequent reversal in output. The chapter argues that credit supply shocks play an important role in instigating increases in credit, while macroeconomic frictions translate debt-induced declines in spending into declines in output.

Chapter 3, co-authored with Atif Mian and Amir Sufi, investigates *how* credit supply expansions affect the real economy. The chapter develops a new methodology for distinguishing whether credit expansions operate by increasing production capacity or by boosting aggregate demand. The chapter then explores these channels in the

context of two natural experiments for credit supply expansion: banking deregulation in the United States during the 1980s and the introduction of the euro in the 2000s. Evidence from these episodes suggests that credit expansions tend to influence real activity primarily by raising aggregate demand.

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This dissertation would not have been possible without the invaluable guidance and support of my adviser, Atif Mian. He has taught me both how to seek out important economic questions and how to answer these questions rigorously using novel empirical approaches. I am grateful for his detailed feedback on innumerable drafts and presentations, as well as our countless engaging discussions, which have been instrumental in my development as an economist and as a person.

My dissertation connects with research in finance, macroeconomics, and international finance. I have therefore benefitted tremendously from interactions and advice from numerous Princeton faculty. Mark Aguiar inspired me to work in international finance and has served as a role model for how to connect theory and empirical evidence. Markus Brunnermeier, Nobu Kiyotaki, Wei Xiong and inspired me to study the connection between financial markets, banks, and business cycles. Amir Sufi, a collaborator on two chapters, taught me a tremendous amount about the role of credit in the economy. The dissertation employs methods from time series econometrics, which I learned in large part thanks to the patience of Chris Sims and Mark Watson. I am also indebted to Will Dobbie, Adrien Matray, and Motohiro Yogo, who provided detailed feedback that substantially sharpened the empirical analysis. Finally, Bo Honoré has provided unrivaled mentorship throughout my graduate studies, from encouraging me to pursue the Ph.D., to giving me extensive advice on how to navigate the profession and complete the dissertation.

One of the best things about graduate school is being surrounded by so many brilliant peers. In this regard, I have been extremely fortunate. In particular, I am grateful to Giulia Brancaccio, Shoumitro Chatterjee, Nik Engbom, Felipe Goncalves, Dan Herbst, Graham McKee, Dmitry Mukhin, Clara Santamaria, Molly Schnell, and Ben Young for making these six years enriching and, more importantly, way more fun than I ever expected.

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I am also grateful for all the help and support provided by the Economics department staff, especially to Laura Hedden, Jen Bello, and Nancy Turco. Their dedication and hard work have made life at Princeton easier and more pleasant in so many ways.

Finally, I could not have embarked on and completed this Ph.D. without the love and inspiration of my mom, dad, and Erik. They constantly encouraged me to think about real-world problems and provided role models of intellectual curiosity and grit. And, of course, I am so thankful to Michala. You are my rock. Without your love, humor, and intellectual sparring in just the perfect doses, who knows what would have become of this dissertation or, for that matter, of me.

To my mom, who showed me that nothing is impossible.

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Chapter 1

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

"I venture the opinion... that, in the great booms and depressions, each of the above-named factors [over-production, under-consumption, over-capacity, price-dislocation, over-confidence, over-investment, over-saving, over-spending...] *has played a subordinate role as compared with two dominant factors, namely over-indebtedness to start with and deflation following soon after."*

– Irving Fisher, (1933), "The Debt-Deflation Theory of Great Depressions"

1.1 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

*Versions of this chapter were previously presented at the Colorado Winter Finance Summit 2017 and seminars at various institutions.

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 2014b). 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 chapter, 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

[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.

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 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

[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).

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 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 chapter 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 ex-

plained 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 chapter 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 mon-

etary 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,

[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.

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 chapter 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 study is the first to analyze the effects of *household* foreign currency exposure, despite the prevalence of 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 study, therefore, brings empirical evidence to the classic Transfer Problem debate (Keynes 1929, Ohlin 1929).

Outline. The remainder of the chapter is structured as follows. Section 1.2 discusses the background of the foreign currency debt crisis in Hungary. Section 1.3 discusses the theoretical framework and empirical methodology. Section 1.4 describes the data. Sections 1.5 through 1.8 present the results, and Section 1.9 concludes.

[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.

1.2 The Hungarian Foreign Currency Debt Crisis

Hungary experienced a large expansion in household credit between 2000 and 2008. Figure 1.1(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]

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

[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.

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 1.1(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 1.2(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

[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).

survey from November 2008, Pellényi and Bilek (2009) find that 87% of respondents with an FC loan did 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 1.2(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 1.2(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 1.3 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

[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.

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 1.3(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]

1.3 Theory and Empirical Framework

1.3.1 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]

[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.

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

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:

$$y_t = \underbrace{\beta_t \Delta e D^*}_{\substack{\text{Debt} \\ \text{revaluation}}} + \underbrace{\gamma_t \Delta e}_{\substack{\text{Expenditure} \\ \text{switching}}}. \tag{1.1}$$

In appendix A.3 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 (1.1) 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 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.

[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.

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). A worse recession also depresses house prices, creating a two-way feedback between the demand and

[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.

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 (1.1) 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 (1.1) 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]

1.3.2 Empirical specification and identification

Equation (1.1) 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

[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).

different exposures to FC debt, $D^{*,H} > D^{*,L}$, isolates the debt revaluation channel:

$$y_t^H - y_t^L = \beta_t \Delta e \left(D^{*,H} - D^{*,L} \right). \tag{1.2}$$

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

Our empirical specification is motivated by equation (1.2). 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:

$$\Delta_{08-10} y_z = \alpha + \beta \cdot (\text{FC Debt Revaluation})_{z08} + X'_{z08}\Gamma + \epsilon_z, \tag{1.3}$$

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 1.3.2, 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_{z08}^{FC}. We therefore cast our discussion of identification in terms of the FC debt share.

We estimate (1.3) 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

[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

by settlement population in 2007, but we report robustness checks for alternative weighting schemes.

Equation (1.3) provides a consistent estimate β under the identifying assumption of parallel trends: the change in the outcome y_{zt} in a low s_{z08}^{FC} settlement is a valid counterfactual for high s_{z08}^{FC} areas, had those regions not been exposed to the depreciation through household FC debt, $\mathrm{E}[\epsilon_z \cdot s_{z08}^{FC} | X_{z08}] = 0$. 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_{z08}^{FC} could be either positive or 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

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.

[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

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 1.2 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 1.2 shows that the FC debt share is uncorrelated with export exposure, consistent with the 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

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 1.2.

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

$$y_{zt} = \alpha_z + \gamma_t + \sum_{y \neq 2008} \beta_y (s_{z08}^{FC} \cdot \mathbf{1}_{y=t}) + \epsilon_{st}, \tag{1.4}$$

[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.

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

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:

$$\Delta d_t = \sum_{j \in C} \Delta e_t^j s_{t-1}^j + \eta_t. \tag{1.5}$$

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 (1.5) 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 1.2 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% of FC debt was denominated in Swiss franc. A settlement's share of debt in FC as of 2008:9, s_{z08}^{FC}, captures most of the variation in exposure to the depreciation, so we use s_{z08}^{FC} 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:

$$\Delta\tilde{d}_{z,08-t} = \frac{\sum_{j\in C}\left(\mathcal{E}_{t+h}^{j} D_{z08}^{j} - \mathcal{E}_{08}^{j} D_{z08}^{j}\right)}{D_{z08}}, \tag{1.6}$$

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

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

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

Equation (1.5) approximates percent changes with log changes.

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

$$\Delta \tilde{d}^{Inc}_{z,08-t} = \frac{\sum_{j \in C} \left(\mathcal{E}^{j}_{t+h} D^{j}_{z08} - \mathcal{E}^{j}_{08} D^{j}_{z08} \right)}{\left(\text{Household disp. income} \right)_{z08}}. \tag{1.7}$$

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).

1.4 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 A.2 provides further details on the data sources and variable definitions.

1.4.1 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 A.2.

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

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

rates. The program retired 21% of outstanding foreign currency debt.[27] Accounting for the 2011 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 A.2 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 A.2 shows that all the main results in this chapter 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.

1.4.2 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.

[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.

[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).

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 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.

[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.

1.4.3 Summary statistics and variation in household foreign currency exposure

Panels A and B of Table 1.1 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 1.4(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 1.4(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 1.1 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.

1.5 Household Responses to Debt Revaluation

1.5.1 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 1.3 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 1.3.2.

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 1.4 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 1.7.3 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 1.5 presents the effect of FC debt exposure on the default rate over time. It plots the estimates of $\{\beta_y\}$ from estimating equation (1.4) for the settlement default rate on housing loans at a quarterly frequency. The omitted period is 2008Q1, the

[30] As can be inferred from Table 1.3, results are almost identical if we instead instrument the increase in household debt with the FC debt share.

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.

1.5.2 Durable spending and non-durable consumption

In Figure 1.3 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 1.5 we ask whether this dramatic decline in spending is related to the household debt revaluation across local areas.

Table 1.5A 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 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 1.6 panel (a) illustrates how FC debt exposure affects new auto registrations over time by plotting estimates of $\{\beta_y\}$ from equation (1.4). In the years leading up

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

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 1.5 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 1.6(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.

1.6 Impact of Debt Revaluation on Real Activity

1.6.1 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 1.6 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 1.6 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 1.7 presents the full dynamic impact of FC debt exposure on unemployment from estimating equation (1.4). 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 1.3). 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.

1.6.2 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 1.7 panel A displays estimates of the effect of household FC debt exposure on firm-level employment growth:

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

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 1.7 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}.

Table 1.7 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.

[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.

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 1.7 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.

1.6.3 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 1.6 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 implies a 1.44 percentage point increase in unemployment relative to the counterfactual where all debt is denominated in local currency, which accounts for

[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.

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.

1.6.4 Robustness

Measurement of the Shock. Table 1.8 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 (1.7). 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.

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

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 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 3.2. 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 1.8 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.

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

[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).

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 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

$$V_z = \frac{\sum_{t=2001}^{2008} \sum_b ms_{z,b,t-1} \hat{\gamma}^{FC}_{b,t}}{\sum_{j \in \{LC,FC\}} \sum_{t=2001}^{2008} \sum_b ms_{z,b,t-1} \hat{\gamma}^{j}_{b,t}}, \tag{1.8}$$

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]

Missing Data. In Appendix A.2 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

[39] We should emphasize, however, that (1.8) 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.

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 A.2.3 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 1.8 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 1.3 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 1.8 depicts estimates of our unemployment specification (1.4) 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.

1.7 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.

1.7.1 Labor market adjustment: Wages and migration

Table 1.9 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).

[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.

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).

1.7.2 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 1.10 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 1.9 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 1.9 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 1.10 indicates that debt revaluation depresses local house prices, potentially through the rise in default rates and the resulting fire sales of fore-

closed 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.

1.7.3 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 1.4 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 house-

holds 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 1.11 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

$$\Delta_{08-10}\text{Default}_{i,b,z} = \beta_0 + \beta_1 FC_i + \beta_2 s^{FC}_{z,-b,08} + X^L_i \Gamma^L + X^B_b \Gamma^B + X^S_z \Gamma^S + \epsilon_{iz}, \quad (1.9)$$

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 1.11 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]

1.8 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.

1.8.1 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 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.

[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.

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 1.2 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 1.2, 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

[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.

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, 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 1.12 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 1.12 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),

[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.

[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.

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]

1.8.2 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 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 1.7 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.

[46]Table A.11 in the appendix confirms that results in Table 1.12 are similar using the FC debt to assets ratio. Moreover, sorting firms by the FC debt-to-assets ratio yields a stronger interaction effect.

Table 1.13 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 1.13 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]

1.9 Conclusion

In this chapter, 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

[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, $\bar{\hat{\alpha}}_z$. The correlation of this average bank fixed effect 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 1.13.

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 is particularly strong when households have foreign currency debt.

Table 1.1: 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 1.2: 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 1.3: 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 1.4: 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 (1.6) 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 1.5: 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 1.6: 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 (1.6) 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 1.7: 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	0.0000005	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	0.00003	0.023	0.000058	0.027	0.00009	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 1.8: 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 1.9: 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 1.10: 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 1.11: 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 1.12: 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 1.13: Controlling for Bank Credit Supply Shocks

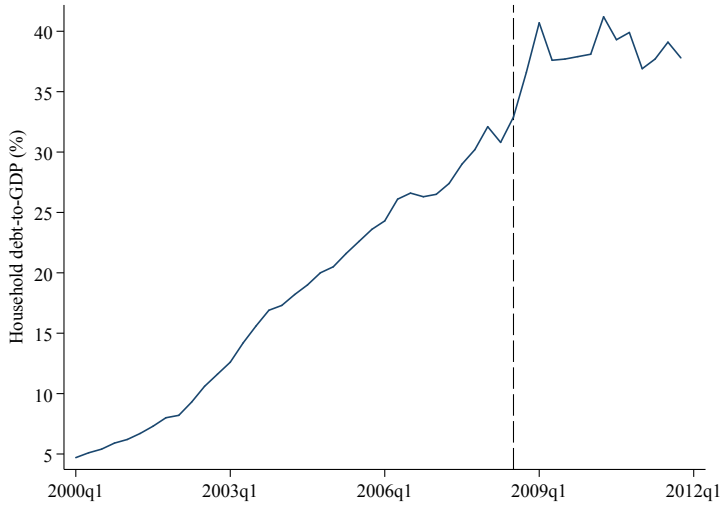
	Firm Employment Growth, 2008-10			
	(1)	(2)	(3)	(4)
HH FC debt share, s_{z08}^{FC}	-9.35*	-7.24^{+}	-14.3**	-12.6**
	(4.13)	(3.83)	(3.84)	(3.75)
Bank FE		Yes		Yes
Firm-level controls			Yes	Yes
Settlement controls			Yes	Yes
2-Digit Industry FE			Yes	Yes
R^2	0.00016	0.0040	0.066	0.069
N Firms	80447	80447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

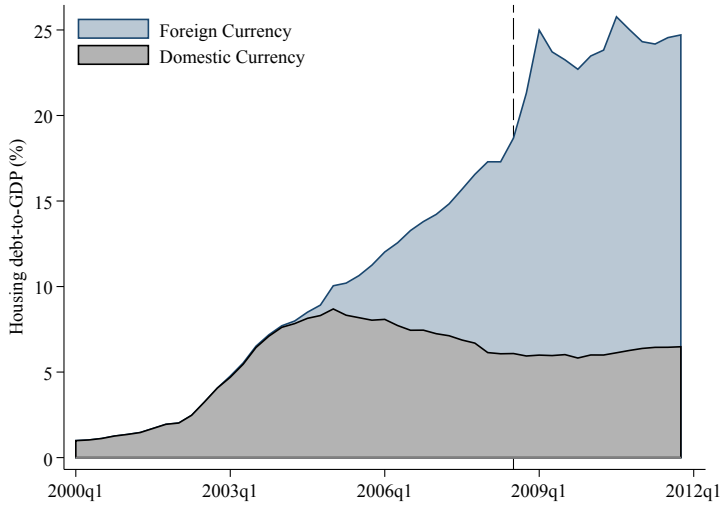
$$g_{08-10,ib}^{E} = \alpha_{bank} + \beta s_{z08}^{FC} + X_{i08}\Gamma^{i} + X_{z08}\Gamma^{z} + \epsilon_{ib},$$

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 1.1: Household Credit Expansion in Domestic and Foreign Currency



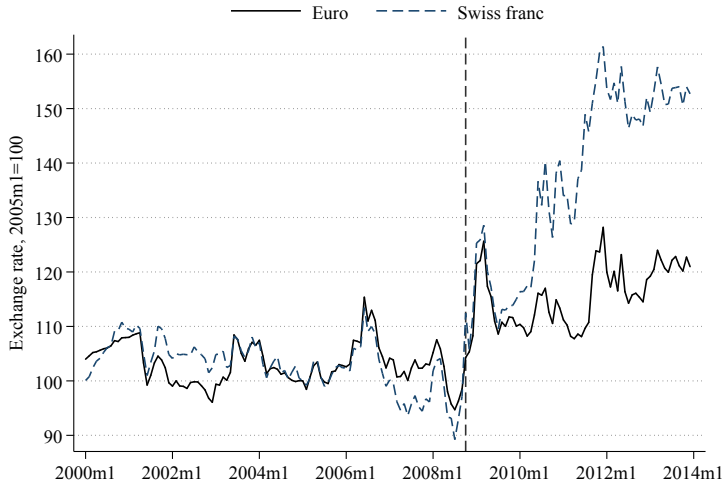
(a) Household debt-to-GDP ratio (%)



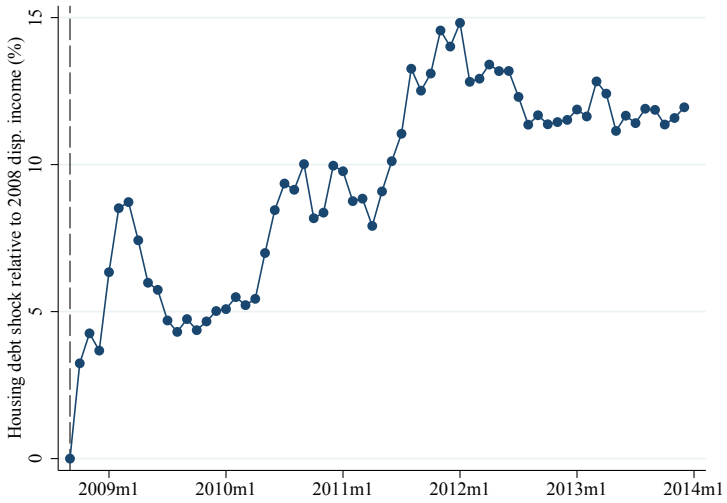
(b) Housing debt in domestic and foreign currency

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 1.2: Household Debt Revaluation Shock Induced by the Forint Depreciation



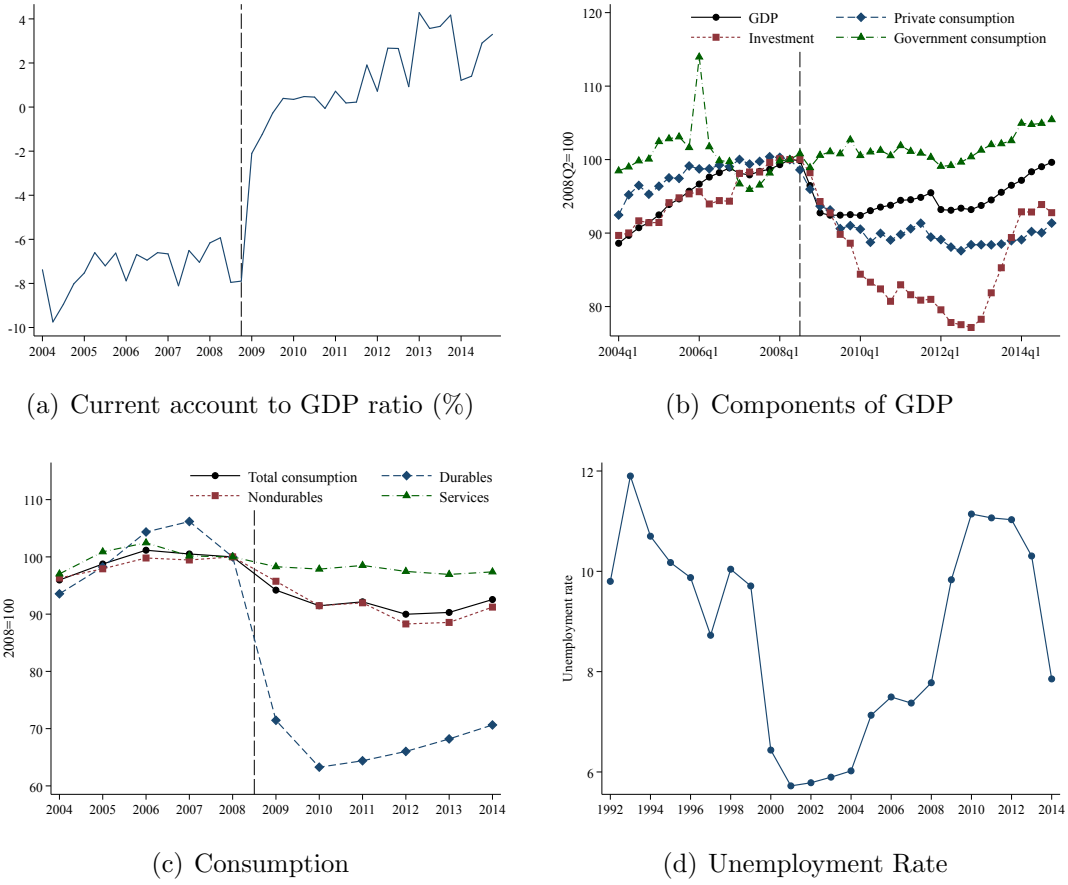
(a) Nominal exchange rate relative to euro and Swiss franc



(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 1.3: Macroeconomic Background



(a) Current account to GDP ratio (%)

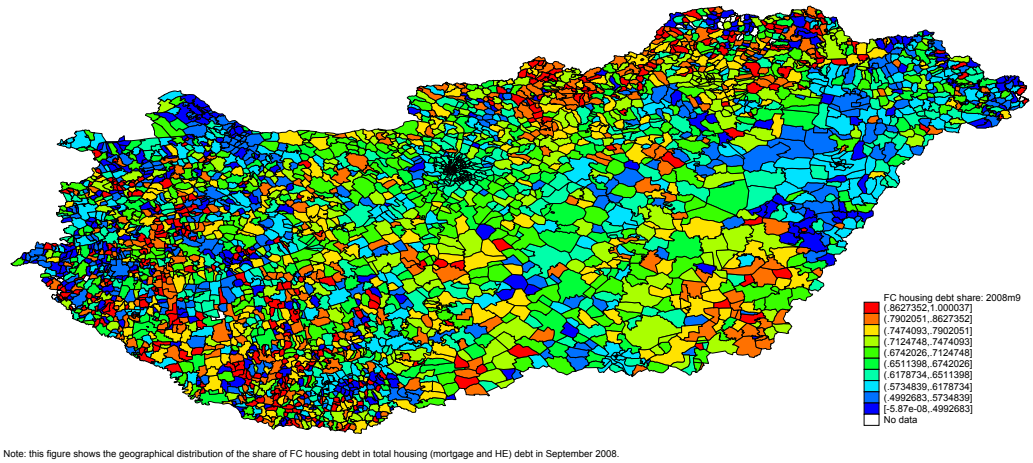
(b) Components of GDP

(c) Consumption

(d) Unemployment Rate

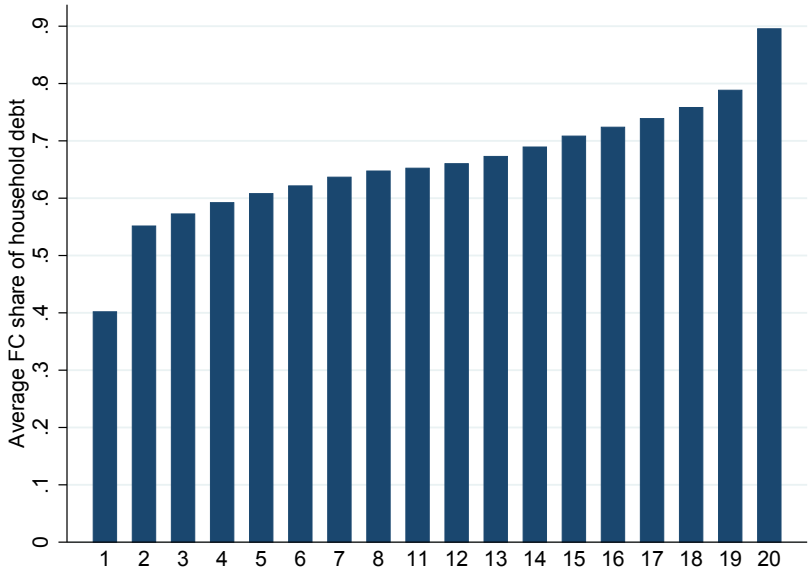
Notes: This figure presents the evolution of key macroeconomic aggregates up to and after the forint depreciation, which started in October 2008.

Figure 1.4: 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.

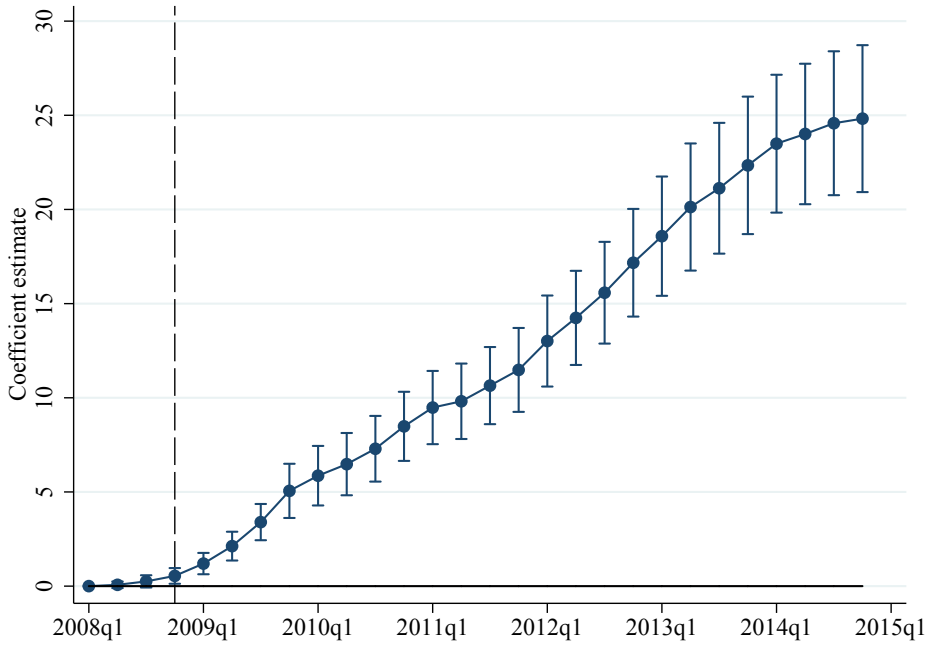
(a) Geographic Distribution of Household FC Debt Exposure



(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 1.5: Household Foreign Currency Debt Exposure and Local Default Rates

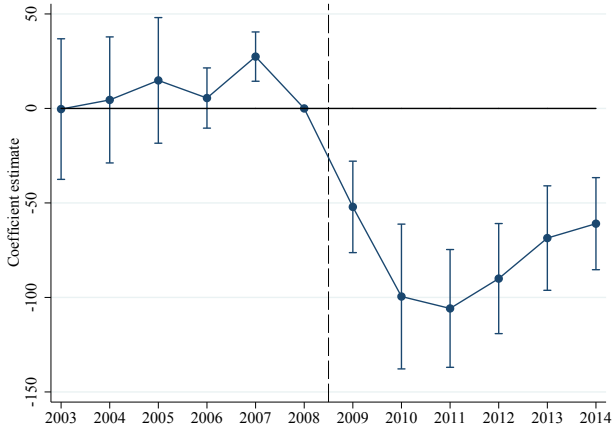


Notes: This figure presents estimates of $\{\beta_q\}$ from

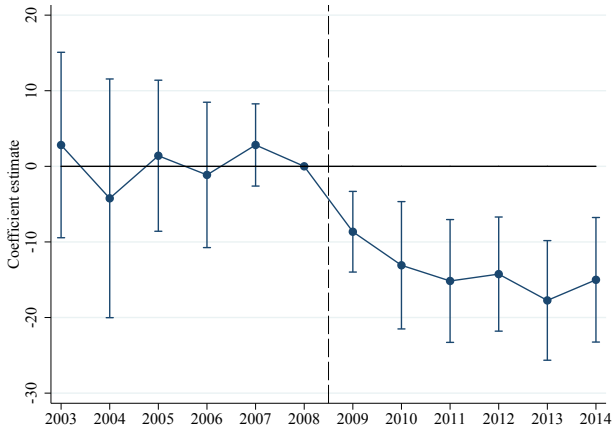
$$\text{Default}_{zt} = \alpha_z + \gamma_t + \sum_{q \neq 2008Q1} \beta_q (s_{z08}^{FC} \cdot \mathbf{1}_{q=t}) + \epsilon_{zt}.$$

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 1.6: Foreign Currency Debt Exposure and Household Spending



(a) Durable spending (new auto registrations)



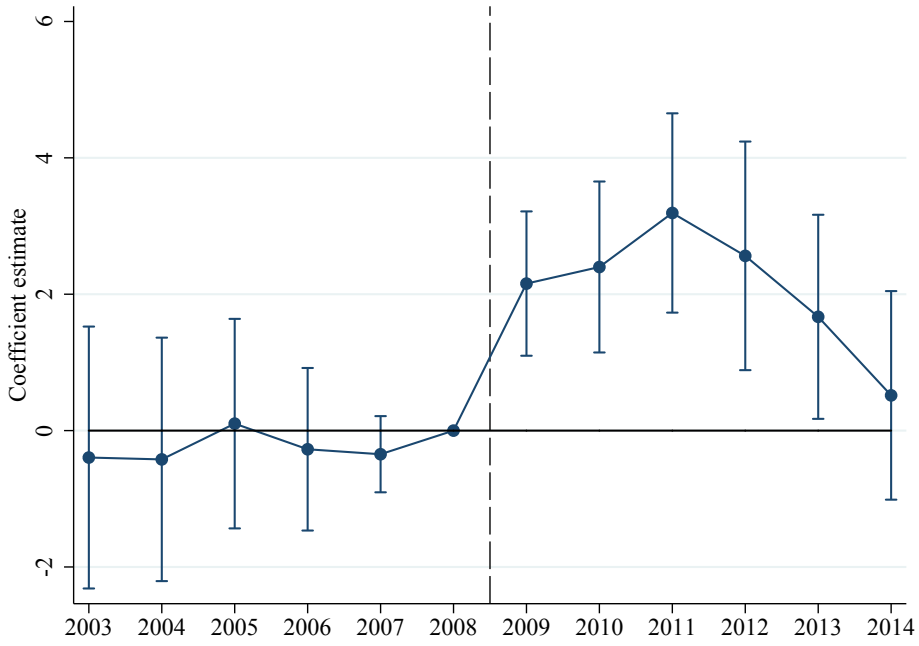
(b) Non-durable consumption (electricity usage)

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 1.7: Foreign Currency Debt Exposure and Unemployment



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

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

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 1.8: Placebo Test: 1998 Russian Financial Crisis

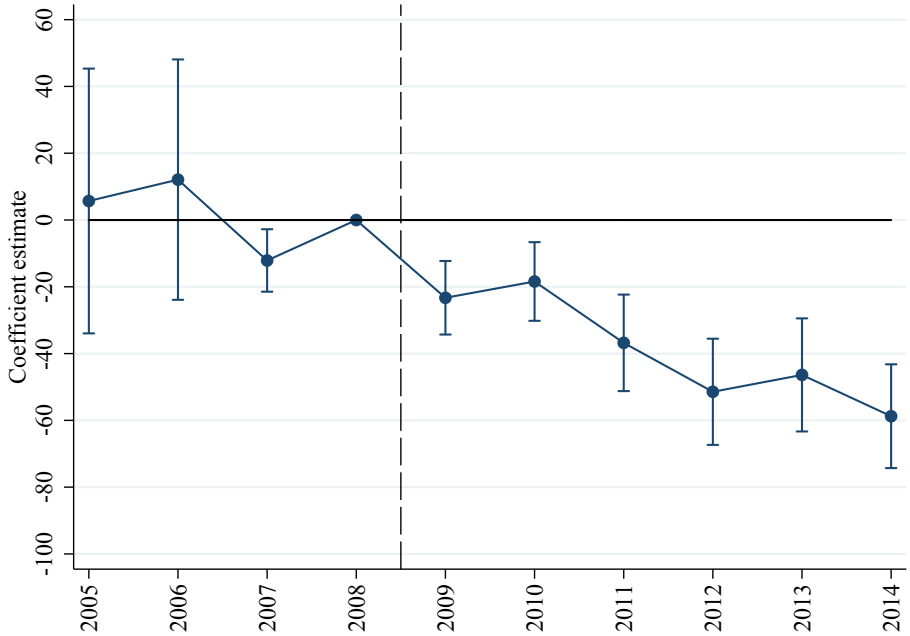


Notes: This figure uses the second half of the 1990s as a placebo sample. Figure 1.3 shows that unemployment in Hungary rose around the 1998 Russian Financial Crisis, and then subsequently recovered. This figure presents estimates of the following specification for the period 1995-2001, where 1997 is 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 1.9: 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 1.10 column 3 interacted with year dummies, as Table 1.10 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.

Chapter 2

Household Debt and Business Cycles Worldwide

2.1 Introduction

The Great Recession has sparked new questions about the relation between household debt and the macroeconomy. The increase in household debt during the years leading up to the Great Recession predicts the severity of the downturn across U.S. counties (Mian and Sufi (2014a)) and across advanced economies (IMF (2012), Glick and Lansing (2010)). A recent body of theoretical research explores the links between behavioral biases, household debt, house prices, macroeconomic frictions, and fluctuations in output. Much of this research emphasizes the importance of shifts in credit supply and behavioral biases by lenders such as underestimation of default risk.[1]

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[1]We discuss the theoretical research in detail in Section 2.4.

In this study, we begin by showing a systematic empirical relation between household debt and business cycles across 30 mostly advanced countries in an unbalanced panel from 1960 to 2012. Results from a vector auto regression (VAR) show that a shock to the household debt to GDP ratio in a country leads to a three to four year rise household debt, which then subsequently reverts. During the household debt boom, the consumption to GDP ratio increases, imports of consumption goods rise, and GDP experiences a boost. However, the boost is temporary, and GDP subsequently falls. As a result, the rise in the household debt to GDP ratio over a three to four year period in a given country predicts a decline in subsequent economic growth.[2]

This predictability is large in magnitude. A one standard deviation increase in the household debt to GDP ratio over the last 3 years (6.2 percentage points) is associated with a 2.1 percentage point decline in GDP over the next three years. This predictive relation is robust across time and space. Exclusion of the post-2006 Great Recession period leads an effect that is 30% smaller, but it remains statistically significant at the one percent level. A rise in non-financial firm debt is associated with a smaller and more immediate negative effect on GDP, but firm debt dynamics do not generate the boom-bust growth cycle associated with household debt. Over the medium-run horizon we examine, a rise in non-financial firm debt has only weak predictive power on subsequent GDP growth once household debt is taken into account.

After documenting this empirical relation, we focus in the rest of the study on the underlying economic model that is most consistent with the facts. We group theories explaining the rise in household debt into two broad categories: models based on credit demand shocks and models based on credit supply shocks. Within both categories, we consider both rational expectations and behavioral models of credit expansion,

[2]We follow standard time-series econometrics terminology and use the term "predict" to refer to the predicted value of an outcome using the entire sample used to estimate the regression. This is in contrast to the term "forecast" that refers to the estimated value of the outcome variable for an observation that is not in the sample used to estimate the regression coefficients. See Stock and Watson (2011), chapter 14.

and we also focus on the role that macroeconomic frictions play in exacerbating the economic downturn that follows the rise in debt. We conclude that the empirical evidence is more supportive of models in which a positive credit supply shock driven in part by flawed expectations of lenders explains the rise in debt during the boom. Further, macroeconomic frictions play an important role in explaining the severity of the bust after a rise in household debt.

Models based on credit demand shocks alone are difficult to reconcile with our findings. In rational expectations-based credit-demand shock models, the underlying shock is an increase in future productivity or permanent income against which households today desire to borrow. Such models yield a *positive* correlation between contemporaneous changes in debt and subsequent economic growth: households borrow because they expect things are getting better. As already mentioned, we find a *negative* correlation between the rise in household debt and subsequent GDP growth.

Further, our results are inconsistent with behavioral models of credit demand shocks that focus exclusively on a change in borrower beliefs. In these models, a sudden rise in optimism by borrowers while credit supply remains fixed should lead to higher interest rate spreads during the boom. We construct a new cross-country panel series on mortgage credit spreads to test this prediction. We find the opposite: increases in household debt are associated with *low* interest rate environments.

The fact that low interest spreads are associated with increases in household debt supports credit supply shock-based models of the rise in debt. We also find that a measure of credit supply shocks based on the quantity of credit originated to low credit quality firms in the United States from Greenwood and Hanson (2013) is positively correlated with household debt booms. We use low interest spreads and the Greenwood and Hanson (2013) variable as instruments for a credit-supply induced rise in household debt, and we show that such rises in household debt predict lower subsequent growth.

Credit supply shocks lead to a rise in household debt which predicts subsequently lower growth. But what is the fundamental source of the increase in credit supply? Models of credit market sentiment suggest that lenders begin to ignore downside risks during debt booms, which makes them willing to make credit more available on cheaper terms (e.g., Gennaioli et al. (2012), Greenwood et al. (2016), Landvoigt (2016)). While we do not have direct evidence on lender beliefs, we show that economic forecasters at the IMF and OECD systematically over-forecast GDP growth at the end of household debt booms. As a result, the rise in household debt over the last three years, which is known by forecasters at the time forecasts are made, predicts growth forecasting errors. These findings are consistent with a growing body of research showing that the negative consequences of aggressive lending by the financial sector are not understood by market participants (e.g., Baron and Xiong (2017) and Fahlenbrach et al. (2016)).

Our results also suggest that when the credit boom stalls, frictions such as nominal rigidities and monetary policy constraints exacerbate the decline in subsequent growth (Eggertsson and Krugman (2012), Guerrieri and Lorenzoni (2015), Farhi and Werning (2016), Korinek and Simsek (2016), Schmitt-Grohé and Uribe (2016), and Martin and Philippon (2014)). For example, the negative relation between the change in household debt and subsequent GDP growth is stronger under more rigid exchange rate regimes such as fixed compared to floating regimes. Similarly, an increase in the household debt to GDP ratio predicts an increase in the future unemployment rate, showing evidence of under-utilization of resources. Also, the relation between household debt changes and subsequent GDP is non-linear in a manner consistent with downward rigidity in wages and interest rates: a rise in household debt leads to lower subsequent growth, but a decline in household debt does not lead to higher subsequent growth.

Finally, we explore the global dimension of the household debt cycle by first showing that a rise in household debt to GDP leads to a subsequent reduction in the trade deficit as imports decline. The resulting increase in net exports partially offsets the large negative effect of the household debt boom on consumption and investment, and it points to the importance of external spillovers to other countries. We find that countries with a household debt to GDP cycle that is more correlated with the global debt cycle see a stronger decline in future output growth after a rise in household debt. This is driven by the inability of countries to boost net exports when many countries are suffering from a household debt hangover at the same time. Trade linkages lead to a global debt cycle: there is a stronger negative relation between the rise in global household debt to GDP and subsequent global growth. Our global regression model suggests that the severity of the Great Recession should not have been surprising given the large increase in global household debt that preceded it.

This chapter follows the recent influential work by Jordà et al. (2014a), Schularick and Taylor (2012), Jordà et al. (2013), and Jordà et al. (2014b) on the role of private debt in the macroeconomy. The authors put together long-run historical data for advanced economies to show that credit growth, especially mortgage credit growth, predicts financial crises (also see Dell'Ariccia et al. (2012)). Moreover, conditional on having a recession, stronger credit growth predicts deeper recessions.[3]

Our analysis provides a number of results that are new to the literature and help guide the nascent theoretical literature on private credit and business cycles. For example, our results on the predictability of labor market slackness and predictability of GDP forecast errors help rule out spurious factors that could produce a relation between changes in household debt and subsequent GDP growth. Our results on fore-

[3]Cecchetti and Kharroubi (2015) find that the growth in the financial sector is correlated with lower productivity growth, and Cecchetti et al. (2011) estimate country-level panel regressions relating economic growth from t to $t+5$ to the *level* of government, firm, and household debt in year t. They do not find strong evidence that the *level* of private debt predicts growth. Reinhart and Rogoff (2009) provides an excellent overview of the patterns of financial crises throughout history.

cast errors also support the recent literature emphasizing the importance of errors in expectations by lenders in explaining credit booms. Our findings regarding the consumption boom, heterogeneity with respect to monetary regimes, and the importance of low spreads in predicting household debt growth are important for understanding the mechanisms that generate the negative relation between household debt changes and subsequent GDP growth. Finally, our results on the external margin spillovers highlight the importance of the "global household debt cycle," which was also an important precursor to the most recent global recession. We believe all of these results are novel to the literature.

While the existing literature in macro-finance has made important contributions in understanding the "investment" channel for business cycle dynamics (see e.g., Bernanke and Gertler (1989), Kiyotaki and Moore (1997), Caballero and Krishnamurthy (2003), Brunnermeier and Sannikov (2014) and Lorenzoni (2008)), our results highlight the importance of a debt-driven "consumption" channel for business cycle dynamics. We hope our results will help guide the burgeoning theoretical literature in this area.

The remainder of the chapter is structured as follows. The next section presents the data and summary statistics. Section 2.3 presents the initial facts. Section 2.4 discusses the underlying theories, and Sections 2.5 through 2.8 report empirical findings designed to test which theories best fit the data. Section 2.9 presents evidence on the global household debt cycle, and Section 2.10 concludes.

2.2 Data and Summary Statistics

2.2.1 Data

We build a country-level unbalanced panel dataset that includes information on household and non-financial firm debt to GDP, national accounts, unemployment, profes-

sional GDP forecasts, credit spreads, and international trade. The countries in the sample and the years covered are summarized in Table B.1.1 of the appendix. The data are annual and range from 1960 to 2012, providing over 900 country-years and an average time series dimension of 30 years before taking differences.[4] Details on variable definitions and data sources are provided in the data appendix. Here we describe the key variables measuring household and non-financial firm debt.

We measure the level of household and non-financial firm debt as the household debt to GDP ratio and non-financial firm debt to GDP ratio, and we refer to these as $d_{it}^{HH} = \frac{D_{it}^{HH}}{Y_{it}}$ and $d_{it}^{F} = \frac{D_{it}^{F}}{Y_{it}}$, respectively. Likewise, we measure the change in household and firm debt from year $t-k$ to year t as $\Delta_k d_{it}^{HH}$ and $\Delta_k d_{it}^{F}$. The household and non-financial firm debt measures, D^{HH} and D^{F}, are defined as the outstanding levels of credit to households and non-financial corporations from the Bank for International Settlement's (BIS) "Long series on total credit to the non-financial sectors" database.[5] The BIS credit data is intended to capture *total* credit to households and firms in the economy, including credit financed by domestic and foreign banks as well as non-bank financial institutions. Credit is defined as loans and debt securities (bonds and short-term paper). This definition of debt is thus broader than measures based on bank lending used in recent work by Schularick and Taylor (2012) and Jordà et al. (2014a), but only allows us to work with shorter time series for many countries. Outstanding credit is measured at the end of the fourth quarter in a given year.[6]

The BIS credit series are drawn from individual country sectoral financial accounts (flow of funds) and are fairly comparable across countries (see Dembiermont et al.

[4] After differencing and relating the changing in debt between $t-4$ to $t-1$ to growth from t to $t+3$, as we outline below, the average size of the time dimension is 23 years.

[5] The series on credit to households and non-financial firms are available for 34 countries. We exclude China, India, and South Africa, as the decomposed credit series only start in 2006 for China and South Africa and 2007 for India. We also exclude Luxembourg, as the data on non-financial firm credit for Luxembourg is highly volatile, with changes of similar magnitude as annual GDP in some years.

[6] The BIS database provides credit aggregates at a quarterly frequency. In some cases the quarterly values are interpolated based on annual financial accounts.

(2013)). In some cases where financial accounts are not available, total credit is proxied with domestic bank credit and cross-border bank credit, which generally does not capture off-balance-sheet securitized lending or lending by non-bank financial institutions.[7] Changes in the underlying data source, measurement, or coverage induce breaks in the series, so we use the break-adjusted series provided by the BIS. Since the breakdown of credit by borrowing sector is usually only available from financial accounts, the majority of our sample is based on consistent information from financial accounts.

2.2.2 Summary statistics

Table 2.1 displays summary statistics for the change in total private, household, and non-financial firm debt to GDP, as well as the other variables.[8] Our empirical analysis uses both the level of debt to GDP in panel VARs and changes over three years in a single equation estimation framework. Table 2.1 shows that total private sector debt to GDP, $d_{it}^{Private}$, which is the sum of household and non-financial firm debt, has been increasing by 3.11 percentage points per year on average, with household debt to GDP increasing slightly more quickly than non-financial firm debt. The change in non-financial firm debt is about two times as volatile as household debt, and both series are reasonably persistent. Other patterns documented in Table 2.1 are consistent with the small open economy business cycle literature. Total consumption expenditure is approximately as volatile as output, while durable consumption and investment are about 2.8 and 3.6 times as volatile as output, respectively. Imports and exports are roughly four times more volatile than output.

[7] This issue is more common in earlier years and especially for the longer series on total credit to the non-financial private sector, since the sectoral breakdown is usually only provided by the financial accounts (see Dembiermont et al. (2013) for details on the construction of the BIS database).

[8] With the exception of the serial correlation, all statistics are computed by pooling observations from all countries. The serial correlation is a weighted average of the serial correlations for each country, with the underlying number of observations for each country as weights.

2.3 Household Debt, Firm Debt, and Economic Growth

We begin by documenting several facts about the relation between household debt, firm debt, and economic growth. We focus initially on the full dynamic relation between debt and growth, and then we move to single-equation specifications.

2.3.1 Full dynamic relation

The full dynamic relation between debt and GDP growth is most easily seen in a recursive VAR specification with impulse responses from a Cholesky identification scheme. We want to be clear from the outset that the VAR analysis is not meant to identify causal patterns. It is only meant to describe the dynamic relation between the three variables of interest.

More specifically, we estimate a VAR in the level of household debt to GDP, non-financial firm debt to GDP, and log real GDP, $\mathbf{Y}_{it} = (y_{it}, d_{it}^{F}, d_{it}^{HH})$. We normalize the debt variables by one-year-lagged GDP to avoid capturing innovations to GDP in the debt equations.[9] It is important to normalize debt so that d_{it}^{HH} and d_{it}^{F} refer to debt normalized by the size of the economy. In theory, it is the growth of debt relative to the size of the economy that matters. The danger in not normalizing debt is that episodes of large real debt growth from a small base can appear large without being economically meaningful.

The VAR in levels with country fixed effects is given by

$$\mathbf{A}\mathbf{Y}_{it} = \mathbf{a}_i + \sum_{j=1}^{p} \alpha_j \mathbf{Y}_{it-j} + \epsilon_{it},$$

[9]The results are qualitatively and quantitatively similar if we normalize by same-period GDP.

where $\mathbf{a}_i$ is a vector of country fixed effects and ϵ_{it} is an $n \times 1$ vector of structural shocks with $\mathrm{E}[\epsilon_{it}\epsilon_{it}'] = I, \mathrm{E}[\epsilon_t\epsilon_s'] = 0$ for $s \neq t$, and I is the identity matrix. We set $p = 5$ based on the Akaike Information Criterion. The reduced form representation can then be written as

$$\mathbf{Y}_{it} = \mathbf{c}_i + \sum_{j=1}^{p} \delta_j \mathbf{Y}_{it-j} + \mathbf{u}_{it}, \tag{2.1}$$

where we define $\mathbf{S} = \mathbf{A}^{-1}$, $\mathbf{c}_i = \mathbf{S}\mathbf{a}_i$, $\delta_j = \mathbf{S}\alpha_j$, and $\mathbf{u}_{it} = \mathbf{S}\epsilon_{it}$ is the vector of reduced form shocks with covariance matrix $\mathrm{E}[\mathbf{u}_{it}\mathbf{u}_{it}'] = \mathbf{S}\mathbf{S}' = \Sigma$. The matrix $\mathbf{S}$ maps the structural shocks into the reduced form residuals. We identify the structural shocks through Cholesky decomposition, with real log GDP ordered first, followed by non-financial debt to lagged GDP, and household debt to lagged GDP, but the shape of the impulse responses is not sensitive to the ordering in this context.

We estimate the reduced form VAR on the full sample and employ an iterative bootstrap procedure to correct for potential Nickell bias from the inclusion of country fixed effects $\mathbf{a}_i$. The bias-corrected reduced form VAR estimates are only slightly different from the OLS estimates, and none of the results we present are sensitive to this procedure.[10] Dashed lines around the impulse responses are 95% confidence intervals computed by resampling cross-sections of the residuals using the wild bootstrap. The 95% confidence intervals thus account for contemporaneous cross-country correlation in the residuals.

We show three impulse responses from the VAR in Figure 2.1.[11] The left panel of Figure 2.1 shows the response of household debt to a shock to itself. This gives us a sense of the length of a "credit boom" in the data. After a shock to itself, household debt continues expanding for three years until peaking, and then it reverts. The

[10] We do not expect the bias to be severe, as the average sample length in the VAR is 25 years. Figure B.1.1 in the appendix compares the IRF for the original and bias-corrected VAR, showing that the bias is small in this context.

[11] All nine impulse response functions are shown in appendix Figure B.1.2.

reversion is substantial, with household debt returning to its initial level by 5 years after the peak of the boom. Given that household debt increases for three to four years after a shock, the single equation analysis we employ below focuses on the rise in household debt over a three year period.[12]

The middle panel shows the response of real GDP to a positive shock to household debt. An increase in household debt initially *increases* GDP. But the boost to GDP proves to be short-lived, as GDP eventually declines just as household debt begins to decline. Five years after the original shock, GDP has returned to the same level where it began.[13] We refer to the effect of the household debt shock on subsequent GDP from $t = 3$ to $t = 6$ as the medium-run effect of a rise in household debt on growth and label this as effect A in Figure 2.1.

From six years to ten years after the original household debt shock, the decline in GDP is large enough that it brings real GDP to a level lower than its starting point, as indicated by the letter B in Figure 2.1. This long-run lower level of GDP is an interesting result from the VAR, but it is not the focus of our study. For both theoretical and statistical reasons, we focus on the medium-run impact of household debt on GDP (effect A) instead of the longer run impact (effect B). From a theoretical perspective, the most relevant models we discuss in Section 2.4 are about the effect of credit shocks on business cycle fluctuations, not long run growth.[14] From a statistical perspective, it is difficult to precisely measure the long-run impact of a credit shock on GDP. The standard errors of estimates of the GDP response to the initial shock increase with the horizon following the shock.

[12]Many other researchers have used a three to four year horizon of private credit changes to examine the effect of credit expansion on outcomes, e.g., Mian and Sufi (2014a), King (1994), Baron and Xiong (2017), Jordà et al. (2014a). We believe we are the first to justify this horizon in a VAR setting.

[13]The IRF has the same general shape when the VAR is estimated in first differences (Figure B.1.3 in the appendix). One notable difference is that the medium-term response of log output to a household debt shock is more negative for the VAR in differences.

[14]Research by Charles et al. (2015), Borio et al. (2016), and Gopinath et al. (2015) suggests that debt booms may distort human capital accumulation and resource allocation in such a manner that reduces even longer run output, but this is not the focus of our study.

The right panel shows the impulse response of GDP to a positive shock to non-financial firm debt. Firm debt leads to an immediate negative effect on GDP as opposed to household debt which initially boosts GDP. The negative effect of a rise in firm debt on GDP is realized more quickly compared to the effect of household debt, and the effect of a rise in firm debt reverts after five years. As we will show below, firm and household debt shocks have statistically distinct effects on GDP growth in the short and medium run.

In Table 2.2, we utilize an alternative regression framework to illustrate the full dynamic relation between GDP growth and changes in household and firm debt. Let y_{it} be log real GDP, α_i be country fixed effects, Δ_3 refer to the change over three years, and d_{it}^{HH} and d_{it}^{F} be household and firm debt to GDP ratios, respectively. Table 2.2 reports estimates of the following regression:

$$\Delta_3 y_{it+k} = \alpha_i + \beta_{HH}\Delta_3 d_{it-1}^{HH} + \beta_F \Delta_3 d_{it-1}^{F} + u_{it+k}$$

for $k = -1, 0, ..., 5$. In other words, we fix the right hand side variable to be the change in household debt from four years ago to last year, and we vary three-year output growth on the left hand side from being contemporaneous to further into the future. For example, with $k = 4$, β_{HH} would be the effect of a rise in the household debt to GDP ratio from four years ago to last year on growth from next year to four years into the future.

As column 1 of Table 2.2 shows, the rise in household debt over a three year period is contemporaneously positively correlated with growth. However, as we examine output growth further into the future, the correlation goes from being positive to negative. In contrast, the rise in firm debt is negatively correlated with GDP growth in the short-run, but as we extend the horizon for examining output growth, firm debt loses predictive power. A test for equality of β_F and β_{HH} shows that the boom

and bust pattern is unique to household debt. Relative to a rise in firm debt, a rise in household debt has a statistically distinct effect, boosting short term growth (column 1) and reducing medium run growth (columns 5 through 7).[15]

2.3.2 Robustness using Jordá local projections

How robust is the dynamic relation shown in Figure 2.1 and Table 2.2? To answer this question we estimate impulse responses using Jordà (2005) local projections. Relative to a VAR, impulse responses from local projections are well suited for assessing robustness of the dynamic relation, as they have been found to be more robust to misspecification, easily allow for the inclusion of control variables, and allow for inference directly on the estimated impulse responses. The local projection impulse responses to household and firm debt shocks are given by the sequence of coefficients $\{\hat{\beta}^h_{HH,1}, \hat{\beta}^h_{F,1}\}$ estimated from the following specification, for $h = 1, .., 10$:

$$y_{it+h-1} = \alpha^h_i + X_{it-1}\Gamma^h + \sum_{j=1}^{5} \beta^h_{HH,j} * d^{HH}_{it-j} + \sum_{j=1}^{5} \beta^h_{F,j} * d^{F}_{it-j} + \sum_{j=1}^{5} \delta^h_j * y_{it-j} + \epsilon^h_{it+h-1}$$

where d^{HH}_{it-j} and d^{F}_{it-j} are nominal household and non-financial firm debt, respectively, both scaled by one period lagged nominal GDP.

We conduct two robustness tests using Jordá local projections: (1) inclusion of a time trend and (2) exclusion of the Great Recession. Controlling for a time trend ensures that the household debt estimate does not simply reflect a combination of the secular expansion in private credit over the past four decades (Jordà et al. (2014a)) and the gradual decline in GDP growth in developed economies over the same period. We exclude the Great Recession because it was preceded by an unprecedented increase

[15] We utilize an alternative methodology for testing whether firm and household debt shocks have distinct effects on output growth in Figure B.1.4 of the appendix. We plot estimates from Jordá local projections comparing the effects of a shock to household debt versus firm debt on annual growth rates from 1 to 10 years after the shock. The effect of a household debt shock on the annual GDP growth rates is statistically significantly more negative than the effect of a firm debt shock in years 3, 4, 5, and 6 after the shock.

in household debt in advanced economies, and we want to test whether the effect of household credit expansions is explained entirely by recent experience.

The top left panel of Figure 2.2 presents the baseline test without controls, along with 95% confidence intervals computed using standard errors dually clustered on country and year. The baseline estimates reveal a dynamic pattern similar to the impulse responses functions from the VAR.[16] The second and third panel of the top row estimate the Jordá projections with inclusion of a time trend and excluding data points after 2006, respectively. The far right panel of the top row both includes a time trend and excludes the Great Recession.

Inclusion of a time trend does little to alter the main finding. Excluding the Great Recession does not eliminate the boom and bust pattern associated with household debt, but the effect of an increase in household debt no longer leads to a lower level of GDP ten years after the initial shock. A specification that both includes a time trend and excludes the Great Recession yields estimates similar to only excluding the Great Recession.

The two right panels of the top row of Figure 2.2 show that the long-run lower level of GDP after a positive shock to household debt shown in Figure 2.1 is not robust to exclusion of the Great Recession period. As mentioned above, this long run effect is not the focus of our study. Instead, we focus on the decline in growth from the peak of the household debt boom ($t = 3$ in Figure 2.2) to three years later ($t = 6$ in Figure 2.2). This decline is present even if we exclude the Great Recession and include a time trend, and we will show below that the decline is statistically significant at the one percent confidence level.

[16] In contrast to the orthogonalized impulse responses from the VAR in Figure 2.1, the local projection impulse responses in Figure 2.2 are responses to the reduced form shocks. The fact that the responses to the orthogonalized (ϵ_{it}) and reduced form shocks ($\mathbf{u}_{it}$) are quite similar squares with the observation that the results are not sensitive to the assumed causal ordering in the Cholesky decomposition.

In Figure 2.2, we also report coefficients from estimation of Jordá projections in first differences. More specifically, the bottom row shows the estimates of $\{\beta^h_{HH,1}, \beta^h_{F,1}\}$ from:

$$\Delta_h y_{it+h-1} = \alpha^h_i + X_{it-1}\Gamma^h + \sum_{j=1}^{5} \beta^h_{HH,j} * \Delta d^{HH}_{it-j} + \sum_{j=1}^{5} \beta^h_{F,j} * \Delta d^{F}_{it-j} + \sum_{j=1}^{5} \delta^h_j * \Delta y_{it-j} + u^h_{it+h-1},$$

for $h = 1, ..., 10$. The results from the first difference specifications are similar to the level specifications. The baseline effect shows that an increase in household debt leads to an increase and then subsequent decrease in output growth. The long run negative effect is strong when we include the Great Recession but weaker if we exclude it. In all eight panels of Figure 2.2, a rise in household debt predicts a decline in output growth from $t = 3$ to $t = 6$.

2.3.3 Single equation estimation

The dynamic relation above shows that an increase in household debt predicts a decline in output growth in the medium run. The local projection impulse response in the top left panel of Figure 2.2 implies that a unit shock to household debt leads to a medium-run change in log output from $t = 3$ to $t = 6$ of -0.42 (standard error of 0.11). The corresponding effect on growth for a unit shock to firm debt is 0.03 (standard error of 0.06), and we can easily reject the hypothesis that firm and household debt have similar medium run effects on growth.

To further explore this result, we turn in this sub-section to estimation of single equation specifications of the following type:

$$\Delta_3 y_{it+3} = \alpha_i + \beta_{HH}\Delta_3 d^{HH}_{it-1} + \beta_F \Delta_3 d^{F}_{it-1} + X'_{i,t-1}\Gamma + \epsilon_{it}, \tag{2.2}$$

where $\Delta_3 d^{HH}_{it-1}$ and $\Delta_3 d^{F}_{it-1}$ are the change in household and firm debt to GDP ratios, respectively, from four years ago to last year. We choose to focus on the change in debt from four years ago to last year as the main right hand side variable for two reasons. First, the impulse response function of household debt to itself shown in Figure 2.1 suggests that a shock to household debt leads to a three to four year rise before reverting. Second, we lag the change by one period to ensure that professional forecasters have seen the rise in debt when making their forecast, which will be important when we discuss forecast errors below.

The vector X_{it} includes additional control variables such as several lags in the dependent variable to ensure that mean-reversion in GDP growth is not responsible for the results. Our baseline specification does not include year fixed effects, but we explore them in detail in this sub-section and in Section 2.9. We dually cluster standard errors on country and year to account for within country correlation and contemporaneous cross-country correlation in the error term. In particular, this accounts for within country correlation induced by overlapping observations.

Table 2.3 presents estimates of equation (2.2). Column 1 sums household debt and non-financial firm debt and uses the overall change in private debt to GDP on the right hand side. Columns 2 through 4 separate out the two components of total private debt. There is a significant negative correlation between changes in private debt and future output growth. Moreover, at this horizon, the negative correlation is driven by the increase in household debt (column 4), and the difference between the household and firm debt coefficients is statistically significant at the 1% level. The magnitude of the negative correlation is large, with a one standard deviation increase in the change in household debt to GDP ratio (6.2 percentage points) associated with a 2.1 percentage point lower growth rate during the subsequent three years.

Figure 2.3 shows the scatter plot of the regressions shown in columns 2 and 4 of Table 2.3, labeling each country-year in our sample. There is a strong negative

relation, and this relation is not driven by outliers. Moreover, the relation is non-linear, a point which we return to in Section 2.7. Ireland and Greece during the Great Recession show up in the bottom right part of the scatter plot, but several other episodes including Finland from 1989 to 1990 and Thailand during the East Asian financial crisis also help explain the robust correlation. Panels b and c show the partial correlation between future output growth and the change in household debt to GDP and non-financial firm debt to GDP ratios, respectively. As already shown in column 4 of Table 2.3, the partial correlation is negative for household debt, but flat for non-financial firm debt.

Column 5 of Table 2.3 includes lagged one-year GDP growth variables over the same period as the change in debt, Δy_{it-1}, Δy_{it-2} and Δy_{it-3}. The estimate of β^h_{HH} is robust to the inclusion of lagged GDP growth controls, which shows that this result is not driven by some spurious mean reversion in the output growth process. Column 6 adds the change in government debt to GDP over the same period on the right hand side. A rise in government debt to GDP is associated with moderately stronger growth over the following three years, but the coefficient is small and not statistically significant.[17]

Columns 7 and 8 explore whether household debt is simply a proxy for periods in which a country accumulates net foreign liabilities. This is an important issue because theoretical models differ on whether gross debt burdens within a country matter, or simply the net financial position of a country vis-á-vis the rest of the world. As column 7 shows, the rise in net foreign liabilities does not predict subsequent GDP growth once household debt is taken into account. Column 8 shows that there is perhaps an amplifying effect: the rise in household debt has a stronger negative effect on subsequent GDP when the country has simultaneously increased net foreign

[17]This result is true at all horizons between one and five years.

liabilities. However, even countries that have not increased net foreign liabilities during the household debt expansion see a decline in subsequent output growth.

In Figure B.1.5 of the appendix, we report coefficients from estimating equation (2.2) separately for each country. The coefficient on the household debt to GDP ratio is negative for twenty-four of the thirty countries in our sample, and none of the country coefficients is significantly positive with the exception of Turkey. The cross-country average of the estimates is -0.36 and the precision weighted average is -0.40.

Tables 2.4 and 2.5 provide robustness checks on sample selection, standard errors, and functional form of our debt variables. Column 1 of Table 2.4 performs a robustness check by only using non-overlapping years for the left-hand-side variable to ensure that our findings are not driven by repeat observations. The estimate and standard errors are similar. The combination of country fixed effects and lagged dependent variables as controls introduces a potential "Nickell bias" in estimation of equation (2.2). The bias is likely to be small given the relatively long average panel length of 23 years in our sample. Nonetheless, column 2 uses the Arellano and Bond (1991) GMM estimator for the sample in column 1 and shows similar results. The Arellano-Bond estimator uses all the lags of three-year GDP growth as instruments for $\Delta_3 y_{it-1}$, and we also instrument $\Delta_3 d^{HH}_{it-1}$ and $\Delta_3 d^{F}_{it-1}$ with their (three-year) lag. As another check, column 3 estimates equation (2.2) without country fixed effects. The coefficient estimate on the change in the household debt to GDP ratio is similar.

Up to this point we have reported standard errors that are robust to correlation in the errors within countries over time and across countries in a given year. Column 4 reports standard errors that allow for arbitrary residual correlation across countries in proximate years, as well as within a country over time. Specifically, we apply the panel moving blocks bootstrap (Gonçalves (2011)), which re-samples the data using

the moving block bootstrap on the vector containing all countries in a given year.[18] These more conservative standard errors yield a similar but slightly lower t-statistic for the household debt estimate of $t = -4.02$, compared to $t = -4.31$ from two-way clustered standard errors.

Columns 5 and 6 report estimates with inclusion of a time trend and year fixed effects, respectively. Inclusion of a time trend or year fixed effects reduces the estimated coefficient on the rise in household debt by one-third, but the estimate remains statistically significant at the one percent level. We believe inclusion of year fixed effects may be over-controlling because of evidence of a global household debt cycle, and we will return to this point in Section 2.9.

The specification reported in column 7 of Table 2.4 uses an alternative definition of growth in debt by scaling the change in household debt and non-financial firm debt from four years ago to last year with GDP from four years ago (i.e., for household debt, $\Delta_3 d^{HH}_{it-1} = \frac{D^{HH}_{it-1} - D^{HH}_{it-4}}{Y_{it-4}}$). The coefficient estimate is unchanged, showing that our results are not driven by spurious movement in the denominator of the debt to GDP variable. In all specifications in Table 2.4, the difference between the estimated coefficients on the rise in household debt and firm debt is statistically significant at the five percent level or better.

In Table 2.5, we explore the coefficient estimates when limiting to sub-samples. Columns 1 and 2 show that the β_{HH} estimate is larger in absolute value for developed economies (-0.37), but the relation is also strong for emerging market economies (-0.24). The estimations reported in columns 3 and 4 exclude the post-1995 period and the post-2006 period, respectively. The coefficient estimates show that the boom and bust cycle around the Great Recession is not uniquely responsible for the negative effect of a rise in household debt on subsequent GDP growth. The estimates reported in columns 5 and 6 focus on the pre-Great Recession period with inclusion of either a

[18] We report standard errors for the block length that produces the highest standard errors. This leads to a block length of $l = 3$ years.

time trend or year fixed effects. The coefficient estimate on the change in household debt remains negative and statistically significant at the one percent level, but the magnitude is smaller. Compared to our baseline estimate of -0.33, inclusion of year fixed effects and removal of the post-2006 data reduces the estimate by one-half.

The analysis in Table 2.5 also reveals that the difference between the estimates on the change in household and firm debt is smaller in certain sub-samples. For example, the difference between the two coefficient estimates is only marginally statistically significant for emerging economies. While the difference is statistically significant in the sample that excludes the Great Recession, it is not significant in the sub-sample that focuses on pre-Great Recession data and includes either a linear time trend or year fixed effects.

2.3.4 What happens during the boom?

What happens to the real side of the economy during household debt booms? We address this question in Table 2.6, which examines the contemporaneous correlation between consumption, investment, and the trade balance with changes in household debt to GDP ratios. As it shows, periods when household debt rises are associated with an increase in the consumption to GDP ratio. The rise in the consumption to GDP ratio is not only driven by durables: there is a rise in both the consumption of non-durables and services as well. In contrast, the investment to GDP ratio is flat during household debt boom.

Household credit booms are negatively associated with changes in both the net export and current account to GDP ratio (columns 6 and 7). A country increases its imports relative to exports as household debt rises. What types of goods are imported? Columns 8 shows that the share of total imports that are consumption goods increases, while there is no such equivalent increase in the consumption share of export goods (column 9).

2.4 Theory

The results in the section above reveal a robust negative correlation between a three to four year change in household debt and subsequent economic growth. But why does household debt expand suddenly? And why might a large increase in household debt presage subsequently lower economic growth in the medium run? In this section, we describe existing theoretical models that help answer these questions. We place the existing models into two broad groups: those in which the increase in household debt is a result of an increase in credit demand by households, and those in which the increase in household debt is a result of an increase in credit supply. Within each category, there are models in which agents have rational expectations and models in which agents form flawed expectations. We note from the outset that it is unlikely that increases in household debt are uniquely driven by credit demand or credit supply shocks, and indeed a credit supply shock may induce an outward shift in credit demand. But a discussion of the theory can offer insights into which types of shocks are most important in the data.

2.4.1 Shocks to credit demand

A natural reason for household debt to expand today is anticipation of higher income tomorrow, as in the standard permanent income hypothesis (e.g., Aguiar and Gopinath (2007)). The anticipation of higher income tomorrow could be driven by shocks ranging from technology shocks to natural resource discovery to terms of trade shocks. Growth in debt in this type of model is driven by higher demand for credit in response to expected future income growth and a desire to smooth consumption. In appendix B.3, we formalize this intuition and we show that increases in debt should be followed by higher economic growth on average.[19]

[19]In the international finance literature which uses a representative agent framework in a small open economy, the rise in debt represents net foreign debt. More broadly, one could introduce

In addition to predicting higher future growth, positive credit demand shocks while credit supply remains fixed should be associated with higher interest rates during the debt boom. Justiniano et al. (2015) in particular emphasize this prediction, which they argue is counter-factual in the United States from 2000 to 2007 when household debt was rising sharply.

An alternative rational expectations-based explanation for the rise in debt would be liquidity hoarding in the face of bad news. Households see a negative economic shock coming, and as a result they borrow aggressively to preserve liquidity and ride out the storm. This model would yield a negative relation between a rise in debt and subsequent growth. But households would not consume out of borrowing, and therefore we would not see a rise in consumption concurrently with the rise in household debt. We have already shown evidence that consumption rises during debt booms, which is difficult to reconcile with liquidity hoarding by households.

Another class of relevant models are behavioral or preference-shock based models in which households suddenly consume more. This could be due to a preference shock as in Laibson (1997) or Barro (1999), or general over-optimism about the future. In these models, there is nothing special about debt except that it fuels consumption. Consumption rises during the boom phase, and subsequent growth may be lower because of less productive investment policy during the boom or a sharp reversal of beliefs about the future which triggers the bust.

If credit supply remains fixed, even a shift in credit demand based on flawed expectations by households should lead to higher interest rates as credit demand rises. Therefore, a common prediction of all credit demand-shock models, whether they are based on rational expectations or behavioral factors, is that the rise in household debt

heterogeneity where some agents within a country receive a positive productivity shock and borrow from other agents in the same economy, which would yield a positive relation between gross debt in a country and future growth.

should be accompanied by an *increase* in interest rates. This is a key prediction we take to the data in the empirical analysis below.

2.4.2 Shocks to credit supply

An alternative interpretation of credit expansions is that they are driven by credit supply shocks. A credit supply shock represents a relaxation of lending constraints. For the same potential borrower and same true risk profile, lenders become willing to lend more or on cheaper terms. Such a shock is modeled in reduced form by Justiniano et al. (2015). In their model, the total amount creditors are willing to lend increases, which leads to higher household debt, lower interest rates, and an increase in house prices. Schmitt-Grohé and Uribe (2016) model a small open economy and assume a credit supply shock where the interest rate faced by the economy suddenly declines. Households boost their consumption of imported goods, and external debt rises.

But why does credit supply all of a sudden increase? In Favilukis et al. (2015), there is a sustained influx of foreign capital into the domestic bond market and a reduction in collateral constraints on mortgages. As a result, the housing risk premium falls which boosts debt and house prices. Justiniano et al. (2015) argue that the source of the credit supply shock could be increased international capital flows into a country or a new lending technology that allows the financial sector to transform more savings into lending. Deregulation of the financial sector is another potential source. Facing fewer restrictions, the financial sector expands lending for a given borrower.

Alternatively, credit supply may rise because of behavioral biases of lenders, what has been called "sentiment" in the literature. Such behavioral biases have been emphasized at least since Minsky (2008), and they are formally modeled in a number of recent studies. For example, in Gennaioli et al. (2012), investors neglect tail risks

which leads to aggressive lending by the financial sector via debt contracts. In Landvoigt (2016), the lending boom is instigated when creditors underestimate the true default risk of mortgages. In Greenwood et al. (2016), exuberant credit market sentiment boosts lending because lenders mistakenly extrapolate previously low defaults when granting new loans. Bordalo et al. (2015) provide micro-foundations for such mistakes by lenders, which they refer to as "diagnostic expectations."

How can we distinguish between models in which credit demand shocks versus credit supply shocks play the larger role? In credit-supply shock models, periods of rising household debt should be associated with low interest rates, which is in direct contrast to the credit-demand based models. Also, if credit rationing is an important aspect of financial markets, then a credit supply-induced increase in household debt should be associated with an increase in credit originations for lower credit quality households or firms that typically are unable to satisfy their demand for credit. If credit rationing is extreme, an outward shift in credit supply may induce a large shift in originations toward low credit quality borrowers and a *rise* in interest rates.

2.4.3 What causes growth to decline?

We have so far focused on explaining the rise in household debt. But what is the shock that leads to lower growth? In "amplification" models, an exogenous negative shock lowers growth, and the effects of such a negative shock are amplified by the presence of elevated debt. The negative shock may not be caused by the prior expansion in debt, but the expansion of debt amplifies the effect of the negative shock on subsequent growth. This negative shock could be either a financial shock, such as a tightening of borrowing constraints, or a real economic shock, such as a negative productivity shock.[20] In these models, the negative shock precipitates a decline in

[20]This is the spirit of models such as Kiyotaki and Moore (1997), Schmitt-Grohé and Uribe (2016), Eggertsson and Krugman (2012), and Korinek and Simsek (2016).

growth regardless of whether the previous increase in debt was due to credit supply or credit demand.

Alternatively, in the "sentiment" models discussed above, the negative shock that triggers the bust may not be exogenous. Instead, the original positive sentiment shock may endogenously lead to an eventual reversal in sentiment. For example, the model by Bordalo et al. (2015) generates predictable reversals in credit supply given the biased expectations formed by investors. As they note, "following this period of narrow credit spreads, these spreads predictably rise on average ... while investment and output decline ...". While the exact timing of the reversal is not known, a rise in credit supply driven by lender optimism eventually reverts as lenders become pessimistic.

The idea that positive credit market sentiment shocks lead to predictable reversals is supported by a number of recent empirical studies. Krishnamurthy and Muir (2017) show that credit spreads appear too low prior to a financial crisis, and the crisis is triggered when spreads rise suddenly. Using data on the United States from 1929 to 2013, López-Salido et al. (2017) show that a sudden rise in credit spreads is predictable given the low spreads that precede it. Further, Baron and Xiong (2017) show that expansions in private debt predict a crash in bank equity prices. These models are also consistent with the left panel of Figure 2.1: a rise in household debt predicts a reversal in household debt from 3 to 7 years after the initial shock.

Regardless of why the credit boom ends, economic growth may be depressed when it ends due to a number of factors. A disruption in the financial system is an important factor, and such evidence is provided by Krishnamurthy and Muir (2017) and López-Salido et al. (2017). An additional source of depressed economic growth is the presence of nominal rigidities. The model by Schmitt-Grohé and Uribe (2016) assumes downward wage rigidity and a monetary policy constraint due to a fixed exchange rate. The negative credit supply shock in their model is the reversal of a

temporary interest rate decline in a small open economy, which causes domestic demand for non-tradables to fall. However, the combination of downward wage rigidity and restricted monetary policy prevents real wages from falling, resulting in unemployment and decline in output. If the country could run its own monetary policy, it could boost investment and consumption through lower interest rates and boost net exports through a weaker currency and lower real wages.

A related but separate rationale for a decline in economic growth is provided by Eggertsson and Krugman (2012) and Korinek and Simsek (2016). These are closed economy models where the negative shock is a tightening of borrowing constraints faced by the impatient consumer. The authors show that if debt levels are sufficiently high, the deleveraging shock will tip the economy into a zero lower bound constraint and recession. The fixed exchange rate in the open economy models plays a similar role as the zero lower bound constraint in the closed economy models: both reduce the ability of monetary policy to lower interest rates to help boost demand. The zero lower bound argument also implies non-linearity in the effect of household debt booms on subsequent growth. The economic downturn must be severe enough to force equilibrium interest rates to be negative. As a result, especially large increases in household debt will trigger especially severe economic downturns.[21]

Given the presence of these ex post constraints in the models of Schmitt-Grohé and Uribe (2016) and Korinek and Simsek (2016), households do not internalize the negative macroeconomic consequences of their borrowing during the boom phase due to aggregate demand externalities. When choosing how much to borrow during the boom, a given household does not internalize that its lower consumption during the bust affects the income of other households. As a result, the economy during the boom

[21] There are other studies that share some of the features detailed here, including Martin and Philippon (2014) and Guerrieri and Lorenzoni (2015). There are additional models based on pecuniary or fire sales externalities that focus on the potential for excessive leverage among non-financial firms. Examples include Shleifer and Vishny (1992), Kiyotaki and Moore (1997), Lorenzoni (2008), and Dávila (2015). Pecuniary externalities can also amplify the effect of household debt, especially for collateralized borrowing such as mortgages.

phase in these models is characterized by "excessive" borrowing; the social planner would choose lower borrowing because she internalizes the negative aggregate demand externalities during the bust of excessive debt during the boom.

2.5 Interest Spreads and Riskier Borrowers

Several of the results from Section 2.3 are difficult to reconcile with standard models in which movements in credit demand are the fundamental shock leading to a rise in household debt. In particular, in rational expectations-based credit demand shock models, it is difficult to explain why a rise in household debt systematically predicts a decline in subsequent growth. In this section, we explore interest rates on household debt, where credit demand and credit supply shock-based models have opposite predictions. We also examine measures of credit supply based on the credit quality of borrowers during the boom.

2.5.1 Mortgage spreads in a VAR setting

The VAR evidence shown in Section 2.3 above provides a natural setting to explore how interest rates evolve during household debt booms. In the analysis below, we define the mortgage-sovereign spread, *MS spread*, as the difference between the interest rate on mortgage loans and the 10-year government bond in a country. We develop a Proxy SVAR approach based on Mertens and Ravn (2013). The idea of such an approach is to use the MS spread as an instrument for the rise in household debt. The "first stage" in this approach is showing that a rise in household debt is systematically related to low interest rate environments, and then the "second stage" is to show that these low interest rate environment-induced increases in household debt lead to lower subsequent output growth.

Recall the reduced form VAR representation from Section 2.3:

$$\mathbf{Y}_{it} = \mathbf{c}_i + \sum_{j=1}^{p} \delta_j \mathbf{Y}_{it-j} + \mathbf{u}_{it}, \quad \mathbf{u}_{it} = \mathbf{S}\epsilon_{it}.$$

Formally, the identification of a credit supply shock to household debt amounts to identifying the third column of $\mathbf{S}$, which we denote $\mathbf{s}$ and partition as $\mathbf{s} = (\mathbf{s}^{1:2\prime}, s^3)'$. An external instrument Z_{it} is valid to identify a credit supply shock if $\mathrm{E}[Z_{it}\epsilon_{it}^3] \neq 0$ and $\mathrm{E}[Z_{it}\epsilon_{it}^j] = 0, j = 1, 2$. The first condition requires that Z_{it} is correlated with the household credit supply shock ϵ_{it}^3. The second condition states that it is uncorrelated with shocks to the non-financial firm debt and GDP equations, such as productivity shocks.

Given these assumptions, the Proxy VAR estimation is as follows: First, we use OLS to estimate the reduced form VAR residuals $\mathbf{u}_{it}$ of the system (2.1) from Section 2.3. We then regress the residuals of the household debt equation (u_{it}^3) on the MS spread instrument. If the coefficient on the MS spread instrument in this regression is negative, it implies that unexplained increases in household debt from the VAR are related to low interest rate environments, which would support the argument that credit supply shocks are the more important driver of increases in household debt.

In the second stage, we estimate the ratio $\frac{\mathbf{s}^{1:2}}{s^3}$ from the 2SLS regression of $\mathbf{u}_{it}^{1:2}$ on u_{it}^3 using the MS spread instrument Z_{it}. Here, s^3 is the response of u_{3it} to the credit supply shock ϵ_{3it}, and $\mathbf{s}^{1:2}$ is a vector that contains the response of $(u_{1it}, u_{2it})'$ to the credit supply shock. This step isolates variation in the non-financial firm debt and GDP equation residuals that is driven by credit supply shocks to household debt. With an estimate of $\frac{\mathbf{s}^{1:2}}{s^3}$ in hand, we can then identify s^3 using the additional restrictions imposed by the reduced form variance-covariance matrix Σ.

As in any macroeconomic setting, it is difficult for a potential instrument to convincingly satisfy the exclusion restriction. In our setting, it may be that the decline

in the *MS spread* has an effect on subsequent output or firm debt independent of its effect on household debt. However, most alternative channels through which the *MS spread* affects subsequent growth would have the opposite sign of what we find here: a decline in the interest spread should occur in expectation of improved household income prospects coming from stronger growth. In other words, the omitted variables associated with a decline in the *MS spread* would likely lead to *stronger* subsequent growth. This argument suggests that the estimates we provide are *conservative* in quantifying the negative effect of credit supply shocks on subsequent growth.[22]

Table 2.7 presents regressions of the reduced form VAR residuals for household debt and non-financial firm debt on the *MS spread* instrument. We estimate the VAR on the full sample, but identify the credit supply shock using the subsample where the MS spread is not missing, as in Gertler and Karadi (2015).[23] The regressions in Table 2.7 use the *MS spread* directly (columns 1 and 3) and an indicator that equals one if the within-country standardized *MS spread* is below the sample median (columns 2 and 4).

Columns 1 and 2 show the first stage and reveal that a low MS spread is statistically significantly correlated with a higher household debt reduced-form residual. The F-statistics are 11.3 and 9.8 for the *MS spread* and low *MS spread* instruments. This is compelling evidence in favor of models in which credit supply shocks are on net more important than credit demand shocks. Booms in household debt that are "unexplained" by GDP growth and non-financial firm debt are systematically related to low interest rate environments.

[22]This would be consistent with the *MS spread* being an "imperfect instrumental variable" (Nevo and Rosen (2012)) that leads to conservative estimates. A similar argument can be made for the OLS estimates. Since credit demand shocks from higher anticipated future income generate a positive relation between household debt expansion and subsequent growth, the OLS estimate of the effect of a credit supply shock in Section 2.3 is biased upward by omitted credit demand shocks.

[23]The reduced form VAR is estimated on 752 observations and identification using the MS spread uses 580 of these country-years.

Further, the results in columns 3 and 4 show that the low *MS spread* is uncorrelated with the residual from the firm debt equation. While this is not conclusive, it does help strengthen the exclusion restriction assumption; low MS spread environments boost household debt, but do not seem to affect firm debt directly.

In the analysis that follows we rely on the low *MS spread* indicator variable as our instrument Z_{it} because we primarily want to capture *positive* shocks to credit supply. We do not want to capture large spikes in the MS spread that capture recessions and periods of financial distress.[24]

Figure 2.4 presents the responses to a household credit supply shock identified using the low mortgage spread indicator. As we saw in column 2 of Table 2.7, a low mortgage spread predicts a positive household debt equation residual. Figure 2.4 shows that a one unit shock to household debt identified using the low mortgage spread instrument raises output by a small 0.05% on impact. Output then rises for two periods, before reversing and falling sharply for several periods. The general shape of the output response from the Proxy SVAR mirrors the response using the Cholesky scheme shown in Section 2.3. In particular, a low *MS spread* induced rise in household debt is followed by a growth slowdown in the medium run.[25] An increase in household debt driven by an increase in credit supply is associated with lower subsequent GDP growth.

2.5.2 Cross-sectional analysis

In this section, we examine the experience of the Eurozone and countries prior to the Great Recession to show in a cross-sectional setting the relation between the interest spreads, household debt changes, and economic growth. We first show that the decline in the sovereign spread relative to U.S. Treasuries can be a useful proxy of a

[24]See Gilchrist and Zakrajšek (2012) and Krishnamurthy and Muir (2017) for an analysis of the impact of spikes in corporate credit spreads on economic activity.

[25]In experiments using the raw MS spread and other cutoffs for a "low" MS spread indicator, we find that the shape and level of the IRF are generally similar the results shown in Figure 2.4.

credit supply shock for the Eurozone in the years leading up to the Great Recession. The introduction of the euro led to a convergence of sovereign spreads between the Eurozone core and peripheral countries because of decreased currency and other risk premia. This in turn translated into an increase in credit supply in peripheral countries, who disproportionately benefited from converging sovereign spreads.[26] We use the convergence in sovereign spreads over 10 year U.S. Treasuries as an instrument for household debt expansion across eurozone economies in a two stage least squares (2SLS) estimation:

$$\Delta_{02-07} d_i^{HH} = \alpha^f + \beta^f * z_i + u_i^f \tag{2.3}$$

$$\Delta_{07-10} y_i = \alpha^s + \beta^s * \Delta \hat{d}_i^{HH} + u_i^s \tag{2.4}$$

Columns 1 through 4 of Table 2.8 and Figure 2.5 confirm this narrative using the decline in the real spread from 1996 to 1999 between a Eurozone country's 10 year government bond and that of the United States as the credit supply shock z_{it} in equation (2.3). Countries that saw the largest decline in their real sovereign yield spread from 1996 to 1999 saw the strongest expansion in household debt to GDP from 2002 to 2007 (column 2).[27] The top left panel of Figure 2.5 shows a strong first stage, with the change in the sovereign spread explaining 52.6% of the variation in the change in the household debt to GDP ratios from 2002 to 2007. The rise in household debt predicted by the interest rate convergence, in turn, predicts a more severe recession from 2007 to 2010 (column 3).

[26] Changes in the sovereign yield spread are often due to changes in the risk premia (Remolona et al. (2007) and Longstaff et al. (2011)), and some recent evidence from the European Union suggests that changes in the sovereign spread have an independent effect on domestic credit supply to firms and households (e.g., Bofondi et al. (2013)).

[27] The result is similar if we consider the rise in household debt to GDP from 1999 to 2007. The fall in spreads does not, however, predict stronger growth in government debt to GDP ratios in this sample of 12 economies.

Some caution is warranted in interpreting these results. The decline in interest spreads in peripheral European countries from 1996 to 1999 affected these economies through channels other than household debt expansion. Some of these alternative channels push the opposite direction of our result: for example, lower spreads may have fueled productive investment which would boost long-term growth. However, if lower spreads misallocated resources toward unproductive industries (e.g., Charles et al. (2015), Borio et al. (2016), and Gopinath et al. (2015)), then the worse performance of peripheral European countries during the Great Recesion may be due to factors other than household debt expansion alone.

In columns 5 through 8 of Table 2.8 and Figure 2.5(b), we consider the spread between mortgage loans and 10-year government bond (*MS spread*) as a credit supply shock to household debt in a broader sample of countries during the 2000s boom. We use the decline in the *MS spread* from 2000 to 2004 as the instrument z_{it}, as spreads bottomed between 2003-2005 in most countries. Column 6 shows a strong first stage, with lower spreads predicting significantly stronger household credit expansion. Countries like Spain, Denmark, and Portugal saw both the largest declines in the MS spread and the largest increases in household debt (top left panel of Figure 2.5(b)). This correlation supports the importance of credit supply in explaining the large increase in household debt in many countries during the 2000s. Column 7 shows that this expansion in household debt predicted by the fall in MS spread led to significantly slower growth from 2007 to 2010.

Overall, both the Proxy VAR evidence and the cross-sectional analysis point to the following mechanism: a positive credit supply shock (captured in lower spreads) boosts the household debt to GDP ratio and output growth. However, by three to four years after the initial shock, growth declines sharply.

2.5.3 Composition of debt and credit supply

In the presence of credit rationing, an increase in the share of debt being originated to lower credit quality borrowers may measure a positive credit supply shock more accurately than a decline in the interest rate. The analysis by Greenwood and Hanson (2013) captures this intuition. They argue that the share of total corporate debt issuances by high yield (i.e., riskier) firms is a better measure of credit market conditions relative to interest spreads on corporate debt.[28] Unfortunately, in our setting, such a quantity-based measure requires microeconomic data on which households within a country receive credit, which is not readily available for our large sample of countries.

However, we can utilize the Greenwood and Hanson (2013) measure to see how it is related to household debt booms in the United States. In Table B.1.2 of the appendix, we use the high yield corporate bond issuance share as an instrument for household debt changes. We show that a rise in the high yield corporate bond issuance share is associated with a rise in household debt, which then subsequently predicts a decline in GDP growth. Of course, there may be other channels through which heightened lending to low credit quality firms affect GDP growth. For example, López-Salido et al. (2017) argue that elevated credit market sentiment predicts a credit market correction, and it is the credit market correction that reduces GDP. However, we view the evidence in Table A2 as supporting the argument that credit supply shocks, as opposed to credit demand shocks, are important for explaining why the rise in debt occurs. We hope future researchers are able to construct quantity-based measures of credit supply shifts similar to Greenwood and Hanson (2013) for a large sample of countries.

[28] Greenwood and Hanson (2013) show that a high value of this share predicts low bond returns in the United States from 1962 to 2008. Ben-Rephael et al. (2016) find that mutual fund flow shifts towards high-yield bonds anticipate an elevated Greenwood and Hanson (2013) high yield share, which suggests that increased investor demand for risky assets drives lending to riskier borrowers.

2.6 Rational or Biased Expectations?

What is the role of behavioral biases in generating the boom-bust cycle in credit and growth shown above? We explore this question in this section. More specifically, in Figure 2.6, we utilize GDP forecast data from the IMF *World Economic Outlook* (WEO) and the OECD *Economic Outlook* publications. The IMF forecasts growth five years out since 1990 for all countries in our sample, and also has one-year ahead forecasts for the G7 countries from 1972 onward. The OECD has one year growth forecasts since 1973 and two year forecasts since 1987 for OECD countries.

The top left panel of Figure 2.6 shows that an increase in the household debt to GDP ratio from four years ago to the end of last year is uncorrelated with the forecast of growth over the next three years by the IMF. The bottom left panel shows the same result using OECD forecasts of growth over the next two years. Neither the IMF nor OECD adjust their forecasts downward after seeing a rise in household debt from four years ago to last year.

Of course, we know from Table 2.3 that the change in the household debt to GDP ratio from four years ago to last year predicts lower subsequent growth, and so a rise in household debt to GDP must also predict negative GDP forecast errors. The top and bottom right panels of Figure 2.6 confirm this result by replacing the growth forecast of the IMF and OECD with the forecast error. The forecast error is defined as the difference between realized and forecasted growth. The figure shows that larger increases in the household debt to GDP ratio are associated with overoptimistic growth expectations and hence negative forecast errors. It is important to emphasize that the previous rise in the household debt to GDP ratio is already known by forecasters when they make their forecast.

Table 2.9 confirms these results in a regression setting. The estimates reported in columns 1 and 2 show that the rise in household debt from four years ago to last year has no effect on the growth forecasts made by the IMF or the OECD over the

next two years. Columns 3 through 7 report coefficient estimates corresponding to forecast errors for forecasts made by the IMF and OECD one to three years out. As they show, the rise in household debt from four years ago to last year predicts forecasting errors. Columns 8 and 9 report the estimates for the pre-2006 period that does not include the Great Recession. The point estimates are about 2/3 as large in the pre-2006 period, and the estimate for the IMF forecast error is weaker in precision.

In Table B.1.3 of the appendix we estimate the same regression but replace the forecast error with the forecast *revision* between t and $t+1$, and between $t+1$ and $t+2$. If forecasts are optimal, then forecast revisions should not be predictable with information available at the time of the original forecast. But columns 1 through 4 of Table A3 show that lagged increases in the household debt to GDP ratio known at time t predict several subsequent downward forecast revisions. An implication is that time t forecasts can be improved by adjusting them downward in response to higher household debt growth from $t-4$ to $t-1$. This is true for both IMF and OECD forecasts. In the appendix (Figure B.1.7), we also analyze the correlation between growth forecasts prior to the household debt expansion. We do not find evidence that forecasters are systematically over-confident about the economy just prior to the period in which credit expands. Forecasters predict growth quite accurately during the household debt boom, but then overstate growth significantly as the household debt boom is close to reverting.[29]

In our view, it is difficult to reconcile the results in Table 2.9 with rational expectations-based models, whether they are based on credit demand or credit supply shocks. We believe the evidence supports the growing body of research showing

[29]We are not arguing that the IMF and OECD forecasts are bad forecasts in an absolute sense. For example, the IMF and OECD forecasts do better than the random walk forecast, and they do a marginally better job forecasting future growth than a forecast based on the panel VAR using GDP growth, the change in household debt to GDP, and the change in the firm debt to GDP (see appendix Table B.1.5). Our central point is that these forecasts could be improved by taking into account the change in private debt to GDP ratios.

that market participants fail to understand the negative effects of increases in private debt (e.g., Baron and Xiong (2017) and Fahlenbrach et al. (2016)). While much of the previous literature focuses on return predictability, we show that credit booms predict forecasting errors for output growth.

One important question is: who exactly is making the expectations error? Creditors or borrowers? The errors by forecasters shown above do not answer this question. As mentioned above, a sudden increase in optimism by borrowers with constant credit supply should lead to a rise in interest rates during household debt booms, which is counter-factual. Bordalo et al. (2015) find that credit market analysts' forecasts tend to be too optimistic during booms when spreads are low, which suggests that creditors are prone to expectational errors from over-extrapolating the recent past.

Another test is to examine whether consumption booms in general lead to lower future economic growth. We conduct such a test, and report the results in appendix Table B.1.4. We find no evidence that increases in consumption predict lower growth. Neither the change in the consumption to GDP ratio nor the change in the durable consumption to GDP ratio have predictive power on GDP growth once the change in household debt is taken into account.[30] The power of household debt booms in predicting lower growth does not merely reflect consumption booms. This provides further support to the idea that a shift in household beliefs alone is not sufficient to explain the negative effect of debt booms on subsequent growth: a shift in lender beliefs seems critical.

2.7 The Role of Macroeconomic Frictions

Theoretical research relating elevated household debt to subsequently lower growth relies on frictions such as constraints on monetary policy and nominal rigidities to

[30]We report the durables consumption to GDP ratio as a robustness test given evidence on the importance of the buildup in durables in explaining the severity of the Great Recession (Rognlie et al. (2017)).

explain the decline in subsequent growth. We present evidence supporting the importance of these frictions in this section.

2.7.1 Non-linearity

First, theories in which macroeconomic frictions play an important role typically assume that a decline in demand is needed to trigger frictions that lead to a decline in output. For example, a large decline in demand may require a large reduction in interest rates, which increases the probability of hitting monetary policy constraints such as the zero lower bound on nominal interest rates. Rigidity in wages in particular may be more relevant on the downside, as is assumed in Schmitt-Grohé and Uribe (2016). As a result, increases in household debt to GDP ratios should be expected to predict lower subsequent GDP, but a decline in household debt to GDP ratios may not lead to a rise in subsequent GDP. The non-parametric relation between a change in the household debt to GDP ratio and subsequent GDP growth in Figure 2.3 of Section 2.3 confirms the presence of such a non-linearity.

Column 1 of Table 2.10 shows this result in a regression context. We create indicator variables for whether the country has experienced a rise or fall in household debt or firm debt, and we interact these indicator variables with the rise in household debt and firm debt, respectively. As the regression coefficients show, the predictive power of household debt changes on subsequent output growth comes completely from situations in which a country sees a rise in household debt. A decline in household debt does not lead to higher subsequent output growth.

2.7.2 Heterogeneity across exchange rate regimes

A key macroeconomic friction that interacts with nominal rigidity is monetary policy constraints, which may bind because a country follows a fixed exchange rate regime. The results reported in columns 2 through 4 of Table 2.10 show that the negative

relation is indeed significantly stronger when a country follows a more rigid exchange rate system. It divides our sample into fixed, intermediate, and freely-floating exchange rate regimes using the *de facto* classification from Reinhart and Rogoff (2004) and updated by Ilzetzki et al. (2010).[31] A rise in the household debt to GDP ratio predicts the largest decline in growth in fixed regimes, followed by intermediate regimes, and the predicted decline in growth is smallest for floating regimes.[32] The difference between the coefficient estimate on changes in the household debt to GDP ratio for the fixed and freely floating sample is significant at the 5% level.

2.7.3 Unemployment

Frictions such as wage rigidities predict an increase in unemployment after a rise in household debt. Table 2.11 replaces GDP growth over the next three years as the left hand side variable with the change in the unemployment rate over the same horizon. Column 1 shows that a rise in the household debt to GDP ratio predicts higher unemployment, and the magnitude is large. A one standard deviation increase in $\Delta_3 d^{HH}_{it-1}$ (6.2) predicts a 0.82 percentage point higher unemployment rate, which is one-third a standard deviation of the left hand side variable.

Column 2 shows that the results are robust to adding lagged annual changes in the unemployment rate to control for any dynamic structure.[33] In contrast to the GDP regressions, a firm debt expansion does have some predictability for unemployment at the three-year horizon. This is because changes in unemployment lag changes in output, and there is a small negative short-run relation between firm debt and growth.

[31] Fixed regimes cover arrangements with no separate legal tender, currency boards, pegs, and narrow horizontal bands (coarse code 1 from Ilzetzki et al. (2010)). Intermediate regimes include crawling pegs, crawling bands, moving bands, and managed floats (coarse codes 2 and 3). We exclude 11 country-years in which the de facto arrangement is classified as freely falling (cases where 12-month inflation is greater than 40%).

[32] The volatility of $\Delta_3 d^{HH}_{it}$ is 7.5, 5.3, and 5.0 in fixed, intermediate, and floating regimes respectively.

[33] These results are also robust to using only subsample of OECD harmonized unemployment rate observations, which are more internationally comparable than the series collected using different methodologies.

However, at longer horizons such as four or five years, we find that only household debt predicts higher unemployment.

The rise in unemployment following household debt expansion is strongest in fixed exchange rate regimes, followed by intermediate and floating regimes. Table 2.11 corroborates the evidence presented above that monetary policy flexibility matters for adjustment.

2.8 House Prices and Other Predictors of Growth

2.8.1 House prices

There is a close connection between household debt and house prices, both from a theoretical and empirical standpoint. For example, Favilukis et al. (2015), Justiniano et al. (2015), and Landvoigt (2016) build models in which a change on the lending side of the market leads to changes in house prices. Further, an extensive body of empirical research shows that credit supply shocks affect house price movements.[34] In our sample, there is indeed a strong correlation between changes in household debt and real house price growth. This relation is shown in column 1 of Table 2.12. The real house price growth variable is the average real house price growth over the past three years for the country in question.

One potential concern with our results is that independent shocks to house prices are responsible for the correlation between household debt changes and subsequent GDP growth. The most likely shock would be a change in beliefs about future house price growth. But if households suddenly become more optimistic on house price growth there is no change in credit supply, then the shift outward in the demand for mortgages would lead to a positive correlation between mortgage spreads and

[34]See for example: Di Maggio and Kermani (2015), Landvoigt et al. (2015), Favara and Imbs (2015), and Adelino et al. (2014).

changes in household debt. This is counter-factual. In order to be consistent with the negative correlation between household debt changes and mortgage spreads, the changes in beliefs about house prices would have to be something about their volatility or downside risk. Of course, changes in beliefs about downside risk or volatility of house prices is almost identical to changes in the assessment of default risk on mortgages by lenders. Therefore, such changes in beliefs could be interpreted as the source of the shift in credit supply.

To shed light on this issue, columns 2 through 5 of Table 2.12 add the lagged change in house price growth to the main regression specification. Both lagged house price growth and lagged changes in the household debt to GDP ratio predict lower subsequent output growth, and the coefficient on the change in household debt to GDP ratio declines slightly. However, the inclusion of time fixed effects or a focus on the pre-2006 data reveals that the rise in the household debt to GDP ratio is a more robust predictor of lower subsequent output growth than house prices. In the horse race between household debt changes and house price growth, household debt changes appear to win.

An alternative approach is to examine the dynamic relation between household debt and house prices. In Figure B.1.8 of the appendix, we explore the relation between house prices and household debt in a bivariate recursive VAR. Interestingly, while house prices and household debt are strongly positively correlated, the data show an asymmetry between the effect of house price shocks and household debt shocks. House price shocks are associated with a gradual rise in household debt to a permanently higher level that begins roughly four quarters after the shock to house prices. Household debt shocks, in contrast, lead to a large and immediate increase in house prices, followed by substantial mean reversion starting roughly 4 years after the shock to household debt.

The impulse response of house prices to a household debt shock is consistent with a model in which the exogenous shock is an outward shift in credit supply which subsequently reverts. Such shocks induce a boom and bust in house prices. The microeconomic evidence in the existing literature also points to a causal effect of credit supply shifts on house prices. While caution is warranted in the interpretation, we believe the body of evidence suggests the chain of causality is more likely to run from credit supply shocks to house prices rather than vice versa.

2.8.2 Robustness to other predictors of output growth

One concern with our findings is that the predictability result is driven by real exchange rate overvaluation. Existing research shows that real exchange rate appreciation is a robust predictor of financial crises (Gourinchas and Obstfeld (2012)), and real exchange rate overvaluation has in certain episodes been labeled as the culprit of slow growth and crises. However, column 4 in Table B.1.4 in the appendix shows that controlling for the 3-year change in the real exchange rate change does not change the coefficient on change in household debt to GDP. Moreover, the coefficient on the real exchange rate is close to zero and insignificant in this sample of mostly advanced economies.

Another concern is that our results are explained by the effect on GDP of sharp movements in corporate credit spreads shown in Krishnamurthy and Muir (2017). They show that GDP growth in year t is negatively related to corporate credit spreads in year $t-1$ and positively related to corporate credit spreads in year $t-2$. Their interpretation of this correlation is almost identical to the interpretation we give our results: credit supply expansions predict a reversion, which negatively affects GDP. Their emphasis is on the financial crisis that results from the period of low credit spreads, but their results and our results are compatible and complementary.

However, we want to ensure that the predictive power of household debt changes on subsequent GDP is not completely subsumed by changes in corporate credit spreads. In Table B.1.4 of the appendix, we first replicate the Krishnamurthy and Muir (2017) finding in our sample (column 7). We then show that including the corporate credit spread does not affect the estimated coefficient on household debt (column 9). These results suggest that the effect of household debt on subsequent GDP is not a mere reflection of a subsequent spike in corporate credit spreads related to banking-sector loan losses and distressed firm balance sheets. This suggests that elevated household debt has a negative effect on the economy for reasons not completely subsumed by financial crisis dynamics.

2.9 The Global Household Debt Cycle

2.9.1 Household debt and external adjustment

Table 2.13 shows that an increase in household debt to GDP predicts an *improvement* in net exports. Column 1 shows an increase in net exports relative to initial GDP after a rise in household debt.[35] Column 2 shows that growth in exports relative to imports increases as well. Columns 3 and 4 separate the two components of net exports and the regression coefficients show that the increase in net exports is driven by a decline in imports rather than an increase in exports. Column 5 shows that the consumption share of imports falls. This evidence of a reversal in the external balance driven by a fall in imports is consistent with a consumption-driven growth slowdown due to a hangover of household debt. The change in non-financial firm debt has little predictive power for the net-export margin.

[35] We present results for the change in net exports relative to initial GDP, $\frac{\Delta_3 NX_{it+3}}{Y_{it}}$, instead of the change in the net exports to GDP ratio in order to highlight the reversal of net exports. The pattern also holds using the change in the net export to GDP ratio.

Household debt positively predicts a change in the net export margin, while it negatively predicts overall GDP growth and unemployment. This suggests that the external margin is useful in "cushioning" some of the negative consequences associated with a large increase in the household debt to GDP ratio. One would expect that the ability to cushion the decline in GDP through net exports is stronger for countries that are more open in terms of their reliance on external trade. Columns 6 and 7 test this hypothesis by interacting the change in household debt to GDP with "openness." Openness is defined as the sample period average of total exports plus imports scaled by GDP for a given country. The interaction term is positive and significant, suggesting that countries that rely more on trade adjust more on the external margin.

2.9.2 Predicting global growth

Countries rely on net exports to boost GDP in the aftermath of a household debt boom. But what happens if all countries are experiencing a household debt hangover at the same time? To answer this question, we first estimate the correlation of each country's household debt cycle with the global household debt cycle:

$$\rho_i^{Global} = \text{corr}\left(\Delta_3 d_{it}^{HH}, \frac{1}{N-1}\sum_{j\neq i}\Delta_3 d_{jt}^{HH}\right). \tag{2.5}$$

The correlation tells us how much a change in household debt in country i is correlated with the contemporaneous change in global household debt, where the latter variable is constructed excluding country i.[36] Column 8 of Table 2.13 shows that countries for which the household debt cycle is more correlated with the global household debt cycle experience a stronger slowdown in GDP in response to a household debt shock, although the result is only marginally statistically significantly distinct from zero.

[36]Figure B.1.9 in the appendix presents the correlation for each country in the sample.

Column 9 helps us understand why: the ability of a country to use net exports to boost economic activity after a rise in household debt is substantially weaker for countries that load more heavily on the global household debt cycle. For a country that is perfectly correlated with the global cycle ($\rho_i^{Global} = 1$), subsequent net exports do not adjust at all after an increase in the household debt to GDP ratio. Perfect correlation with the global credit cycle completely removes a country's ability to export its way out of difficulties.

Taken together, these results motivate the specification in column 10:

$$y_{it+3} - y_{it} = \alpha_i + \beta_{HH}\Delta_3 d_{it-1}^{HH} + \beta_F \Delta_3 d_{it-1}^{F} + \beta_G Global_{-i}\Delta_3 d_{it-1}^{HH} + \epsilon_{it}$$

where the third term is the global change in the household debt to GDP ratio excluding country i. The specification does not include year fixed effects, and we are interpreting the global change in the household debt to GDP ratio as the time series variable that matters most for GDP growth in a given country i. In other words, we are putting an economic interpretation on the year fixed effects.

As column 10 shows, the global household debt variable has strong predictive power for GDP growth in country i. But the increase in the household debt to GDP ratio for country i also has predictive power in addition to the global factor. Both the global and country-specific debt cycle matter for growth in a given country. Given these results, we believe inclusion of year fixed effects in the baseline specification leads to an under-estimate of the importance of household debt changes in predicting subsequent growth in a country. Year fixed effects remove variation in the global household debt cycle, and this variation is important for a country's future GDP growth.

The coefficient on global household debt changes in column 10 of Table 2.13 motivates the following global time series regression:

$$\Delta y_{t+3} = \alpha + \beta * \Delta_3 d_{t-1}^{HH} + \gamma * \Delta_3 d_{it-1}^{F} + \epsilon_t.$$

The specification utilizes a single time series where we calculate the sample average of all variables for all countries for each year.

Table 2.14 presents the estimates. As column 1 shows, there is a strong global household debt cycle. An increase in global household debt from four years ago to last year predicts a decline in world GDP growth from this year to three years into the future. In terms of magnitudes, the coefficient estimate implies that a one standard deviation increase in global household debt to GDP ratio (2.0) predicts a 2.2% decline in GDP growth over the next three years. Similar to the results above, the global debt cycle is driven by changes in household debt; non-financial firm debt has no predictive power at the medium-run horizon we examine (columns 2 and 3). Column 4 shows robustness to controlling for distributed lags of the dependent variable.

Figure 2.7 plots each year in a scatter-plot of global changes in household debt to GDP ($\Delta_3 d_{t-1}^{HH}$) against subsequent global GDP growth ($y_{t+3} - y_t$). The global changes are equally-weighted averages across countries. The top panel shows the univariate relation between changes in global household debt to GDP and subsequent GDP growth, whereas the bottom two panels show the partial correlations of increases in household debt and non-financial firm debt after controlling for the other. Changes in household debt to GDP are strongly related to subsequent GDP growth.

The results in Table 2.14 are based on time series data alone, and therefore warrant caution in interpretation. Our panel is relatively short (40 years), and there are only two to three global debt cycles in this period. There may be global factors unrelated to household debt that explain the patterns in Table 2.14. We test the robustness of

these findings in column 5 of Table 2.14 and in Table B.1.6 of the appendix. Column 5 of Table 2.14 shows that a regression of subsequent GDP growth on changes in household debt to GDP using only pre-Great Recession data produces a coefficient estimate that is similar to the full sample estimate. This implies that a regression model relating changes in household debt to subsequent GDP using the pre-Great Recession data alone forecasts quite accurately the collapse in global GDP growth during the 2007 to 2012 period given the large rise in household debt during the 2000 to 2006 period.

Table B.1.6 in the appendix shows that the patterns in Table 2.14 are qualitatively similar but smaller in magnitude when controlling for a linear or quadratic time trend. The estimate on household debt falls most when controlling for a linear trend (from -0.966 to -0.406 when controlling for linear trend compared to -0.807 for a quadratic trend). Table A6 also presents tests that compute the global variables based on aggregates of the levels of debt and output across countries instead of taking unweighted averages, and we find similar qualitative patterns but smaller estimates. If we construct the time series variables using aggregated variables instead of country-level means and we use only pre-Great Recession data, the coefficient estimate falls to -0.316 and is no longer statistically significantly different than zero.

2.10 Conclusion

An increase in the household debt to GDP ratio predicts a subsequent reversal in debt and lower subsequent GDP growth. The predictive power is large in magnitude and robust across time and space. We show that household debt booms are associated with low interest spread environments and periods in which credit is flowing toward riskier borrowers. We also show that forecasters systematically overstate output growth toward the end of a boom in household debt.

Macroeconomic frictions are an important aspect of explaining the severity of the downturn following the rise in household debt. The effect of household debt on subsequent growth is non-linear: an increase in debt leads to lower subsequent GDP but a fall in debt does not boost GDP. Further, the negative effect of an increase in household debt on subsequent growth is stronger in situations in which monetary policy is constrained. A rise in debt is also associated with higher subsequent unemployment. We also uncover evidence of a global household debt cycle. Countries with a household debt cycle more correlated with the global cycle experience a sharper decline in GDP growth in response to rise in household debt.

Taken together, we believe the evidence is most consistent with a model in which an outward shift in credit supply is the fundamental shock that explains the rise in household debt. It is likely that incorrect expectations formation by lenders and investors, what has been referred to as "credit market sentiment" in the literature, is an important factor in explaining the outward shift in credit supply. Credit demand shocks may be an important part of the boom in household debt; but on net it appears that credit supply shocks are more salient.

Some caveats are in order. Our sample period focuses on the years since 1960, a period that has seen "an unprecedented surge in the scale and scope of financial activities in advanced economies" (Jordà et al. (2014a)). The household debt channel we uncover in this chapter may be a relatively new phenomenon that reflects heightened financialization. Further, our focus is on short- to medium-run business cycle frequency. As such our results do not necessarily speak to the literature that compares cross-country differences in financial development and growth. There are multiple institutional factors that drive differences across countries in their financial dependence and level of economic development. Our focus is instead on within-country business cycles and their relation with household debt.

Our chapter is related to some promising avenues of research. First, more research is needed to understand the variation across time in credit supply. For example, some scholars have pointed to monetary policy in core countries such as the United States as a potential driver (Bruno and Shin (2015), Miranda-Agrippino and Rey (2014), and Rey (2015)). Others have highlighted behavioral factors by credit market participants. Whatever the fundamental source of the shift in credit supply, we believe that household debt plays a crucial role in explaining why credit supply shocks are related to subsequent output growth.

Second, why is the medium-run impact of household debt growth on output larger than that of firm debt growth? There is little theoretical or empirical research to help answer this question.[37] Here, we offer a few explanations to guide future research.

One reason could be the strong link between household debt and house prices (Jordà et al. (2014b)). Mortgage credit expansion can cause a boom and bust in house prices, and mortgage borrowing exposes households to potentially large changes in net worth when house prices fall. Empirical estimates show that consumers and the local economy display high sensitivity to housing net worth shocks (Mian et al. (2013)). In contrast to the central role that housing plays in household finances, firms employ many forms of collateral in addition to real estate in their financing and are therefore less exposed to real estate cycles.

Another reason may be behavioral biases. There is a growing literature which suggests that some households display high sensitivity to increases in available credit (Gross and Souleles (2002), Agarwal et al. (2016)). This sensitivity may be driven by behavioral biases such as time inconsistency (Laibson (1997)), overoptimism about the ability to repay, or overconfidence about the riskiness of future income (Brunnermeier and Parker (2005)). In contrast, the owner or CFO of a representative firm may be

[37] An exception is Jappelli and Pagano (1994), who suggest that looser borrowing constraints faced by consumers lead to higher household debt and lower growth because the reduction in savings hampers capital accumulation by firms. If growth is endogenous then the lower level of investment slows productivity and output growth.

more sophisticated than the average household and base borrowing on a more realistic assessment of debt service costs and future cash flow. Behavioral biases of households generate a large elasticity of household borrowing with respect to credit supply shocks, and therefore could explain why credit supply shocks work through the household as opposed to firm sector.

A related reason is that large investment grade firms smooth their cash flows and borrow substantially during recessions. For example, Erel et al. (2012) show that investment grade firms' borrowing is countercyclical, with public debt offerings increasing during recessions. Credit demand may thus be a more important driver of borrowing decisions for large firms that account for a substantial fraction of overall debt issuance.

Finally, there are typically more developed institutional arrangements (such as bankruptcy laws) to deal with debt-restructuring at the firm level compared to the household level. In several countries in our sample, there is no consumer bankruptcy framework that allows for debt adjustment or for individuals to discharge debt in a bankruptcy proceeding. Examples of such countries without consumer bankruptcy arrangements in our sample period include Hungary, Italy, and Poland. In European countries that have consumer bankruptcy laws in place, these are generally creditor-friendly with limits on the amount of debt that can be discharged (e.g., in Spain where at most 50% can be discharged), long discharge periods (e.g., Ireland with a 12 year waiting period), or requirements to attempt an amicable settlement outside of the courts. In practice few individuals actually undergo consumer bankruptcy proceedings in countries such as Ireland and Spain. Household over-leveraging can therefore lead to a prolonged period of adjustment and cause a more sustained drag on demand.

Table 2.1: Summary Statistics

	N	Mean	Median	SD	$\frac{SD}{SD(\Delta y)}$	Ser. Cor.
Δy	695	2.90	3.08	2.98	1.00	0.29
$\Delta_3 y$	695	8.40	8.65	6.56	2.21	0.71
$\Delta d^{Private}$	695	3.11	2.52	6.96	2.34	0.39
$\Delta_3 d^{Private}$	695	8.52	7.28	16.04	5.39	0.74
Δd^{HH}	695	1.62	1.33	2.56	0.86	0.43
$\Delta_3 d^{HH}$	695	4.58	3.68	6.24	2.10	0.79
Δd^{F}	695	1.48	1.04	5.66	1.90	0.30
$\Delta_3 d^{F}$	695	3.89	3.11	12.21	4.10	0.69
$\Delta_3 d^{Gov}$	627	1.73	1.16	9.92	3.33	0.71
$\Delta_3 d^{Netforeign}$	636	-0.57	1.30	15.01	5.04	0.79
Δc	678	2.81	2.90	2.84	0.95	0.33
Δc^{dur}	469	4.91	5.35	9.27	3.12	0.21
Δc^{nondur}	469	1.53	1.47	2.53	0.85	0.26
$\Delta C/Y$	690	-0.06	-0.01	1.17	0.39	0.04
Δi	678	2.66	3.67	10.79	3.63	0.15
Δg	688	2.84	2.60	2.79	0.94	0.26
Δx	695	8.64	9.30	12.29	4.13	0.15
Δm	695	8.08	9.55	13.87	4.66	0.12
$\Delta NX/Y$	695	0.14	-0.01	2.11	0.71	0.03
$\Delta CA/Y$	648	0.08	-0.02	2.29	0.77	-0.01
Δs^{XC}	695	-0.15	-0.07	1.80	0.61	0.04
Δs^{MC}	695	0.16	0.15	1.67	0.56	0.00
$\Delta reer$	614	-0.03	0.59	6.75	2.27	0.05
Δu	669	0.08	-0.01	1.08	0.36	0.34
$\Delta_3 u$	662	0.19	-0.01	2.43	0.82	0.67
$\Delta_3 y^{WEO}_{t+3\|t}$	484	9.41	8.60	3.76	1.26	0.50
$\Delta_3(y_{t+3} - y^{WEO}_{t+3\|t})$	484	-2.53	-1.79	5.35	1.80	0.54
$\Delta_3 \ln(P^{Housing})$	514	6.56	7.16	17.42	5.85	0.72
spr^{real}	622	0.43	0.40	2.11	0.71	0.42
spr^{MS}	517	1.15	0.99	1.52	0.51	0.45
spr^{corp}	460	0.76	0.65	1.03	0.35	0.42

Notes: Log changes and ratios are multiplied by 100 to report changes in percentages or percentage points. Δ and Δ_3 denote to one-year and three-year changes, respectively. The variables $y, d^{Private}, d^{HH}, d^{F}, d^{Gov}, \Delta_3 d^{Netforeign}, c, c^{dur}, c^{nondur}, C/Y, i, g, x, m, NX/Y, CA/Y, s^{XC}, s^{MC}$, $reer, u, y^{WEO}_{t+3|t}$, $\ln(P^{Housing})$, spr^{real}, spr^{MS}, and spr^{corp} denote log real GDP, private non-financial debt to GDP, household debt to GDP, non-financial firm debt to GDP, government debt to GDP, change net foreign liabilities (sum of current account to GDP deficits), log real consumption, log real durable consumption, log real nondurable consumption, consumption to GDP, log real investment, log real government consumption, log nominal exports, log nominal imports, net exports to GDP, current account to GDP, the share of consumption exports to total exports, the share of consumption imports to total imports, log real effective exchange rate, the unemployment rate, the IMF Fall *World Economic Outlook* time t forecast of growth from t to t+3, the log real house price index, the real 10 year government bond yield spread with respect to the United States, mortgage-sovereign spread, and the corporate-sovereign spread, respectively.

Table 2.2: Credit Expansion and Contemporaneous and Future Three-Year GDP Growth

	Dependent variable: $\Delta_3 y_{it+k}, k = -1, 0, ..., 5$						
	(1) $\Delta_3 y_{it-1}$	(2) $\Delta_3 y_{it}$	(3) $\Delta_3 y_{it+1}$	(4) $\Delta_3 y_{it+2}$	(5) $\Delta_3 y_{it+3}$	(6) $\Delta_3 y_{it+4}$	(7) $\Delta_3 y_{it+5}$
$\Delta_3 d^{HH}_{it-1}$	0.176*	0.121	-0.0136	-0.178**	-0.337**	-0.410**	-0.405**
	(0.0793)	(0.0810)	(0.0680)	(0.0629)	(0.0779)	(0.0905)	(0.102)
$\Delta_3 d^{F}_{it-1}$	-0.0430	-0.140*	-0.159**	-0.108**	-0.0411	0.0327	0.0876*
	(0.0556)	(0.0550)	(0.0437)	(0.0362)	(0.0349)	(0.0395)	(0.0373)
Country fixed effects	✓	✓	✓	✓	✓	✓	✓
Test for equality of β_{HH} and β_F, p-value	.0465	.0184	.0905	.3558	.0017	.0002	.0002
R^2	0.0256	0.0631	0.0999	0.103	0.128	0.138	0.128
Observations	815	785	755	725	695	665	635

Notes: This table presents results from estimating the following specification $\Delta_3 y_{it+k} = \alpha_i + \beta_{HH} \Delta_3 d^{HH}_{it-1} + \beta_F \Delta_3 d^{F}_{it-1} + u_{it+k}$ for $k = -1, ..., 5$. Each column gradually leads the left-hand-side variable by one year. Reported R^2 values are from within-country variation. Standard errors in parentheses are dually clustered on country and year. +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Table 2.3: Household Debt Expansion Predicts Lower Subsequent Growth

	Dependent variable: $\Delta_3 y_{it+3}$							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta_3 d_{it-1}^{Private}$	-0.119**							
	(0.0313)							
$\Delta_3 d_{it-1}^{HH}$		-0.366**		-0.337**	-0.333**	-0.340**	-0.325**	-0.192*
		(0.0772)		(0.0779)	(0.0771)	(0.0868)	(0.0839)	(0.0959)
$\Delta_3 d_{it-1}^{F}$			-0.0978*	-0.0411	-0.0464	-0.0235	-0.0519	-0.0498
			(0.0391)	(0.0349)	(0.0354)	(0.0437)	(0.0395)	(0.0380)
$\Delta_3 d_{it-1}^{Gov}$						0.0534		
						(0.0430)		
$\Delta_3 d_{it-1}^{Netforeign}$							0.00793	
							(0.0523)	
$\mathbf{1}(\Delta_3 d_{it-1}^{Netforeign} > 0\ )$								0.736
								(1.005)
$\Delta_3 d_{it-1}^{HH} * \mathbf{1}(\Delta_3 d_{it-1}^{Netforeign} > 0\ )$								-0.235+
								(0.140)
Country fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
Distributed lag in Δy					✓	✓	✓	✓
Test for equality of β_{HH} and β_F, p-value				.002	.003	.003	.007	
R^2	0.0869	0.123	0.0364	0.128	0.131	0.126	0.168	0.181
Observations	695	695	695	695	695	627	636	636

Notes: This table reports regressions of real GDP growth from t to $t+3$ on the change in total private, household, and non-financial firm debt to GDP from the end of $t-4$ to the end of $t-1$. Columns 5-8 control for three lags of GDP growth over the same period as the change in debt to GDP, $\Delta y_{it-1}, \Delta y_{it-2}$, and Δy_{it-3}. Column 6 includes the increase in government debt to GDP over the same period, and column 7 controls for the change in net foreign debt, calculated as the sum of current account deficits to GDP over the same 3 year period. Column 8 interacts the increase in household debt with a dummy for whether the cumulated current account over the same period is negative. All specifications include country fixed effects. Reported R^2 values are from within-country variation. Standard errors in parentheses are dually clustered on country and year. +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Table 2.4: Household Debt Expansion Predicts Lower Growth: Robustness

	Dependent variable: $\Delta_3 y_{it+3}$						
	(1) OLS	(2) AB-GMM	(3) OLS	(4) MBB SE	(5) OLS	(6) OLS	(7) OLS
$\Delta_3 d^{HH}_{it-1}$	-0.32**	-0.32**	-0.31**	-0.33**	-0.23**	-0.21**	
	(0.081)	(0.11)	(0.087)	(0.083)	(0.075)	(0.063)	
$\Delta_3 d^{F}_{it-1}$	-0.057	-0.069	-0.063	-0.046	-0.042	-0.037	
	(0.044)	(0.071)	(0.045)	(0.031)	(0.033)	(0.033)	
Trend					-0.23**		
					(0.063)		
$\Delta_3 d^{HH}_{it-1}$, alt norm.							-0.30**
							(0.070)
$\Delta_3 d^{F}_{it-1}$, alt. norm.							0.020
							(0.034)
Country fixed effects	✓			✓	✓	✓	✓
Distributed lag in Δy	✓	✓	✓	✓	✓	✓	✓
Year fixed effects						✓	
Sample	Non-overl.	Non-overl.	Full	Full	Full.	Full	Full
Test for equality of β_{HH} and β_F, p-value	.007	.0004	.035	.0043	.031	.012	.0002
R^2	0.15		0.18	0.13	0.26	0.50	0.15
Observations	232	203	695	695	695	695	695

Notes: This table presents a variety of robustness tests of the main specification in Table 2.3. Column 1 uses the non-overlapping sample that only includes every third year. This specification controls for $\Delta_3 y_{it-1}$. Column 2 uses the Arellano-Bond GMM estimator for the equation in differences on the same non-overlapping sample. We instrument for $\Delta_3 d^{HH}_{it-1}$ and $\Delta_3 d^{F}_{it-1}$ with a double lag, $\Delta_3 d^{HH}_{it-4}$ and $\Delta_3 d^{F}_{it-4}$. Column 3 omits country fixed effects from the main specification estimated using the full sample. Column 4 computes standard errors using the panel moving blocks bootstrap (Gonçalves (2011)) with a block length of $l = 3$. Column 5 includes a time trend, and column 6 includes country fixed effects. Column 7 replace the three year change in debt to GDP with the change in debt normalized by initial $(t-4)$ GDP. Standard errors in all columns (except column 4) are dually clustered on country and year. Reported R^2 values in regressions including country fixed effects are from within-country variation. +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Table 2.5: Household Debt Expansion Predicts Lower Growth: Subsamples

	Dependent variable: $\Delta_3 y_{it+3}$					
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta_3 d^{HH}_{it-1}$	-0.37**	-0.24**	-0.29**	-0.22**	-0.19**	-0.16**
	(0.097)	(0.070)	(0.10)	(0.054)	(0.072)	(0.057)
$\Delta_3 d^{F}_{it-1}$	-0.027	-0.069	-0.038	-0.053	-0.055	-0.061
	(0.040)	(0.063)	(0.062)	(0.039)	(0.038)	(0.038)
Trend					-0.16*	
					(0.066)	
Country fixed effects	✓	✓	✓	✓	✓	✓
Distributed lag in Δy	✓	✓	✓	✓	✓	✓
Year fixed effects						✓
Sample	Developed	Emerging	Pre 1995	Pre 2006	Pre 2006	Pre 2006
Test for equality of β_{HH} and β_F, p-value	.005	.082	.009	.021	.116	.17
R^2	0.16	0.11	0.13	0.088	0.16	0.37
Observations	529	166	259	517	517	517

Notes: This table reports estimates on various subsamples. Columns 1 and 2 present separate estimates for developed and emerging economies. Emerging market economies are the Czech Republic, Hong Kong, Hungary, Indonesia, Korea, Mexico, Poland, Singapore, Thailand, and Turkey. Developed economies are the remaining countries. Column 3 uses data up to 1995, and columns 4-6 use data up to 2006. Column 5 includes a time trend, and column 6 controls for year fixed effects. Standard errors in all columns are dually clustered on country and year. Reported R^2 values in regressions including country fixed effects are from within-country variation. +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Table 2.6: Household Debt Increases Finance Consumption Booms

	(1) $\Delta_1 \frac{C}{Y}_{it}$	(2) $\Delta_1 \frac{C^{nondur}}{Y}_{it}$	(3) $\Delta_1 \frac{C^{dur}}{Y}_{it}$	(4) $\Delta_1 \frac{C^{services}}{Y}_{it}$	(5) $\Delta_1 \frac{I}{Y}_{it}$	(6) $\Delta_1 \frac{NX}{Y}_{it}$	(7) $\Delta_1 \frac{CA}{Y}_{it}$	(8) $\Delta_1 s_{it}^{MC}$	(9) $\Delta_1 s_{it}^{XC}$
$\Delta_1 d_{it}^{HH}$	0.120**	0.0432**	0.0333**	0.0709**	0.0174	-0.173**	-0.185*	0.152**	0.0371
	(0.0462)	(0.0152)	(0.00701)	(0.0230)	(0.0756)	(0.0582)	(0.0813)	(0.0500)	(0.0365)
$\Delta_1 d_{it}^{F}$	0.0249+	0.0200*	-0.0161**	0.0293**	-0.0194	-0.0167	-0.0125	-0.0261	-0.0400*
	(0.0146)	(0.00781)	(0.00238)	(0.00923)	(0.0264)	(0.0247)	(0.0207)	(0.0204)	(0.0197)
Country fixed effects	✓	✓	✓	✓	✓	✓	✓	✓	✓
R^2	0.0825	0.0802	0.0647	0.138	0.00216	0.0408	0.0374	0.0417	0.0129
Observations	690	466	466	466	688	695	648	695	695

Notes: This table shows the contemporaneous correlation between the change in household and firm debt to GDP and the change in total consumption to GDP, non-durable consumption to GDP, durable consumption to GDP, services consumption to GDP, investment to GDP, net exports to GDP, current account to GDP, the share of consumption imports in total imports, and the share of consumption exports in total exports. All specifications include country fixed effects. Reported R^2 values are from within-country variation. Standard errors in parentheses are dually clustered on country and year. +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Table 2.7: Proxy SVAR First Stage Regressions

	Residual from VAR Household Debt Equation		Residual from VAR Firm Debt Equation	
	(1) $\hat{u}_{it}^{d^{HH}}$	(2) $\hat{u}_{it}^{d^{HH}}$	(3) $\hat{u}_{it}^{d^{F}}$	(4) $\hat{u}_{it}^{d^{F}}$
MS Spread, residual	-0.341**		-0.0182	
	(0.101)		(0.267)	
Low MS Spread Indicator, residual		0.689**		0.0347
		(0.220)		(0.588)
F statistic	11.372	9.834	.005	.003
R^2	.024	.021	0	0
Observations	580	580	580	580

Notes: This table shows regressions of the reduced form VAR residuals on the mortgage-sovereign spread instruments. The MS spread residual is the residual from a regression of the MS-spread on the VAR independent variables (including country fixed effects). The low MS spread indicator is the residual of a dummy variable that equals 1 if the standardized spread is below the sample median. Standard errors in parentheses account for contemporaneous correlation in residuals across countries, consistent with the bootstrap resampling procedure used to construct confidence intervals on the Proxy SVAR impulse responses in Figure 2.4. +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Table 2.8: Declining Spreads, Credit Expansion, and Output: Sovereign Spread Convergence in the Eurozone and Falling Mortgage Spreads During the 2000s Credit Boom

	Eurozone Case and Sovereign Spread over U.S.				2000s Boom and Mortgage-Sovereign Spread			
	(1) $\Delta_{07-10}y_i$	(2) $\Delta_{02-07}d_i^{HH}$	(3) $\Delta_{07-10}y_i$	(4) $\Delta_{07-10}y_i$	(5) $\Delta_{07-10}y_i$	(6) $\Delta_{02-07}d_i^{HH}$	(7) $\Delta_{07-10}y_i$	(8) $\Delta_{07-10}y_i$
$\Delta_{96-99}spr_i^{real}$		-11.66**						
		(3.428)						
$\Delta_{02-07}d_i^{HH}$	-0.170**		-0.222**	-0.218*	-0.180		-0.296*	-0.347
	(0.0404)		(0.0479)	(0.107)	(0.118)		(0.144)	(0.306)
$\Delta_{02-07}d_i^{F}$				0.0326				0.0975
				(0.0833)				(0.179)
$\Delta_{02-07}y_i$				-12.76				0.416**
				(14.36)				(0.103)
$\Delta_{00-04}spr_i^{MS}$						-10.28**		
						(2.889)		
Equation	OLS	FS	IV	IV	OLS	FS	IV	IV
First stage F-statistic		11.6				12.669		
R^2	0.530	0.526	0.480	0.537	0.164	0.398	0.0952	0.362
Observations	12	12	12	12	21	21	21	21

Notes: This table reports instrumental variables regressions of GDP growth from 2007 to 2010 on the expansion in household debt to GDP from 2002 to 2007. Column 1 shows the OLS estimate for the Eurozone countries and Denmark (in ERM II). Columns 2-4 use the change in the real sovereign spread (nominal spread minus inflation difference) with respect to the United States during 1996-1999 as an instrument for the 2002-2007 expansion in household or firm debt to GDP. Column 5 shows the OLS estimate for the broader sample of countries for which the mortgage-sovereign spread variable is non-missing. Columns 6-8 use the change in the mortgage spread over the 10 year government bond yield during 2000-2004 as an instrument for the increase in household or firm debt to GDP from 2002-2007. The regressions in columns 6-10 exclude Hungary, as Hungary's decline in the mortgage-sovereign spread is a large outlier in this period. Standard errors in parentheses are robust to heteroskedasticity. +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Table 2.9: Rise in Household Debt Predicts Overoptimistic IMF and OECD Growth Forecasts

	Growth Forecast		Forecast Error					Forecast Error Sample up to 2006	
	(1) $\Delta_2 y^{IMF}_{t+2\|t}$	(2) $\Delta_2 y^{OECD}_{t+2\|t}$	(3) $e^{IMF}_{t+1\|t}$	(4) $e^{IMF}_{t+2\|t}$	(5) $e^{IMF}_{t+3\|t}$	(6) $e^{OECD}_{t+1\|t}$	(7) $e^{OECD}_{t+2\|t}$	(8) $e^{IMF}_{t+1\|t}$	(9) $e^{OECD}_{t+1\|t}$
$\Delta_3 d^{HH}_{it-1}$	0.0016	0.0013	-0.060**	-0.17**	-0.31**	-0.070**	-0.17*	-0.035+	-0.042**
	(0.023)	(0.028)	(0.020)	(0.057)	(0.091)	(0.023)	(0.071)	(0.021)	(0.015)
$\Delta_3 d^{F}_{it-1}$	-0.029	-0.041*	-0.019	-0.026	-0.031	-0.013	-0.0084	-0.029	-0.020*
	(0.021)	(0.017)	(0.027)	(0.045)	(0.051)	(0.015)	(0.029)	(0.020)	(0.0080)
Country fixed effects	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sample	Full	Full	Full	Full	Full	Full	Full	Pre 2006	Pre 2006
Test for equality of β_{HH} and β_F, p-value	.367	.227	.311	.089	.02	.053	.07	.863	.29
R^2	0.034	0.064	0.026	0.063	0.13	0.040	0.073	0.026	0.027
Observations	484	471	590	484	484	594	471	469	490

Notes: This table reports regression estimates of GDP growth forecasts and forecast errors on the change in household and non-financial firm debt to GDP from $t-4$ to $t-1$. The forecasts are from the fall issues of the IMF *World Economic Outlook* and the *OECD Economic Outlook*. $\Delta_h y^f_{t+h|t}$ is the forecasted change in log GDP from t to $t+h$ made in the Fall of year t, and $e^f_{t+h|t}$ is the realized forecast error. The IMF and OECD forecast errors are constructed using the realized log GDP change reported in the IMF's Historical WEO Forecasts Database and the *OECD Economic Outlook* reports, respectively. The *World Economic Outlook* forecast sample includes all 30 countries in the sample and covers the years 1990-2012, with one-year-ahead forecasts extending back to 1972 for the G7. One- and two-year-ahead *OECD Economic Outlook* forecasts are for years 1973-2012 and 1987-2012, respectively. We exclude Hong Kong, Indonesia, Singapore, and Thailand from the OECD sample because of gaps in the forecast series. The regressions in columns 8 and 9 are estimated using data to 2006.
Reported R^2 values are from within-country variation. Standard errors in parentheses are dually clustered on country and year. +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Table 2.10: Non-linearity and Heterogeneity across Exchange Rate Regimes

	Non-linearity	Fixed	Intermediate	Freely floating
	(1)	(2)	(3)	(4)
	$\Delta_3 y_{it+3}$	$\Delta_3 y_{it+3}$	$\Delta_3 y_{it+3}$	$\Delta_3 y_{it+3}$
$\Delta_3 d^{HH}_{it-1} * \mathbf{1}(\Delta_3 d^{HH}_{it-1} > 0)$	-0.436**			
	(0.106)			
$\Delta_3 d^{HH}_{it-1} * \mathbf{1}(\Delta_3 d^{HH}_{it-1} \leq 0)$	0.0655			
	(0.156)			
$\Delta_3 d^{F}_{it-1} * \mathbf{1}(\Delta_3 d^{F}_{it-1} > 0)$	-0.0537			
	(0.0367)			
$\Delta_3 d^{F}_{it-1} * \mathbf{1}(\Delta_3 d^{F}_{it-1} \leq 0)$	-0.0396			
	(0.0631)			
$\Delta_3 d^{HH}_{it-1}$		-0.534**	-0.311**	-0.0673
		(0.128)	(0.0716)	(0.129)
$\Delta_3 d^{F}_{it-1}$		-0.113*	-0.0119	0.0519
		(0.0495)	(0.0425)	(0.116)
Country fixed effects	✓	✓	✓	✓
Distributed lag in Δy	✓	✓	✓	✓
Test for equality of β_{HH} and β_F, p-value		.008	.004	.535
R^2	0.146	0.281	0.114	0.0324
Observations	695	221	341	120

Notes: Column 1 explores non-linearity in the relation between credit expansion and growth in the full sample. For both household and firm debt, we estimate separate coefficients for positive and negative changes in debt to GDP. Columns 2-4 report separate regressions by *de facto* exchange rate arrangement in year t from Ilzetzki et al. (2010). Fixed regimes cover arrangements with no separate legal tender, currency boards, pegs, and narrow horizontal bands (coarse ERA code 1 from Ilzetzki et al. (2010)). Intermediate regimes include crawling pegs, crawling bands, moving bands, and managed floats (coarse ERA codes 2 and 3). We exclude 11 country-years in which the *de facto* arrangement is classified as "freely falling" (cases where 12-month inflation is greater than 40%). All regressions include country fixed effects and three lags of GDP growth. Reported R^2 values are from within-country variation. Standard errors in parentheses are dually clustered on country and year. +,*,** indicates a significance at the 0.1, 0.05, 0.01 level, respectively.

Table 2.11: Unemployment and Household Debt Expansions

	Full Sample		Fixed ER Regimes	Intermediate	Freely floating
	(1)	(2)	(3)	(4)	(5)
	$\Delta_3 u_{it+3}$	$\Delta_3 u_{it+3}$	$\Delta_3 u_{it+3}$	$\Delta_3 u_{it+3}$	$\Delta_3 u_{it+3}$
$\Delta_3 d^{HH}_{it-1}$	0.132**	0.105**	0.264**	0.0709+	-0.0159
	(0.0380)	(0.0390)	(0.0736)	(0.0367)	(0.0587)
$\Delta_3 d^{F}_{it-1}$	0.0363*	0.0373*	0.0615+	0.0385*	0.0403
	(0.0153)	(0.0158)	(0.0319)	(0.0194)	(0.0332)
Country fixed effects	✓	✓	✓	✓	✓
Distributed lag in Δu		✓	✓	✓	✓
Test for equality of					
β_{HH} and β_F, p-value	.026	.131	.001	.425	.506
R^2	0.145	0.207	0.397	0.235	0.254
Observations	662	638	211	296	120

Notes: This table reports regression estimates of the change in the unemployment rate from t to $t+3$ on the change in household and non-financial firm debt to GDP from $t-4$ to $t-1$. All columns include country fixed effects. Columns 2-5 include three lags of the change in the unemployment rate as controls. Columns 3-5 estimate the regression across exchange rate regimes, as defined in Table 2.10. Reported R^2 values are from within-country variation. Standard errors in parentheses are dually clustered on country and year. +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Table 2.12: House Prices, Household Debt, and GDP Growth

	$\Delta_3 \ln(P_{it-1}^{Housing})$	$\Delta_3 y_{it+3}$			
	(1)	(2)	(3)	(4)	(5)
$\Delta_3 d_{it-1}^{HH}$	1.035**	-0.243**	-0.241**	-0.210**	-0.179*
	(0.263)	(0.0658)	(0.0709)	(0.0481)	(0.0742)
$\Delta_3 d_{it-1}^{F}$		-0.0443	-0.0575	-0.0676	-0.0348
		(0.0379)	(0.0381)	(0.0429)	(0.0348)
$\Delta_3 \ln(P_{it-1}^{Housing})$		-0.0607**	-0.0688*	-0.0552+	-0.0288
		(0.0224)	(0.0280)	(0.0333)	(0.0269)
Country fixed effects	✓	✓	✓	✓	✓
Distributed lag in Δy			✓	✓	✓
Year fixed effects					✓
Sample	Full	Full	Full	Pre 2006	Full
R^2	0.109	0.175	0.184	0.184	0.502
Observations	514	514	514	395	514

Notes: This table explores the relationship between household debt and house prices and presents robustness to including house price growth in the main specification. Column 1 shows the correlation between the increase in household debt to GDP and real house price growth over $t-4$ to $t-1$. Real house price growth is constructed from the BIS's "Long series on nominal residential property prices" (fourth quarter value) deflated by the CPI. Columns 2-5 report results from robustness checks that include the change in real house prices from $t-4$ to $t-1$ in the main specification. Columns 3-5 control for three GDP growth lags. All columns include country fixed effects, and column 5 also includes year fixed effects. Reported R^2 values are from within-country variation. Standard errors in parentheses are dually clustered on country and year. +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Table 2.13: Credit Expansion, Net Exports, and Correlation with the Global Household Debt Cycle

	(1) $\frac{\Delta_3 NX_{it+3}}{Y_{it}}$	(2) $\Delta_3 \ln \frac{X_{it+3}}{M_{it+3}}$	(3) $\frac{\Delta_3 X_{it+3}}{Y_{it}}$	(4) $\frac{\Delta_3 M_{it+3}}{Y_{it}}$	(5) $\Delta_3 s^{MC}_{it+3}$	(6) $\frac{\Delta_3 NX_{it+3}}{Y_{it}}$	(7) $\frac{\Delta_3 NX_{it+3}}{Y_{it}}$	(8) $\Delta_3 y_{it+3}$	(9) $\frac{\Delta_3 NX_{it+3}}{Y_{it}}$	(10) $\Delta_3 y_{it+3}$
$\Delta_3 d^{HH}_{it-1}$	0.17**	0.39**	-0.061	-0.23	-0.076*	0.049	0.11+	-0.22*	0.25**	-0.22**
	(0.049)	(0.15)	(0.13)	(0.16)	(0.035)	(0.052)	(0.057)	(0.090)	(0.039)	(0.060)
$\Delta_3 d^{F}_{it-1}$	0.022	0.12+	-0.033	-0.055	0.013	0.031+	0.023	-0.045	0.024	-0.063*
	(0.021)	(0.069)	(0.057)	(0.063)	(0.015)	(0.019)	(0.020)	(0.036)	(0.020)	(0.027)
$\Delta_3 d^{HH}_{it-1} \times \text{openness}_i$						0.17**	0.14**			
						(0.027)	(0.036)			
$\Delta_3 d^{HH}_{it-1} \times \rho^{Global}_i$								-0.33	-0.22**	
								(0.22)	(0.071)	
$\text{Global}_{-i} \Delta_3 d^{HH}_{it-1}$										-0.74**
										(0.26)
Distributed lag in Δy	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year fixed effects							✓			
Test for equality of β_{HH} and β_F, p-value	.013	.144	.868	.359	.026					
R^2	0.062	0.075	0.021	0.039	0.058	0.080	0.19	0.16	0.080	0.22
Observations	695	695	695	695	695	695	695	693	693	693

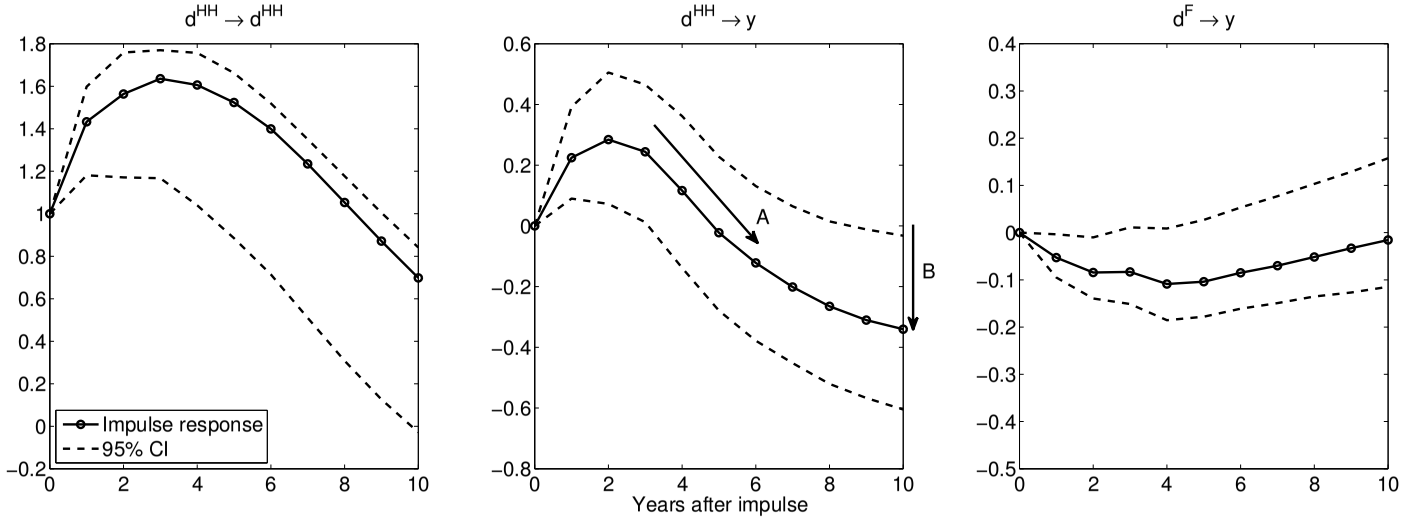
Notes: This table reports regressions of a variety of outcomes from t to $t+3$ on the expansion in household and non-financial firm debt to GDP from $t-4$ to $t-1$. openness_i is defined as the average imports plus exports to GDP ratio during the sample period. ρ^{Global}_i is the correlation between country i's three-year household debt expansion and the sample average household debt expansion excluding country i, given by equation (2.5). $\text{Global}_{-i} \Delta_3 d^{HH}_{it-1}$ is the global average change in household debt to GDP over $t-4$ to $t-1$ excluding country i. All regressions include country fixed effects. Reported R^2 values are from within-country variation. Standard errors in parentheses are clustered at the country level. +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Table 2.14: Global Household and Firm Debt and Global Growth

	Dependent variable: global average $\Delta_3 y_{t+3}$				
	(1)	(2)	(3)	(4)	(5)
Global $\Delta_3 d^{HH}_{t-1}$	-1.094**		-1.097**	-0.966**	-0.928**
	(0.300)		(0.311)	(0.252)	(0.288)
Global $\Delta_3 d^{F}_{t-1}$		-0.103	0.00896	-0.0756	0.0727
		(0.192)	(0.177)	(0.149)	(0.192)
Global Δy_{t-1}				0.341	0.342
				(0.244)	(0.257)
Global Δy_{t-2}				0.390+	0.426*
				(0.224)	(0.189)
Global Δy_{t-3}				0.477+	0.532+
				(0.258)	(0.280)
Sample	Full	Full	Full	Full	Pre 2006
Test for equality of β_{HH} and β_F, p-value			.0072	.0076	.0037
R^2	.295	.007	.295	.471	.426
Observations	46	46	46	46	40

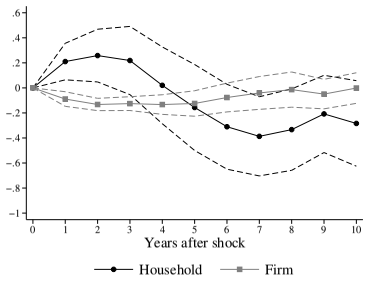
Notes: This table reports time series regressions of the sample average real GDP growth from t to $t+3$ on the sample average change in household and firm debt to GDP from $t-4$ to $t-1$. Newey-West standard errors in parentheses are computed with 6 lags. +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Figure 2.1: Impulse Responses from a Recursive VAR in Real GDP, Non-financial Firm Debt, and Household Debt

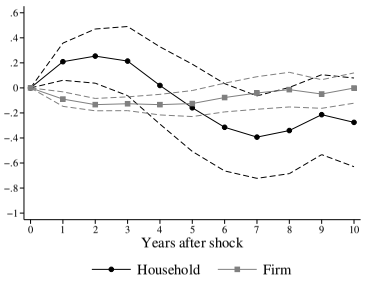


Notes: This figure presents impulse responses from a three variable VAR in log real GDP, firm debt to lagged GDP, and household debt to lagged GDP. The left panel shows the household debt response to a household debt shock. The middle panel presents the real GDP response to a household debt shock. The right panel shows the real GDP response to a firm debt shock. The shocks are identified using a Cholesky decomposition with the ordering $\left(y_{it}, d_{it}^{F}, d_{it}^{HH}\right)$. The VAR is estimated in levels with country fixed effects on the 30 country sample. The reduced form VAR coefficients are corrected for Nickell bias using an iterative bootstrap procedure. Dash lines represent 95% confidence intervals that account for contemporaneous cross-country residual correlation and are computed by resampling cross-sections of residuals using the wild bootstrap.

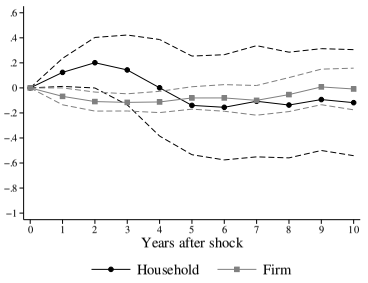
Figure 2.2: Robustness with Jordà (2005) Local Projection Impulse Responses



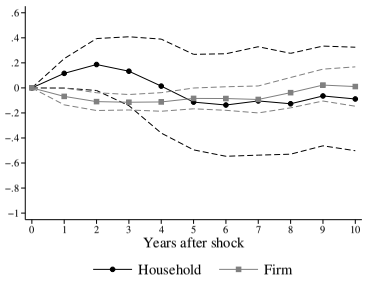
(a) Baseline: Jordà (2005) Local Projection VAR in levels on full sample



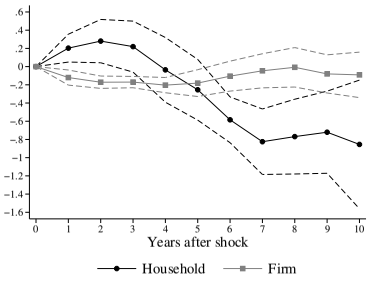
(b) Levels, include time trend



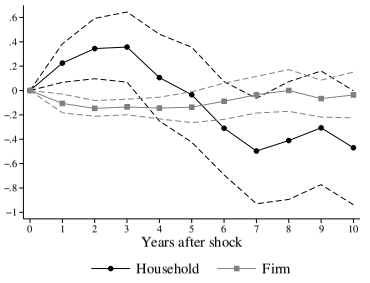
(c) Levels, excluding Great Recession



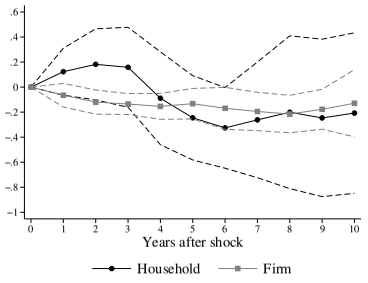
(d) Levels with time trend, excluding Great Recession



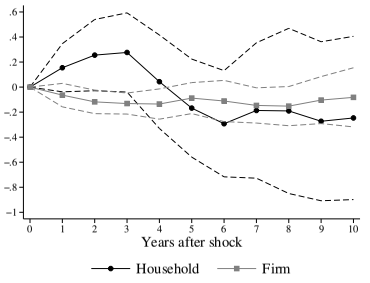
(e) First differences



(f) First difference, include time trend



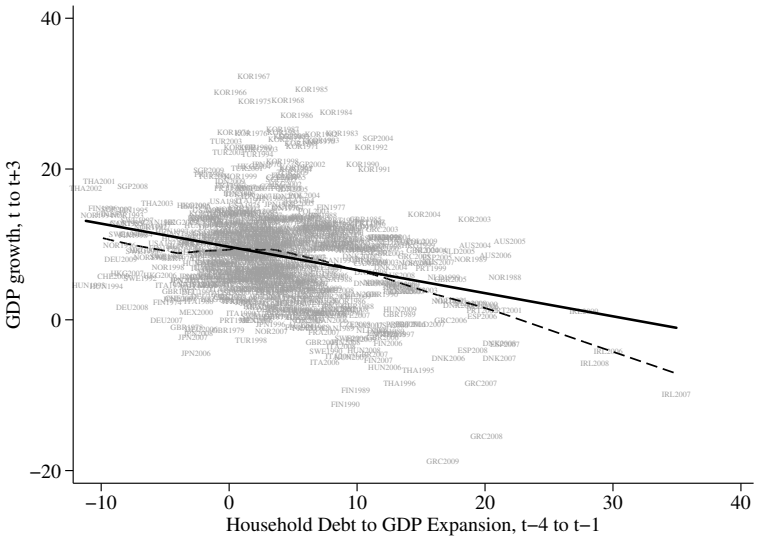
(g) First difference, excluding Great Recession



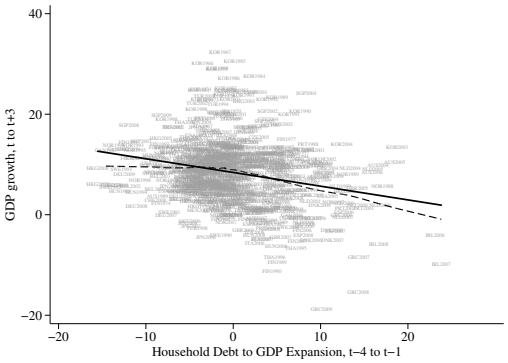
(h) First difference with time trend, excluding Great Recession

Notes: This figure presents impulse responses from Jordà (2005) local projections estimated in levels and first differences. The specification in levels is: $y_{it+h-1} = \alpha_i^h + X_{it-1}\Gamma^h + \sum_{j=1}^{5}\beta_{HH,j}^h d_{it-j}^{HH} + \sum_{j=1}^{5}\beta_{F,j}^h d_{it-j}^{F} + \sum_{j=1}^{5}\delta_j^h y_{it-j} + \epsilon_{it+h-1}^h$ for horizons $h = 1, ..., 10$. To be consistent with the VAR model, d_{it}^s is nominal debt in sector $s = HH, F$ in year t scaled by nominal GDP in $t-1$. The model in first differences is $\Delta_h y_{it+h-1} = \alpha_i^h + X_{it-1}\Gamma + \sum_{j=1}^{5}\beta_{HH,j}^h \Delta d_{it-j}^{HH} + \sum_{j=1}^{5}\beta_{F,j}^h \Delta d_{it-j}^{F} + \sum_{j=1}^{5}\delta_j^h \Delta y_{it-j} + u_{it+h-1}^h$, for horizons $h = 1, ..., 10$, where here d_{it}^s refers to the debt to GDP ratio in sector $s = HH, F$. Models that exclude the Great Recession use data up to 2006. Dash lines represent 95% confidence intervals computed using standard errors dually clustered on country and year.

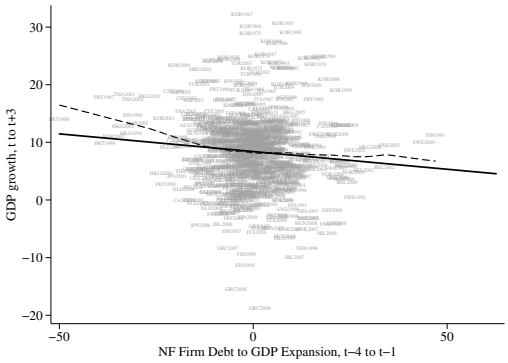
Figure 2.3: Household Debt to GDP Expansion and Growth



(a) Household Debt



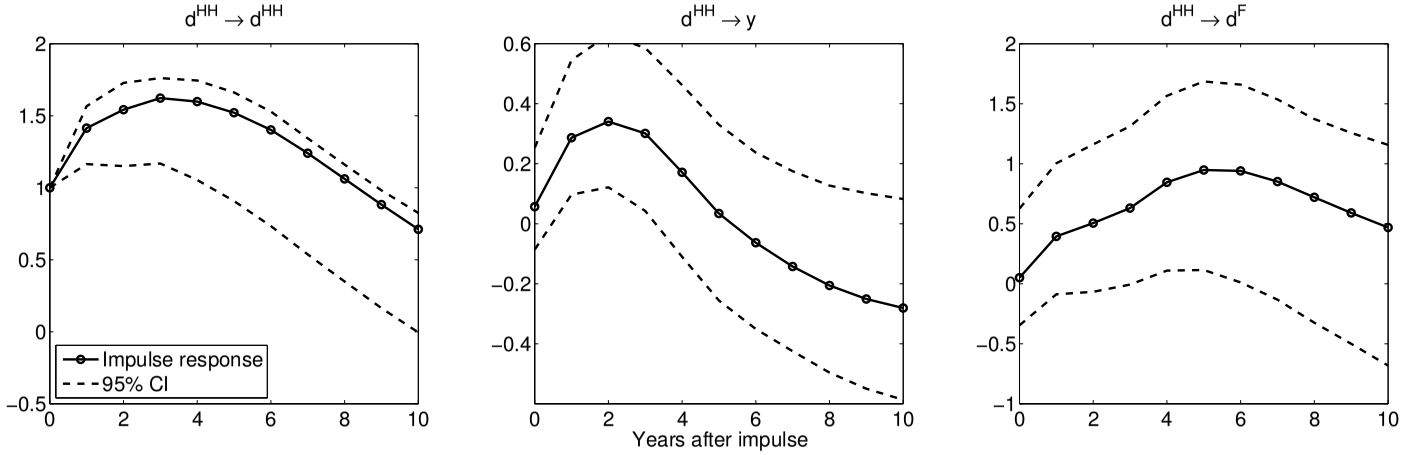
(b) Household Debt, Partial Correlation



(c) NF Firm Debt, Partial Correlation

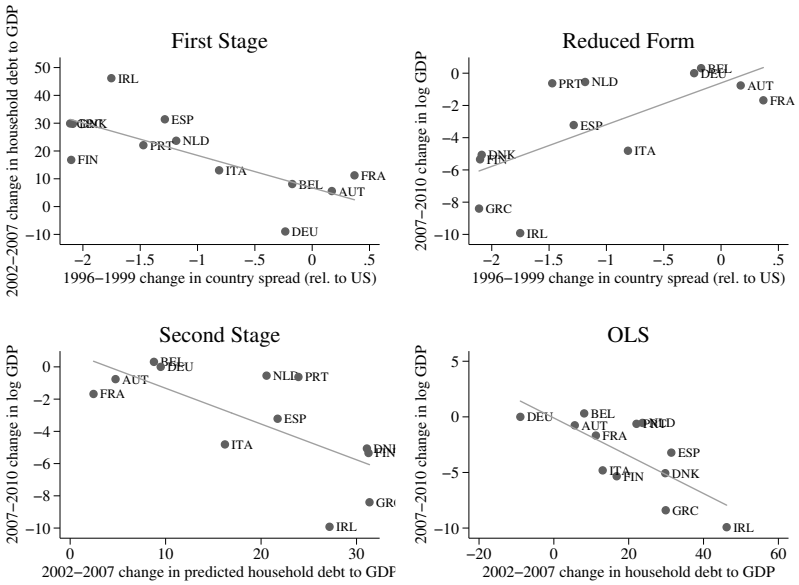
Notes: This figure plots the relationship between GDP growth from t to $t+3$ and the expansion in household and firm debt to GDP from $t-4$ to $t-1$. Each point refers to year t. The dashed line is the non-parametric plot of GDP growth from t to $t+3$ against the increase in household or firm debt to GDP from $t-4$ to $t-1$. In panel (b) household debt is partialed out with the expansion in non-financial firm debt to GDP, while in panel (c) non-financial firm debt is partialed out with the expansion in household debt to GDP.

Figure 2.4: Impulse Responses to a Household Debt Shock Identified with the Mortgage Lending Spread in a Proxy SVAR

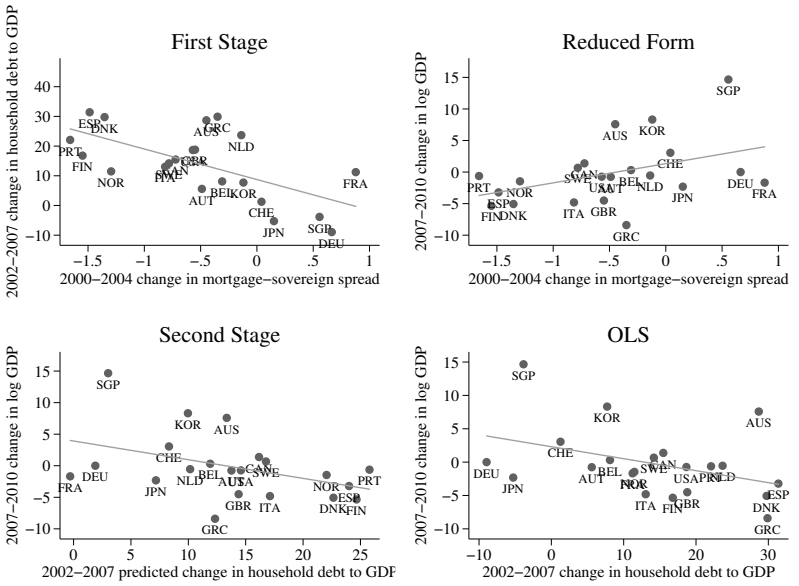


Notes: This figure shows impulse responses to a household debt shock identified using an indicator variable for whether the standardized mortgage spread is below the median as an external instrument in a Proxy SVAR. The reduced form VAR coefficient estimates are corrected for Nickell bias using an iterative bootstrap procedure. Dash lines represent 95% confidence intervals that account for contemporaneous cross-country residual correlation and are computed by resampling cross-sections of residuals using the wild bootstrap.

Figure 2.5: Declining Spreads, Credit Growth, and Output Growth



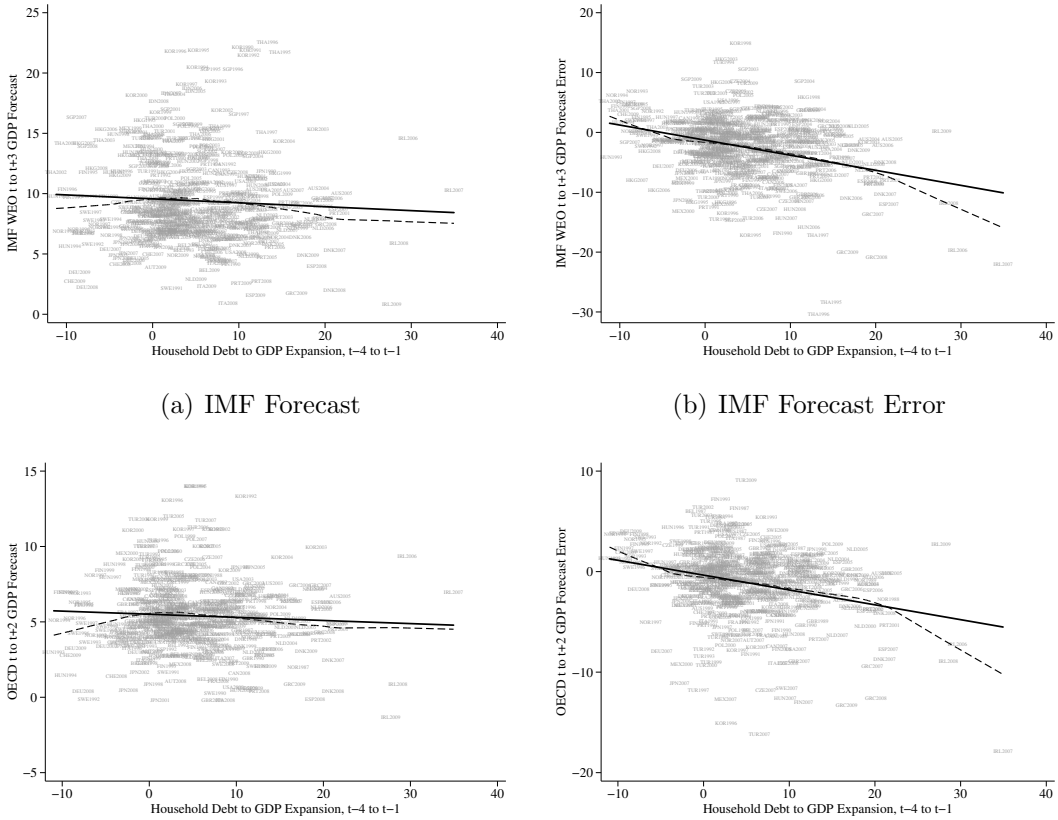
(a) Eurozone Case and Sovereign Spread over U.S. 10-Year Treasury



(b) 2000s Mortgage Credit Boom and Mortgage-Sovereign Spread

Note: Panel (a) illustrates the relation between the decline in real sovereign spreads (nominal spread minus difference in inflation) between 1996 and 1999, the expansion in household debt from 2002 to 2007, and the change in log real GDP from 2007 to 2010 for 11 Eurozone countries and Denmark (in ERM II). Panel (b) illustrates the relation between the change in the mortgage lending rate relative to the 10-year government bond yield between 2000 and 2004, the expansion in household debt to GDP from 2002 to 2007, and the change in log real GDP from 2007 to 2010. The figures in panel (b) include 21 countries in the sample with non-missing mortgage lending rate data. These figures exclude Hungary, as the decline in spreads is a large outlier for this observation.

Figure 2.6: Household Debt Expansion Predicts Negative GDP Growth Forecast Errors



(a) IMF Forecast

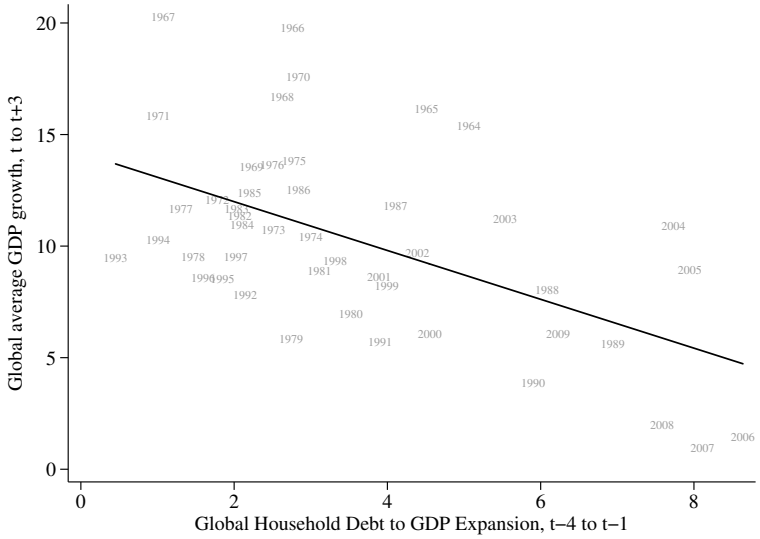
(b) IMF Forecast Error

(c) OECD Forecast

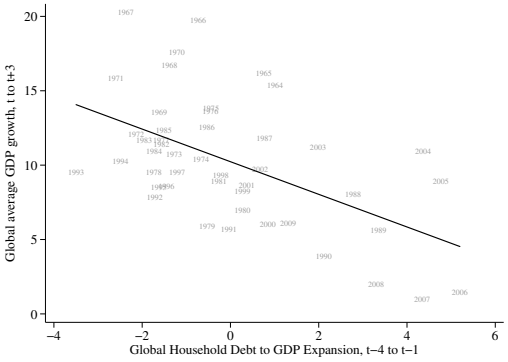
(d) OECD Forecast Error

Notes: Panels (a) and (b) plot the three-year GDP forecasts and forecast errors from the Fall issue of the IMF *World Economic Outlook* against the change in household debt to GDP from $t-4$ to $t-1$. The IMF WEO sample for the three-year ahead forecasts includes years 1990-2012. Panels (c) and (d) plot the two-year GDP forecasts and forecast errors from the Fall *OECD Economic Outlook* against the change in household debt to GDP from $t-4$ to $t-1$. The OECD sample includes years 1987-2012. We exclude Hong Kong, Indonesia, Singapore, and Thailand from the OECD sample because of gaps in the forecast series. Each point refers to year t.

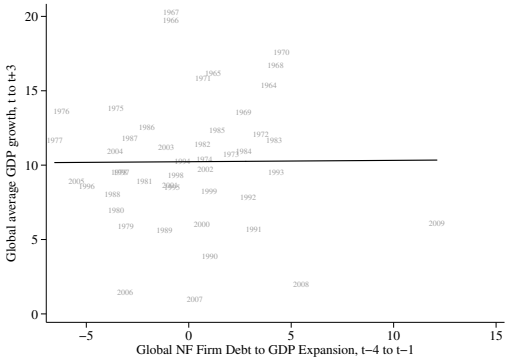
Figure 2.7: Global Household Debt Expansions and Global Growth



(a) Household Debt



(b) Household Debt, Partial Correlation



(c) NF Firm Debt, Partial Correlation

Note: This figure illustrates the relationship between the sample average of real GDP growth from t to $t+3$ and the sample average of the change in household and firm debt to GDP from $t-4$ to $t-1$. Each point refers to year t. In panel (b) household debt is partialed out with the expansion in non-financial firm debt, while in panel (c) non-financial firm debt is partialed out with the expansion in household debt.

Chapter 3

How Do Credit Supply Shocks Affect the Real Economy? Evidence from the United States in the 1980s

3.1 Introduction

There is increasing recognition that credit supply expansions and business cycles are closely connected.[1] While establishing a causal connection between credit and business cycles is typically difficult, even less is known about *how* credit affects the

*Versions of this chapter were previously presented at NBER Summer Institute 2017, the Norgesbank Workshop on Housing and Household Finance, and seminars at various institutions.

[1]For example, Jordà et al. (2013), Krishnamurthy and Muir (2017), Reinhart and Rogoff (2009), Mian et al. (2017), Baron and Xiong (2017) and López-Salido et al. (2017). Credit supply expansion refers to a greater willingness to lend, all else equal. It may be driven by factors such as deregulation, liberalization, global savings glut, or behavioral factors (as examples, see Favilukis et al. (2015), Justiniano et al. (2015), Gennaioli et al. (2012), Bordalo et al. (2015), Landvoigt (2016), and Greenwood et al. (2016))

business cycle. There are two ways through which credit can influence the macroeconomy. First, credit expansion may allow constrained firms to borrow and invest more, increasing the economy's *production capacity*. Second, credit expansion may allow households to borrow and consume more, increasing overall *local demand*. The two channels are fundamentally different since the *production capacity* channel shifts out aggregate supply while the *local demand* channel shifts out aggregate demand.

The two channels are not mutually exclusive. However, understanding which one dominates in practice is important since they have different implications for prices and real allocations. Bahadir and Gumus (2016) show that credit expansion operating through the *local demand* channel is inflationary in nature, expands the non-tradable sector relative to tradable sector and leads to real exchange rate appreciation. In contrast, credit expansion operating through the *production capacity* channel is deflationary in nature and increases labor productivity and employment in sectors that were financially constrained.

Separating these two channels is also important since they have different implications for business cycle amplification and macroprudential policy. A number of recent theoretical papers, e.g. Schmitt-Grohé and Uribe (2016), Korinek and Simsek (2016) and Farhi and Werning (2016), show that the local demand channel of credit expansion amplifies business cycles by generating short term gain at the expense of an eventual bust. A natural macroprudential implication is that household leverage growth may need to be regulated.

This chapter studies the business cycle consequences of credit supply expansion with a particular emphasis on understanding whether credit expansion works through the local demand channel or the production capacity channel. We focus on state level business cycle in the United States during the 1980s, which provides an appealing natural experiment for two reasons. First, there was rapid expansion in credit sup-

ply during this period. Second, the strength of this expansion varied across states depending on how deregulated a state's banking sector was.

The top panel in Figure 3.1 shows that credit to GDP expanded by 21.8 percentage points between 1982 and 1988, the highest growth in credit during an expansionary cycle until 2001. Moreover, as credit quantity expanded, credit spread, i.e. the price of risk, fell by over a hundred basis points. At the same time, the share of high-yield corporate debt issuance increased from 14.6% to 56.1%. The fall in credit spread and the rise in the high yield share during an era of rapid overall credit growth are considered tell-tale signs of credit supply expansion (see Greenwood and Hanson (2013)).

Equally important from an identification perspective, the expansion in credit supply in a given state depended critically on the extent of banking deregulation in that state. The bottom panel in Figure 3.1 shows that growth in total bank credit between 1982 and 1988 was on average 42 percentage points stronger in states that had started deregulating their banking sector before 1983 compared to states that did not deregulate until after 1983. Credit growth in early deregulating states was broad-based as well, including a sharp rise in household debt to income, consumer credit and mortgage applications.

We use the natural experiment described in Figure 3.1 to estimate the effect of credit supply expansion on the local business cycle. We also develop a new test to understand whether the effect of credit expansion on the business cycle is primarily driven by the local demand channel or through production capacity. The basic idea is that credit operating through the local demand channel should be inflationary in nature, with real expansion concentrated in the non-tradable sector. On the other hand, credit operating through increased production capacity should be deflationary in nature for the sectors that experience real expansion (Section 3.2 provides full details).

We find that states exposed to stronger credit supply expansion experience a much more amplified business cycle. The amplification is driven by higher loading on aggregate factors, and not higher state-level idiosyncratic volatility. A one standard deviation increase in our banking deregulation measure leads to 21.3 percentage points stronger credit growth and a much more amplified overall business cycle. In particular, a one s.d. increase in banking deregulation leads to a 72.6% larger "beta" or loading for GDP, 61.0% for employment and 111.1% for house prices.

What is the mechanism through which credit supply expansion amplifies the business cycle? We find that *local demand channel* is the primary mechanism responsible for the amplification on the upside of the cycle. In particular, early deregulation states that experience a large increase in credit also experience strong relative expansion in non-tradable employment, while seeing *no* relative change in tradable sector employment. These results are extremely robust and hold within the same 4-digit industry across states. Moreover, even among small tradable sector firms, which Chen et al. (2017) find are likely to be sensitive to expansions in local bank credit supply, we find no differential employment growth in early deregulation states. We further find strong evidence of inflationary pressure in the non-tradable sector as early deregulation states see a relative increase in the price of non-tradable goods compared to late deregulation states. At the same time there is no relative change in the price of tradable goods.

The expansion in state level employment in early deregulating states, driven by the non-tradable sector, is also accompanied by relative increase in nominal wages. Interestingly the increase in nominal wage occurs throughout the economy, including non-tradable as well as tradable sector, but is stronger in the non-tradable sector. The simultaneous real exchange rate appreciation, growth in non-tradable employment, and stability of tradable employment is consistent with a model in which credit supply

shocks boost local local demand. However, these patterns are inconsistent with the view that deregulation operated primarily by boosting firms' production capacity.

Why is the recession worse in early deregulation states? Downward nominal wage rigidity, as in Schmitt-Grohé and Uribe (2016), could be one reason. We find that the significant relative increase in nominal wages in early deregulation states from 1982 to 1989 does not subsequently reverse from 1989 to 1992. While there is some evidence of a small relative decline by 1993 and 1994, wages remain significantly higher even as of 1995 relative to their 1982 level. Moreover, wages in the tradable sector do not decline from 1989 to 1995, despite the large relative increase during the 1983 to 1989 period. These results suggest that credit supply expansion may have reduced the long-term competitiveness of labor in the tradable sector in early deregulation states.[2]

In addition to downward nominal rigidity, we also show evidence that banking sector problems and household debt overhang played a role in explaining the worse recession in early deregulation states. We find that in the cross-section of states, of all the outcomes we measure during the boom phase, the rise in household debt from 1982 to 1989 is the strongest predictor of recession severity from 1989 to 1992. These results for the early 1990s recession confirm the pattern found by other researchers across U.S. counties during the Great Recession (Mian and Sufi (2014a)), across countries during the Great Recession (Glick and Lansing (2010), IMF (2012)), across countries during the 1990 to 1991 recession (King (1994)), and in a large panel of countries from the 1960s through 2010 (Mian et al. (2017)).

One concern with our results may be that early banking deregulation states are spuriously correlated with factors that independently lead to a more amplfied cycle. However, this concern is mitigated by the fact that our chapter follows a long literature in finance starting with Jayaratne and Strahan (1996)'s seminal work that

[2]Rodrik and Subramanian (2009) argue foreign finance can inhibit long-run growth because capital inflows appreciate the real exchange rate and reduce the returns to tradable sector investment.

uses the timing of deregulation as an instrument for credit expansion. Kroszner and Strahan (2014) review the extensive evidence suggesting that the timing of banking deregulation was plausibly exogenous to current and anticipated business cycle conditions. We also provide additonal evidence for the plausibility of exclusion restriction through placebo tests in earlier business cycles.

Our chapter connects with work in finance and open economy macro. We follow existing finance literature in using deregulation as an instrument for credit expansion, but our motivation and approach are different. Existing work typically examines short run effects of banking deregulation on growth, market structure and prices[3], whereas we analyze the full cyclical implications of credit expansion. Our motivation comes from Kindleberger (1978), Minsky and others who emphasize that positive short-run effects of credit expansions may be reversed due to endogenous consequences of credit boom.

As we explain in section 3.4.5, the desire to focus on full business cycle consequences changes our methodology relative to the literature. Our methodology shows that credit supply shocks lead to a more amplified business cycle due to higher loading on aggregate factors, even though state-level idiosyncratic volatility goes down as Morgan et al. (2003) document.

This chapter is closely related to the long-standing interest in open economy macro about the impact of large credit flows on business cycles (see e.g. Calvo et al. (1996)). Empirical progress on the question has been hampered by the difficulty in generating plausibly exogenous variation in credit flows at the level of a small open economy. We address this critical challenge by using the staggered deregulation timing and analyzing its macroeconomic implications[4].

[3]See Kroszner and Strahan (2014) for review. Favara and Imbs (2015) and Landier et al. (2017) examine the effect of deregulation on house price growth and correlation, respectively.

[4]Di Maggio and Kermani (2015) is another related example. Borio et al. (2016) show that periods of rapid growth in credit are associated with labor reallocation to lower productivity growth sectors, construction in particular.

Since our focus is on macroeconomic implications, we deliberately keep our analysis at the aggregate state level. Focusing on firm or household level data may miss spill-overs created by credit supply shocks. For example, if credit expansion temporarily boosts local demand, wages may rise, resulting in tradable firms becoming less competitive. There may also be a reallocation of labor toward less productive firms producing non-tradable goods. While credit expansion may relax borrowing constraints at the firm level within a narrowly defined industry, the afore-mentioned spillovers could offset some of the partial equilibrium gains estimated at micro level[5].

The rest of this study proceeds as follows. In the next section, we describe our methodology for testing whether credit supply shocks operate through demand or supply. Section 3 presents the data and summary statistics. In Section 4 we discuss banking deregulation in the 1980s, our empirical framework, and the relation of our study with existing research on banking deregulation. Sections 5 through 7 present results, and Section 8 concludes.

3.2 Theoretical Framework

We outline a simple two-sector small open economy model that yields two conclusions about the real consequences of credit supply expansions. First, as in Bahadir and Gumus (2016), a credit supply shock that boosts *local demand* raises non-tradable employment relative to tradable sector employment, and also raises non-tradable goods prices relative to tradable goods prices. On the other hand, a credit supply shock that expands either tradable or non-tradable firms' *production capacity* does not make this joint prediction. Second, as in Schmitt-Grohé and Uribe (2016), presence of frictions such as downward nominal wage rigidity leads to a subsequent reversal

[5]See Bai et al. (2016) for evidence on labor reallocation for small manufacturing firms after banking deregulation.

of economic expansion. This results in a more amplified business cycle relative to a counterfactual without the initial credit supply shock.

3.2.1 Environment

States exist in a currency union with each state having a tradable (T) and non-tradable (N) production sector. Time $t = -1, 0, 1, \ldots$ represents half a cycle - e.g., an expansion of 5 years - with $t = 0$ refering to the boom phase, and $t = 1$ the bust phase of a business cycle. We omit the state subscript to minimize notational clutter, and write preferences for the representative household as,

$$\sum_{t=-1}^{\infty} \beta^{t+1} u(C_t - v(L_t)),$$

with $u(C_t - v(L_t)) = \log(C_t - \frac{1}{2}L^2)$. Consumption, C_t, is a Cobb-Douglas aggregate over tradable and non-tradable consumption, $C_t = A(C_{T,t}, C_{N,t}) = C_{T,t}^{\alpha} C_{N,t}^{1-\alpha}$. We assume that a fraction θ_H of the household's members can borrow at the risk free rate i_t plus a spread s_t, while the remaining fraction $1-\theta_H$ borrow at the risk free rate i_t. The interest rate faced by the household as a whole is thus $i_t + \theta_H s_t$. The value of θ_H captures the household sector's exposure to the state's credit supply shock s_t. The household is subject to the sequence of budget constraints

$$C_{T,t} + P_{N,t} C_{N,t} + B_t = W_t L_t + \frac{B_{t+1}}{1 + \theta_H s_t + i_t} + \Phi_t,$$

where $P_{N,t}$ is the price of the non-tradable good relative to the tradable numeraire, W_t is the nominal wage, B_t is one-period bond brought into period t, and Φ_t are profits from ownership of firms in the tradable and non-tradable sectors. The risk-free rate is set at the union-wide level, and we assume that $i_t = i = \frac{1}{\beta} - 1$, so that debt is constant in a steady state with $s_t = 0$. Households starts off with zero debt, $B_{-1} = 0$.

The household's first order conditions are

$$\frac{A_{C_{N,t}}}{A_{C_{T,t}}} = P_{N,t}$$
$$\frac{v'(L_t)}{A_{C_{N,t}}} = \frac{W_t}{P_{N,t}}$$
$$u'(C_t - v(L_t))A_{C_{T,t}} = \beta(1 + \theta_H s_t + i_t)u'(C_{t+1} - v(L_{t+1}))A_{C_{T,t+1}}$$

Firms in the tradable and non-tradable sectors produce output with labor as the only input using a decreasing returns production function, $Y_{j,t} = A_j L_j^{1-\eta}$, where $j \in \{T, N\}$. As in Neumeyer and Perri (2005), firms face an intra-period working capital constraint and need to borrow $\theta_j \in [0, 1]$ fraction of the wage bill, $W_t L_{j,t}$, between the start and end of each period at a cost $r_t = i_t + s_t$. The sector j firm's first order condition for labor is

$$W_t = (1 - \eta)P_{j,t}\frac{A_{j,t}}{1 + \theta_j r_t}L_{j,t}^{-\eta}, \qquad j \in \{T, N\}.$$

When the working capital constraint is positive $\theta_j > 0$, a reduction in the cost of working capital r_t leads to a rise in labor demand for a given wage. A reduction in r_t is thus similar to an increase in the firm's productivity.

Labor market and non-tradable goods market clear each period

$$L_{N,t} + L_{T,t} = L_t$$
$$C_{N,t} = A_{N,t}L_{N,t}^{1-\eta},$$

and the state's budget constraint satisfies

$$C_{T,t} + B_t = A_{T,t}L_{T,t}^{1-\eta} - \omega_t + \frac{B_{t+1}}{1 + \theta_H s_t + i_t},$$

where $\omega_t = \theta_T r_t W_t L_{T,t} + \theta_N r_t W_t L_{N,t}$ is the working capital expense.

3.2.2 Credit shock and nominal rigidity

We model credit shock as a one-time decline in credit spread s_0. States differ in the strength of this shock with some states experiencing a stronger positive credit supply shock ("strong shock") than others ("weak shock"). The shock hits unexpectedly at the beginning of period 0, and everyone understands that its lasts for only one period. "Strong shock" states correspond to states that deregulated their banking system earlier and "weak shock" states correspond to those that deregulated later in our empirical setting. In the beginning of period 0, a strong shock state experiences the sequence of interest rates $(i, i + s_0^{strong}, i, i, ...)$, whereas a weak shock state faces interest rates $(i, i + s_0^{weak}, i, i, ...)$, with $s_0^{strong} < s_0^{weak} < 0$.[6]

Business cycles result from the interaction of credit shock with downward wage rigidity as in Schmitt-Grohé and Uribe (2016). We assume that the nominal wage cannot adjust downward between period $t = 0$ and $t = 1$, i.e. $W_1 \geq W_0$, and wage are fully flexible from period $t = 2$ onwards when economy is in steady state. [7]

3.2.3 How does the business cycle respond to credit supply shock?

We feed in the credit supply shock into our model under three different assumption. First, we shut down the *production capacity* channel by assuming that $\theta_T = \theta_N = 0$ and only allow the *local demand* channel to operate via $\theta_H > 0$. Panel (a) in Figure 3.2 plots the response of various macroeconomic outcomes for this case.

The top left panel shows the path of $(i + s_t)$ for strong and weak shock states respectively. Since households in the strong shock state experience a larger decline

[6]The credit supply expansion here is modeled simply as a reduction in the interest rate. One could instead assume that credit supply expansion relaxes borrowing constraints for households and firms, and the qualitative results would be unchanged. See Bahadir and Gumus (2016) for an example of such a model.

[7]More generally, we could assume that the wage could only adjust partially downward in each period so that convergence to the steady state takes several periods.

in the interest rate at $t = 0$, debt rises more to fuel a boost in consumption. The boost to local demand in $t = 0$ raises non-tradable employment and the price on the non-traded good, as the non-tradable good becomes relatively scarce. This *real appreciation* leads to a reallocation of labor from the tradable to the non-tradable sector.

Local demand expansion in period $t = 0$ boosts the nominal wage W_0. However, as local demand contracts in period $t = 1$ due to increase in interest rate, wage cannot automatically adjust downwards due to wage rigidity. Consequently households are off their labor supply condition ($\frac{v'(L_1)}{A_{C_{N,1}}} \neq \frac{W_1}{P_{N,1}}$), and there is an excess supply of labor at the elevated wage $W_1 = W_0$. The economy experiences a bust in non-tradable and total employment in $t = 1$. As in Schmitt-Grohé and Uribe (2016), the bust is caused by the fact that during the boom agents do not internalize that an increase in the wage will generate unemployment if the boom subsides.

Panel (a) shows that the *local demand* channel of credit expansion leads to a more amplified business cycle with *both* non-tradable employment and non-tradable price rising faster than the economy during the expansion phase.

Panels (b) and (c) shut down the *local demand* channel with $\theta_H = 0$ and sequentially turn on the *production capacity* channel first in the non-tradable sector with $\theta_N > 0$ (panel b), and then in the tradable sector with $\theta_T > 0$ (panel c). Since credit expansion is assumed not to affect households, household debt does not rise more in the strong shock state at $t = 0$.

When *production capacity* channel operates through the non-tradable sector, labor in that sector become more productive. Consequently employment in the non-tradable sector expands while price of non-tradable goods falls (panel b). On the other hand, when *production capacity* channel operates through the tradable sector, it is employment in the tradable sector that expands, and price in the non-tradable

sector rises due to higher demand for local goods given homothetic preferences (panel c).

Figure 3.2 only turned on one channel at a time for expositional simplicity. In reality, local demand and production capacity channels are likely to operate contemporaneously, but with different intensities. Our objective is to understand which channel is the most dominant. The analysis above shows that an increase in the size of the non-tradable sector accompanied by an increase in the price of this sector during expansion is unique to the *local demand* channel. We will use this insight in the analysis that follows.

Our model is stylized and abstracts from several potentially important effects of credit shocks. An obvious omission is that the model does not include capital. In Bahadir and Gumus (2016) firms produce with capital and labor, and capital is produced from tradable output. They find similar effects of credit shocks on employment and prices. If, however, producing the investment good requires a non-tradable input, then a tradable credit shock also expands demand for non-tradable goods, boosting non-tradable employment. An example is a tradable credit shock that increases firms' investment in commercial real estate. Similarly, a tradable credit shock would also boost non-tradable employment if preferences over tradable and non-tradable consumption are complements (elasticity of substitution less than one). Nevertheless, even if a tradable credit shock increases non-tradable employment, as in both of these examples, we would still expect a rise in tradable employment.[8] As we discuss in section 3.6, we find no evidence that credit supply expansion boosts tradable employment.

[8]In the extreme case where preferences are Leontief over tradable and non-tradable consumption, a rise in tradable labor productivity would actually reduce tradable employment as workers are reallocated to the non-tradable sector. An implicit assumption for the predictions of the sectoral effects of credit shocks is therefore that complementarities between the tradable and non-tradable sector are not too strong.

3.3 Data and Summary Statistics

We construct state-year level data set for the 1980s and 1990s with information on bank credit, household debt, house prices, retail sales, employment by industry, wages, unemployment, residential construction, inflation, and GDP. The state-year level data on household debt and retail sales are new to the literature. Information on household debt comes from three sources. First, we calculate household debt using a random sample of individual tax return data at the NBER. We follow the capitalization methodology used by Saez and Zucman (2016) to impute total household debt and income at the state level. This calculation excludes the top 2 to 3% of filers for whom state identifiers are missing for confidentiality reasons. Our second source of household debt is HMDA data which reports data at the loan application level. We aggregate this data at the state level to compute total number and amount of loan applications. Unlike HMDA data from 1991 onwards, the earlier sample does not tell us whether a loan is actually originated.

Third, we measure credit to households using bank-level Call Report data at the state level.[9] We use two different measures of loans to the household sector derived from Call Report data. Household loans include real estate loans and loans to individuals. Consumer loans are loans to individuals, and "loans secured by 1-4 family residential properties, revolving open end loan." The first measure includes all mortgage debt, whereas the second measure is the cleanest measure of consumer loans other than mortgages used to purchase a new home. The second measure includes home equity loans, but not primary mortgages. Consumer loans are a sub-set of household loans.

[9]Call Report data come from the Commercial Bank Database from the Federal Reserve Bank of Chicago, which contains data of all banks filing the Report of Condition and Income that are regulated by the Federal Reserve System, Federal Deposit Insurance Corporation (FDIC), and the Comptroller of the Currency. We do not have data from savings institutions (e.g., S&L associations) that file with the Office of Thrift Supervision (OTS).

One potential problem with using Call Report data to measure household debt is that a significant fraction of household mortgages are ultimately securitized and held by the GSEs. Moreover, as Kroszner and Strahan (2014) report using data from Frame and White (2005), the share of mortgages held by GSEs expanded by more than 20 percentage points during the 1980's. The corresponding share fell for banks and saving institutions. While banks were actively involved in originating mortgages during this period, they increasingly sold these mortgages to the GSEs. We have three sources from which we measure the growth in household debt from 1982 to 1989: the IRS, HMDA, and Call Report data. As mentioned above, each has certain drawbacks. As a result, we construct a variable *household leverage index* which is the first principal component of the change in the household debt to income ratio, growth in mortgage loan applications, and growth in consumer loans.

In terms of real variables, our data set includes total employment from the County Business Patterns data set published by the U.S. Census Bureau. We classify employment into non-tradable, construction, and tradable industries using the classification scheme in Mian and Sufi (2014b). Our data set also includes state-level retail sales data from 1986 to 1996 for 19 states from the Census, which were obtained from the Census website. Our measure of residential construction is based on new building permits collected by the Census, and is available at the state-year level for our full sample starting in 1980.

We utilize state-level inflation series from Del Negro (1998), which is also utilized in Nakamura and Steinsson (2014). In addition, to construct state-level CPI inflation for subcategories of goods, we use the Bureau of Labor Statistics MSA level CPI series, which begin in 1984. More specifically, to proxy for the price of non-tradable goods in an MSA, we use the BLS price index for services, and to proxy for the price of tradable goods in a given state, we use the BLS price index for commodities. We

average across all MSAs in a state to obtain the state-level index. This is available for only 26 states in our sample.

We also estimate state level wages from the CPS Outgoing Rotation Group using the CEPR extracts, which are cleaned and adjusted for top-coding.[10] We construct both raw and residualized state average hourly wages for workers age 21-55. Residual wages are constructed by estimating log hourly wages on age dummies, education dummies, and race dummies for each year. We estimate the wage equations separately for males and females and construct average wages for all workers, separately for males and females, and by industry.

Table **??** reports state-level summary statistics of the key variables used in this study. We break the sample period of 1982 to 1992 into two sub-periods: the expansion phase from 1982 to 1989 and the contraction phase from 1989 to 1992. The household debt to income ratio increased by an average of 0.21 during the expansion phase. Loans to households (which include mortgages) grew by 72%, while consumer loans (which exclude mortgages through 1987 but include home equity loans after 1987) grew 70%. Commercial and industrial loans increased by only 42%. House prices grew by 27% on average during the boom phase, but then grew by only 4% during the contraction phase. The unemployment rate fell from 1982 to 1989 on average by 4 percentage points, but then increased from 1989 to 1991 by 1.8 percentage points. The boom and bust in employment in the non-tradable and construction sectors was especially pronounced. On average across states, prices rose by 24% from 1982 to 1989.

[10]The data are available from the CEPR's webpage.

3.4 Empirical Setting and Methodology

3.4.1 Banking deregulation

The United States experienced a period of significant deregulation of the banking sector in the late 1970s and 1980s, with the pace of deregulation differing across states. Deregulation consolidated the fragmented banking system in multiple ways. First, out-of-state banks were gradually allowed to operate in various states. Second, intra-state branching restrictions were removed to allow banks to expand their branch network within a state.[11]

Table 3.1 lists each state and the year in which it removed restrictions on inter-state bank branching and intra-state bank branching. The two types of deregulation are positively correlated with a correlation coefficient of 0.46. Following the existing literature on deregulation, our methodology excludes South Dakota and Delaware, two states that took advantage of elimination of usury laws to attract credit card businesses.[12]

Table 3.1 shows that there is no single date when a state's banking system was deregulated. Instead, deregulation was a continuous process that occurred across states at different times. Moreover, the years shown in Table 3.1 reflect the start of a deregulation process that expanded over time. For example, the year of inter-state banking deregulation is the first year that a state allowed *some* out-of-state banks to open a branch. The decision to allow out-of-state banks to open branches was based on bilateral arrangements between states, until the Riegle-Neal Act of 1994

[11] These changes only applied to commercial banks.

[12] Arkansas did not fully deregulate the intra-state restrictions until 1996. Although Maine permitted out-of-state bank holding companies (BHC) to operate in 1978, the statute only permitted this if the home state of the acquiring BHC reciprocated by permitting Maine-based BHCs to operate in their state. This only happened in 1982, when Alaska, Massachusetts, and New York permitted out-of-state BHCs to enter.

opened inter-state banking everywhere. Once states allowed some out-of-state banks to operate within their state, the state typically expanded the list of states over time.[13]

To take into account the continuous process and varying pace of bank deregulation across states, we utilize a measure of state-level banking deregulation that is based on the number of years since deregulation began in the state as of 1989. A higher measure indicates more deregulation as of 1989, as the state began deregulating further into the past. More specifically, we use 1989 minus the initial year of inter-state and intra-state branching deregulation as the two variables of interest. Since we focus on the aggregate credit supply expansion during the 1980s, we cap this value at 10, treating states that deregulated before 1979 equally. For each state we then take the average of these two deregulation variables to obtain a single "deregulation measure" that captures the combined effect of the two types of deregulation.[14] For Connecticut, for example, the first measure takes on the value (1989-1983=) 6 and the second measure takes on the value (1989-1980=) 9, which gives it a high deregulation score relative to the mean. The last column of Table 3.1 shows the deregulation measure by state.[15]

3.4.2 Empirical methodology

As we described in the introduction and top panel of figure 1, our starting point is the expansion in credit supply at the aggregate level in the U.S. starting in 1983. The key role played by banking deregulation in our natural experiment is that states with more deregulated banking system experience a stronger credit supply expansion from 1983 onwards (lower panel of figure 1)[16]. Thus our "instrument" for state level credit

[13] Michalski and Ors (2012) report in detail how these bilateral arrangements expanded over time in each state until the Riegle-Neal Act.

[14] Specifically, our deregulation score for a state s is defined as the standardized value of $.5 \sum_{j \in \{inter, intra\}} \min\{\max\{1989 - DeregYear_{j,s}, 0\}, 10\}$.

[15] In Table C.1.1 in the appendix, we show regressions relating credit expansion in a state during the 1980s to the year of removal of inter-state branching restrictions and intra-state branching restrictions separately. For both intra- and inter-state branching restriction removal, states with earlier deregulation years see larger growth in credit during the 1980s.

[16] Figure 1 uses an alternative measure of deregulation, an indicator variable that is one if a state implemented either intra- or inter-state deregulation as of 1983 or earlier, and zero otherwise.

supply expansion should be seen as the *interaction* of aggregate credit supply shock with state-level deregulation status.

What caused the aggregate increase in credit supply in the United States during the 1980s? We are agnostic on the fundamental source of this underlying process. Global capital flows, behavioral biases and change in monetary policy regime may be posited as potential explanations (e.g. Walsh (1993) and Feldstein (1993)). However, the exact source is not important for our methodology. What matters is that the aggregate shock "loads" differentially on states with different levels of deregulation. The exclusion restriction needed is that these cross-state differences are not spuriously related to business cycle expectations.

In what follows, we use NBER dating convention to define expansion or boom phase as 1982 to 1989 period, and the contraction or bust phase as 1989 to 1992 period. But we also present results for the each year in graphical from to show the full timing transparently.

Our goal is to understand how the aggregate credit cycle differentially affects early versus late deregulation states. We begin by exploring the differential increase in lending, employment, consumer prices, and wages during the expansion phase from 1982 to 1989. More specifically, we estimate equations of the following form:

$$\Delta_{82,89} Y_s = \alpha^{boom} + \pi^{boom} \cdot DEREG_s + \Gamma^{boom} \cdot Z_s + \epsilon_s^{boom} \tag{3.1}$$

where $\Delta_{82,89} Y_s$ reflects the growth in a given outcome variable from 1982 to 1989, $DEREG_s$ is the deregulation measure capturing the extent of deregulation in the 1980s (described above), and Z_s is a set of control variables. The key coefficient

Twenty-two states are early deregulators according to this measure, and this measure is highly correlated with our main measure described above with an an R^2 of 0.84. Appendix Tables C.1.11-C.1.14 show that all of our main results are robust to using this alternative deregulation measure.

is π^{boom} which measures whether early deregulation states witness lower or higher growth in outcome Y from 1982 to 1989.

We then turn toward empirical tests to assess whether states with a more deregulated banking sector see an amplified business cycle from 1982 to 1992. We use three different techniques. First, we run first-difference regressions separately for the boom and bust, showing that outcomes Y such as GDP or residential construction increase by more in early deregulation states from 1982 to 1989 and fall by more in early deregulation states from 1989 to 1992. The boom equation is already shown above in equation 3.1, and the bust equation takes the following form:

$$\Delta_{89,92} Y_s = \alpha^{bust} + \pi^{bust} \cdot DEREG_s + \Gamma^{bust} \cdot Z_s + \epsilon_s^{bust} \tag{3.2}$$

We also exploit the full state-year panel by estimating equations of the following sort:

$$Y_{st} = \alpha_s + \gamma_t + \sum_{q \neq 1982} \mathbb{1}_{t=q} \cdot DEREG_s \cdot \beta_q + \epsilon_{st} \tag{3.3}$$

This specification yields a series of estimates of β_q in order to show the full dynamics for outcome Y, and how they differ for early versus late deregulation states.

Finally, we also use a specification motivated by asset pricing tests where one wants to understand the "loading" of a specific asset return on aggregate factors such as the overall market return. As mentioned above, we believe there are two aggregate states during our time period: expansion from 1982 to 1989, and contraction from 1989 to 1992. And we want to understand how a state's loading on the aggregate state differs based on the extent of banking deregulation in the 1980s. The specification takes the following form:

$$\Delta Y_{sb} = \alpha + \beta \cdot \Delta S_b \cdot DEREG_s + \gamma \cdot \Delta S_b + \delta \cdot DEREG_s + \epsilon_{sb} \tag{3.4}$$

The equation is estimated in changes using two periods, the boom from 1982 to 1989 and the bust from 1989 to 1992 (i.e., $b = \{boom, bust\}$). The key coefficient of interest is β, which measures the differential loading of early deregulation states for outcome Y on the aggregate cycle S_b. We use log aggregate GDP as our aggregate S_b measure. For example, one of the outcomes we examine is state level GDP. In this case, ΔY_{sb} is the log change in state level GDP during the boom and bust, and β measures whether log state GDP in early deregulation states changes more for a given change in log aggregate GDP.

3.4.3 Was credit growth stronger in early deregulation states?

Figure 3.1, lower panel, showed that total credit growth was much stronger in states that started deregulating before 1983 relative to those that started deregulation afterwards. Table 3.3 estimates equation (3.1) and shows that credit growth was significantly stronger in early deregulation states. Panel A presents the baseline estimates without control variables. All measures of household credit increase relatively more in states that deregulated their banking sector earlier. In terms of magnitudes, a one standard deviation increase in the deregulation measure (1.01) leads to a 0.04 increase in the household debt to income ratio, which is almost one-half a standard deviation. Growth in mortgage loan applications is also larger in early deregulation states.

All measures of credit from the Call Report data show stronger growth from 1982 to 1989 in early deregulation states. Household loan and consumer loan growth is stronger, as is commercial and industrial loan growth. This latter results suggests that the larger increase in credit in early deregulation states was not isolated to household loans. However, some caution is warranted in evaluating this result. C&I loans include loans to construction companies and local businesses, which are likely influenced by

local demand effects coming from the rise in credit to the household sector. As illustrated in Section 3.2, a joint examination of consumer prices and employment patterns is needed to understand whether credit expansion operates primarily through local demand or production capacity expansion.

The final column reports the estimate for growth in the household leverage index from 1982 to 1989, which as mentioned above is the first principal component of the three measures of household debt growth shown in columns 1, 2, and 7. A one standard deviation increase in the deregulation measure leads to a 0.74 increase in household leverage, which is more than half a standard deviation. The specifications reported in Panel B add control variables for pre-1982 growth in the outcome variables where available. The estimates on the deregulation measure are similar.

Figure 3.3 presents coefficient estimates of β_q from equation 3.3 from section 3.4.2 for five measures of credit growth: the household debt to income ratio, household loans, commercial and industrial loans, consumer loans, and mortgage application volume. For all five measures, we see similar results. Prior to 1982, there is no differential increase in credit in early deregulation states. From 1982 to 1989, credit grows more in early deregulation states.[17] After 1989, measures of credit growth in early deregulation states decline relative to the peak. Figure 3.3, as in Figure 1, shows no strong pre-trend for the credit variables.

Table 3.4 tests for robustness by estimating equation 3.1 using growth in the household leverage index from 1982 to 1989 as the outcome variable and including extensive control variables. The coefficient estimate remains significantly positive even when including measures of exposure to the oil industry, regional indicator variables, unemployment levels prior to the credit boom, and contemporaneous measures of GDP growth and C&I loan growth.

[17]Household debt-to-income in the top-left panel of Figure 3.3 only rises in 1987 because household debt and income grow at a similar rate before then.

3.4.4 Exclusion restriction

One concern with using deregulation timing to generate credit supply shocks is that the timing of deregulation is spuriously correlated with other sources of business cycle variation. For example, if deregulation occurred earlier in states that had better income prospects, then the more rapid expansion in credit or residential construction from 1982 to 1989 may be due to better income prospects as opposed to more credit supply from a more liberalized banking sector.

Fortunately, the source of variation in banking deregulation has already been researched extensively. Kroszner and Strahan (2014) provide an excellent review of the banking deregulation literature. States initially restricted bank entry and geographical expansion in order to generate revenue through granting state charters, owning bank shares and taxes. Kroszner and Strahan (1999) argue that a combination of public and private interest kept these banking restrictions in place until the 1980's, but technological innovations, e.g. the advent of money market funds, the ATM and credit scoring models, eroded the competitive edge of small local banks. Such developments reduced opposition to deregulation, and states started to deregulate with Republican controlled states typically deregulating earlier.[18]

While a number of political and technological factors contributed to the varied timing of deregulation across U.S. states, Kroszner and Strahan (2014) argue that "there is no correlation between rates of bank failures or the state-level business cycle conditions and the *timing* of branching reform." They further argue based on results from earlier work that "states did *not* deregulate their economies in *anticipation* of future good growth prospects."[19]

[18]Kane (1996) further argues that failure of geographically concentrated banks that imposed costs on local population also lowered the appetite of restrictive regulation among the public. For example, exemptions were specifically granted for out of state banks to acquire failing banks and savings institutions.

[19]These results are based on the work of Jayaratne and Strahan (1996), Kroszner and Strahan (1999), and Morgan et al. (2003).

The Kroszner and Strahan (2014) view is further corroborated by our finding of no differential pre-trend in early versus late deregulating states. We also conduct additional placebo tests using prior economic cycles to show that states that deregulated their banking sectors earlier in the 1980s did not see differentially large credit growth during the economic expansions of the 1960s and 1970s. Likewise, before the 1980s, we find no evidence that early deregulation states had an amplified economic cycle relative to late deregulation states.

3.4.5 Comparison to literature

The existing empirical work on deregulation typically adopts the difference-in-differences specification first used by Jayaratne and Strahan (1996). This specification estimates the coefficient on a deregulation indicator variable that turns on when a state adopts a specific deregulation policy[20]:

$$Y_{st} = \alpha_s + \gamma_t + \beta * DEREG_{st} + \epsilon_{st} \tag{3.5}$$

(3.5) estimates the immediate effect of deregulation on Y by comparing states the deregulate in t with states that have not yet deregulated[21].

However, equation (3.5) is not appropriate for the question in our study for two reasons. First, (3.5) is designed to estimate the immediate causal impact of deregulation per se. On the other hand the premise of our study is that a more deregulated banking system will pass-through an aggregate credit supply shock more strongly even it it has been deregulated for a while. Thus the appropriate first-stage for our

[20] Strahan (2003) shows that interstate deregulation as opposed to intra-state branching deregulation led to significantly increased banking acquisitions. Kroszner and Strahan (2014) and Black and Strahan (2001) find that the share of small banks falls significantly, and bank efficiency as measured by noninterest costs, wages, and loan losses increases when states deregulate.

[21] In Tables C.1.4 through C.1.6 of the appendix, we replicate this specification from Jayaratne and Strahan (1996) in our data and find similar results for economic growth, and also find a significant effect of deregulation on bank loan growth.

natural experiment is the one shown in bottom panel of figure 1, or equation (3.3), and not equation (3.5).

A second limitation of equation 3.5 for our purpose is that it focuses on the short-term impact of deregulation by construction, and is not designed to analyze the full business cycle implications of credit expansion. For example, consider two states that deregulate three years apart. Equation 3.5 estimates the effect of deregulation by comparing differences between the two states when one state has started the deregulation process but the other has not. However, once both states have deregulated, differences between these states are not attributed to deregulation. Our methodology in (3.3) on the other hand is meant to capture both the short- and medium-run effects of credit expansion.

Another related difference is that our specification captures the higher loading on aggregate credit supply shocks that comes from a longer cumulative period of deregulation. In contrast, the methodology in equation 3.5 treats two states equally once they are both deregulated even if one deregulated much earlier than the other. For example, let us compare a state that deregulates its banking sector in 1982 versus a state that deregulates in 1988, and let us assume that deregulation boosts lending gradually over the subsequent five years after deregulation. As of 1989, we would expect for the state that deregulated in 1982 to have a larger cumulative increase in lending from deregulation than the state that deregulated in 1988, and hence be more vulnerable to a credit supply contraction in 1989. Our methodology is designed to capture exactly this heightened vulnerability, whereas the methodology in equation 3.5 would miss it by treating both states as the same as of 1989.

A related study by Morgan et al. (2003) finds that state-level idiosyncratic volatility in economic growth declined with banking integration after deregulation. More specifically, Morgan et al. (2003) first estimate the idiosyncratic component of economic growth in a state-year by obtaining the residual from regressing growth in a

state-year on year and state indicator variables. They then show that these residuals decline in a given state as the banking system becomes more integrated due to deregulation. In Table C.1.7 of the appendix, we replicate this result for employment growth. The finding of lower idiosyncratic volatility in economic growth after deregulation in Morgan et al. (2003) is distinct from our finding of a higher loading, or "beta," on aggregate GDP growth. A more integrated banking sector can stabilize a state's economy after a negative idiosyncratic shock such as a shock to a specific industry, but it could also increase exposure to national-level credit supply expansions and contractions.

3.5 Does credit expansion lead to business cycle amplification?

3.5.1 Main results

Figure 3.4 examines the effect of credit expansion on the state level business cycle by estimating equation 3.3 using five measures of economic activity: the unemployment rate, total employment, real GDP, new construction of residential units, and house prices. More specifically, Figure 3.4 presents coefficient estimates of β_q from estimation of equation 3.3 using these five outcome measures. For all five outcomes, we see an amplified cycle in states that deregulated their banking system earlier.

The unemployment rate fell more in early deregulation states from 1982 to 1989, before rising sharply during the recession. Employment and real GDP expanded significantly more in early deregulation states during the expansion, and then fell more in the recession, although the fall is not as large for real GDP as for the other outcomes.

The patterns are most pronounced in the housing market. House prices and residential construction see a significantly stronger boom-bust pattern in early deregulation versus late deregulation states, suggesting that banking deregulation had strong effects on the housing market during this time period. For three of the four outcomes, there is no differential pre-trend, and the differences begin during the heart of the aggregate credit expansion from 1982 onwards.

Table 3.5 separately tests for amplification over the boom and bust phases of the cycle by estimating equations 3.1 and 3.2.[22] The first four columns present results for the expansion phase from 1982 to 1989, and the fifth through eighth column presents results for the contraction phase from 1989 to 1992. The boom-bust pattern in these four outcomes is robust to control variables for exposure to oil prices, demographics, and regulatory forbearance during the S&L crisis.[23] In terms of magnitudes, a one standard deviation increase in the deregulation measure leads to a 0.6 percentage point decline in the unemployment rate from 1982 to 1989, and a 0.9 percentage point increase from 1989 to 1992. The former is almost a third of a standard deviation and the latter is two-thirds a standard deviation. Overall, the correlation between the deregulation measure and the decline in economic outcomes during the contraction is larger in magnitude and more statistically robust than the correlation between the deregulation measure and the increase in economic outcomes during the expansion period.

Panel A of Table 3.6 presents estimates from equation (3.4) described in section 3.4.2. The data set is a state-level panel where the two time periods for the outcome variables are 1982 to 1989, and 1989 to 1992. Contemporaneous aggregate GDP growth is the aggregate measure we employ. For any given state, we calculate GDP growth excluding the state in question to avoid mechanical correlation. As the coef-

[22]Figure C.1.3 in the appendix presents scatterplots of the regressions in Table 3.5.

[23]The results are also robust to controlling for other state institutional characteristics such as state union density in the 1980s, which we estimate from the CPS.

ficient on the interaction term shows, early deregulation states see a stronger loading on aggregate GDP growth for all five measures. For example, a state with a deregulation measure of zero has a β of its own GDP growth on aggregate GDP growth of 0.7 to 0.9. A state with a deregulation measure of one (which is one standard deviation relative to the mean) has a β that is 1.2 to 1.3, and the difference is statistically significant at the one percent level. In general, one standard deviation increase in our banking deregulation measure leads to a much more amplified business cycle with a 72.6% larger β for GDP, 61.0% for employment and 111.1% for house prices.

3.5.2 Placebo tests for amplification

In Panels B and C of Table 3.6, we conduct placebo tests for prior economic cycles that are similar to the analysis presented in Panel A of Table 3.6. For the previous cycles, we use the NBER dates for expansions and recessions to define the dates of the cycle. Panel B presents results for the 1975 to 1982 cycle, where we define the end of the expansion in 1979. In contrast to the 1982 to 1992 period, there is no evidence of a differential loading on the aggregate GDP growth in the earlier cycle. If anything, there is some evidence of a smaller loading for house price growth. In Panel C, we examine the 1970 to 1975 cycle, where we define the end of the expansion in 1973. Once again, for the three outcome variables for which we have data available, we see no evidence of a differential loading on aggregate GDP growth. Taken together, the results in Table 3.6 Panels B and C are inconsistent with the hypothesis that states deregulating their banking sectors in the late 1970s or early 1980s are inherently more cyclical.

3.6 Is amplification driven by demand or production capacity?

3.6.1 Employment, prices, and wages during credit expansion

The discussion in section 3.2 highlights how the behavior of tradable versus non-tradable employment and prices can be used to analyze whether credit supply shocks impact the economy primarily through their impact on local demand or labor productivity. Figure 3.5 presents state-level scatter plots of employment growth by sector from 1982 to 1989 against the deregulation measure. As we saw in the previous section, employment growth is stronger in early deregulation states. However, the higher employment growth in early deregulation states is driven by employment in the non-tradable and construction sector. There is no relative rise in employment in the tradable sector in early deregulation states. This is consistent with the hypothesis that credit supply shocks work through local demand.

We confirm these results in a regression context in Table 3.7. Columns 1 through 4 estimate equation 3.1 using measures of employment as the outcome variable. They confirm that there is a statistically significant and economically meaningful relative rise in employment in the non-tradable and construction sectors in early deregulation states. In contrast, there is no differential increase in employment in the tradable sectors in early deregulation states. In terms of magnitudes, a one standard deviation increase in the deregulation measure leads to a 6% and 16% larger increase in employment in the non-tradable and construction industries, respectively. For both industries, this is one-half a standard deviation of the outcome variable.[24]

[24]In Table C.1.2 of the appendix, we include a control variable for the exposure of the labor force in a state to Chinese import competition from Autor et al. (2013). The results are similar with inclusion of this control variable. In Table A8 we show that the results are similar when using a within-state specification for employment growth as in equation (3.5) which is closer to the

In columns 5 through 8, we utilize a data set covering employment growth from 1982 to 1989 at the state by 2 digit industry level. This data set allows us to fully control for 2-digit industry fixed effects and state fixed effects. We do so in the specification reported in column 8, which shows a relative increase in employment in the non-tradable and construction sectors from 1982 to 1989 in early deregulation states. The inclusion of 2-digit industry fixed effects ensures that the coefficient estimate on the deregulation variable is independent of any secular trends related to a state's industrial composition.

One potential explanation for the limited effect on tradable employment growth is that large firms account for the majority of tradable employment, and these large tradable firms do not rely on financing from local banks. Table 3.8 presents estimates for tradable, non-tradable, and construction employment growth separately by establishment size categories. Even for small tradable establishments, those with between 1 and 9 or 10 and 50 employees, we do not find stronger tradable employment growth in early deregulating states. This argues against a local credit supply channel operating through tradable firms, especially since Chen et al. (2017) find that small tradable firms are on average more reliant on local bank credit than small non-tradable firms.

In Figure 3.6, we explore predictions from the model on consumer price inflation. As the top left panel shows, early deregulation states see higher inflation rates during the credit expansion phase from 1982 to 1989. When we split the prices of consumer goods into non-tradable (services) and tradable (commodities) categories, we see that the positive correlation is significantly stronger for the price of non-tradable goods. Table 3.9 presents similar results in a regression context. There is a larger rise in consumer prices in early deregulation states from 1982 to 1989 which is driven in particular by consumer prices of non-tradable goods. In terms of magnitudes, a one standard deviation increase in deregulation leads to 2 percentage point larger increase

specification estimated in Jayaratne and Strahan (1996). The results in Table A8 are consistent with deregulation spurring non-tradable and construction employment in the short-run.

in prices of all goods from 1982 to 1989 and a 4 percentage point larger increase in prices of non-tradable goods. In column 5 of Table 3.9, we show that the relative rise in consumer prices of non-tradable goods is statistically significantly larger compared to prices of tradable goods.

Overall, the results on the growth in employment and prices are consistent with a model in which credit supply expansion boosts local demand in early deregulation states. The results are inconsistent with the view that the dominant impact of credit supply expansion is to boost labor productivity among either tradable or non-tradable firms.

As shown in Section 3.2, all three types of credit shocks result in higher wage growth. We confirm this pattern in Figure 3.7 and Table 3.10. Wage growth is significantly stronger in early deregulation states from 1982 to 1989. This is true for both males and females, and across all industries. The magnitude is large. A one standard deviation increase in the deregulation measure leads to more than a half standard deviation increase in average wages. The relative growth of wages in early deregulation states is especially strong for construction and non-tradable firms.

Figure 3.8 presents estimates of β_q from equation 3.3 for employment in the non-tradable, tradable, and construction industries. These estimates show the dynamic pattern in employment for early versus late deregulation states from 1975 to 1995. The results for the non-tradable and construction industries are similar to the results for other measures of real economic activity shown in Figure 3.4. In particular, early deregulation states see a sharp relative rise in employment in the non-tradable and construction sectors from 1982 to 1989. Subsequently, early deregulation states witness a sharp relative drop which brings employment in these industries close to its initial level. This same pattern can be seen in total employment as well.

3.6.2 Placebo tests from earlier expansions

One explanation of the results above is that early deregulation states always experience a larger expansion in credit, consumer prices, wages, and employment in the non-tradable sector during economic expansions. We test this hypothesis in Table 3.11, and we find no evidence supporting it. More specifically, we measure economic expansions using the NBER recession dates, where an expansion is measured from the trough of the last recession to the peak before the next recession. For the 1960s, we present also an alternative definition of the expansion from 1960 to 1967 given some evidence that the credit cycle peaked in 1967 instead of 1969. We then present specifications similar to equation 3.1, but using the dates of previous economic expansions instead of 1982 to 1989. We estimate specifications for whichever outcomes we can measure going back in time.

Across the 15 specifications for which we have outcome variables available, we find only one positive and statistically significant coefficient for previous expansions (consumer price growth from 1970 to 1973). Overall, the evidence is difficult to reconcile with the view that states that deregulated their banking sectors early in the late 1970s and 1980s always witnessed larger credit growth or a larger boost in demand for non-tradable goods during economic expansions.[25]

3.7 Why a worse recession: nominal rigidity, banking losses and household leverage

Why did early deregulation states experience a worse recession? We present evidence on three factors which have been emphasized in the literature as amplifying forces on the downside of a cycle: nominal rigidity, banking sector losses and high household

[25]We do not have data on wages prior to 1979.

leverage. As we show below, all three of these factors were significantly more powerful in early deregulating states.

3.7.1 Evidence on nominal rigidity

In our theoretical framework in Section 3.2, employment declines during the recession because wages cannot adjust downward. We see evidence of downward wage rigidity in Figure 3.9, which presents estimates of β_q from equation 3.3 for wages. As the top left panel shows, average wages in early deregulation states are almost constant in relative terms from 1989 to 1992, despite the previous large relative rise in wages from 1982 to 1989 and the significant relative rise in unemployment during the recession. When we examine wages by sector, we see evidence of some decline in wages for jobs in the non-tradable sector, but wages are still slow to adjust. In the tradable sector, there is almost no relative decline even through 1995 despite the much larger rise in wages from 1982 to 1989.[26] This latter result suggests that the credit boom in early deregulation states may have led to long-run higher relative wages in the tradable sector, thereby reducing competitiveness. The tradable employment dynamics in Figure 3.8 show suggestive evidence consistent with a loss of competitiveness. Tradable employment in early deregulation states begins to gradually decline starting in 1988, prior to the recession, although the change is not statistically significant.

Figure 3.10 presents estimates of β_q for the overall CPI and the tradable and non-tradable price indexes. In early deregulation states, the overall CPI and non-tradable price index stop increasing in 1990. But, similar to wages, there is limited downward price adjustment during the recession. By 1994 there is some evidence of a modest reversal in prices for early relative to late deregulation states. These results suggest

[26] We also explored whether the lack of decline in wages among early deregulators was stronger in high union density states, but we did not find a significant interaction effect between the deregulation measure and unionization.

that consumer prices also face some downward rigidity, which leads to longer run real exchange rate appreciation in early deregulation states.[27]

3.7.2 Disruption in the banking sector

One result that is inconsistent with our theoretical framework is the relative decline in employment for early deregulation states in the tradable sector during and after the recession. This is shown in the top right panel of Figure 3.8. Consistent the results above, during the 1982 to 1989 period of rapid credit growth, employment in the tradable industry does not grow disproportionately in early deregulation states. But employment in the tradable sector does show a sharper decline in growth during the contraction phase after 1989. What explains this asymmetry? One reason could be the downward rigidity in wages already analyzed since higher wages make the tradable sector less competitive.

Table 3.13 and Figure 3.11 explore another explanation based on bigger disruption in the banking sector in early deregulation states during the contraction. We use Call Report data to construct the non-performing loans to total loans ratio ("NPL ratio") for the banking sector in a state in 1990. We construct the NPL ratio for both total and household loans. In columns 1 and 2 of Table 3.13, we report estimates from specifications relating the NPL ratio in a state to the deregulation measure, and it shows that early deregulation states experienced a significantly higher NPL ratio in 1990 for both total loans and household loans.

[27] These results on downward wage and price rigidity in the bust implicitly assume that changes in wages and prices are related to changes in employment (see also Beraja et al. (2016)). In appendix Table C.1.10 we explore Phillips curve regressions of wage and price inflation on the level of the unemployment rate, using the deregulation measure as an instrument for the level of the unemployment rate separately in the expansion and contraction. Table A10 shows that the deregulation measure predicts a lower (higher) level of unemployment in the expansion (contraction). Using the predicted level of the unemployment rate in a second stage regression yields a larger Phillips curve slope estimate in the expansion (1982 to 1989) than in the contraction (1989 to 1994), consistent with downward wage and price rigidity in the bust.

Figure 3.11 shows that the larger NPL ratio in early deregulation states is concentrated in the contraction phase of 1989 to 1992. More specifically, we estimate equation 3.3 using the NPL ratio for total and household loans as the outcome variable, and we plot in Figure 3.11 the coefficient estimates of β_q. As the estimates show, the higher NPL ratio in early deregulation states is only present in the 1989 to 1992 period. Outside of this contraction period, early deregulation states do not see more non-performing loans in their banking sector.[28]

These results suggest that more severe losses by banks during the recession in early deregulation states may have had spillover effects on employment even in the tradable industry. The estimates reported in columns 3 and 4 of Table 3.13 are consistent with this view. If we regress total employment growth in a state from 1989 to 1992 on NPL ratio of the banking sector in 1990, we find a large negative coefficient that is statistically distinct from zero. The estimates in column 4 show that the power of the NPL ratio in predicting employment comes from the NPL ratio on household loans.

One interpretation is that expansion in credit in early deregulation states led to larger losses for banks, which then led to a negative effect on employment during the recession. Column 5 reports an instrumental variables specification where we instrument for the NPL ratio of the banking sector with the deregulation instrument. The interpretation of such a specification is that deregulation is responsible for the larger losses in the banking sector in the state, which in turn exacerbated the decline in employment during the recession.

3.7.3 Household debt and the recession of 1990 to 1991

How is the boom related to the bust? All of our results are estimated in reduced form, which makes it impossible to say with certainty the underlying structural relationships between measures of the boom in a state and the severity of the subsequent recession.

[28]The estimation in Figure 3.11 includes control variables. We show the results without control variables in Figure C.1.4 in the appendix.

We explore the role of the expansion of household debt from 1982 to 1989. Our focus on household debt is motivated by the extensive body of research showing a robust correlation between a rise in household debt and subsequently lower growth (e.g., Glick and Lansing (2010), IMF (2012), King (1994), Mian and Sufi (2014a), Mian et al. (2017)). We are also motivated by the aggregate rise in household debt that occurred during the 1980s. From 1984 to 1989, the household debt to disposable personal income ratio of the United States rose from 0.58 to 0.72 after staying roughly constant from 1963 to 1984 (see Figures C.1.1 and C.1.2 in the appendix). We already know from Figure 3.3 that early deregulation states saw a substantially larger rise in household debt from 1984 to 1989.

In Table 3.14, we estimate "horse-race" specifications where we examine how measures of expansion in a state correlate with recession severity during the bust. As Panel A of Table 3.14 shows, the rise in household debt from 1982 to 1989 in a state, as measured by the state's household leverage index, predicts recession severity for all measures except for real GDP per capita. The explanatory power is strong: The R^2 is 0.35 or above for five of the six measures we have. Figure 3.12 shows the scatter plot of these regressions for all outcome variables. The rise in household debt prior to 1989 is a statistically powerful predictor of recession severity.

In Panel B of Table 3.14, we include five other measures of the economic expansion in the state. The coefficient estimates on the household leverage index are similar, and none of the other measures has the same predictive power as the rise in household debt. Early deregulation states saw an increase in several measures of credit and economic activity from 1982 to 1989, but the rise in household debt is statistically most powerful in predicting recession severity.

3.8 Conclusion

The implications of positive credit supply shocks are substantially different depending on whether they primarily boost demand or improve labor productivity. In this chapter, we develop a simple empirical test based on movements in employment and prices to disentangle whether credit supply shocks primarily boost demand or firms' production capacity.

We implement this methodology in the context of bank deregulation across the United States in the 1980s. This is a particularly interesting environment given that many argue bank deregulation improves the allocation of resources across firms, thereby increasing labor productivity. Our results suggest that banking deregulation during the 1980s primarily affected the real economy by boosting demand as opposed to improving labor productivity. In particular, early deregulation states experienced a relative rise in household debt, and a relative increase in employment in the non-tradable sector. In contrast, employment in the tradable sector was similar in early and late deregulation states. This is true even for small firms producing tradable goods, which we know rely on bank credit. Early deregulation states also witnessed substantial real exchange rate appreciation during the expansion.

Consistent with demand-based models of credit supply cycles, we find that early deregulation states witnessed an amplified business cycle from 1982 to 1992 relative to late deregulation states. The recession of 1990 to 1991 was significantly worse in states that deregulated their banking systems earlier. This is explained in part due to downward nominal wage rigidity, banking sector losses, and elevated household debt.

While we focus on the United States in the 1980s, we believe this methodology can be used in other contexts to help uncover the nature of credit expansions. An example is the introduction of the euro during the late 1990s. The introduction of the euro led to a positive credit supply shock in many European countries such as Portugal and Spain, and this positive credit supply shock can be seen in the substantial decline in

sovereign debt interest rate spreads relative to the United States (e.g., Schmitt-Grohé and Uribe (2016), Mian et al. (2017), Gopinath et al. (2015)). In Table 3.15, we split the 11 euro countries in the Mian et al. (2017) sample into two groups based on the decline in in the sovereign debt interest spread relative to the United States from 1996 to 1999. On average, Denmark, Finland, Greece, the Netherlands, Spain, and Portugal saw a decline in the sovereign debt interest spread of 1.7 percentage points, compared to a decline of only 0.1 percentage points for Austria, Belgium, Germany, France, and Italy.

As Table 3.15 shows, European countries experiencing the largest decline in sovereign interest spreads due to introduction of the euro witnessed substantially stronger employment growth from 2002 to 2007 in the non-tradable and construction sector but almost no difference in employment growth in the tradable sector. Further, countries seeing the largest positive credit supply shock also witnessed stronger nominal price and wage growth. These same countries experienced a more severe recession from 2007 to 2010. This suggests that the stronger positive credit supply shock due to the introduction of the euro in countries such as Spain and Portugal primarily worked through boosting demand as opposed to improving labor productivity.[29]

As a final caveat, it is important to note that we avoid normative claims in regards to banking deregulation in the 1980s: states that deregulated their banking systems earlier may end up better in the long run, and we do not claim that the regulations in place prior to deregulation were optimal or better than a deregulated system. The long run effects of deregulation are difficult to estimate precisely in our empirical setting. In Table C.1.3 of the appendix, we estimate "long-horizon" regressions of outcomes from 1982 to 1995 on the deregulation measure. The estimates are inconclusive, based

[29]Gopinath et al. (2015) examine data on manufacturing firms in Spain to show that capital inflows actually reduced total factor productivity because they were misallocated toward higher net worth firms.

largely on the fact that standard errors are large in such long-horizon specifications. The only correlation that appears robust is a positive relation between house price growth from 1982 to 1995 and deregulation. We look forward to future research that focuses on the long-term implications of deregulation for economic growth.

Table 3.1: Year of State Level Deregulation

State	Inter-state deregulation	Intra-state deregulation	Dereg. measure
Alaska	1982	1970	1.62
Alabama	1987	1981	0.37
Arkansas	1989	1994	-1.43
Arizona	1986	1970	0.90
California	1987	1970	0.72
Colorado	1988	1991	-1.25
Connecticut	1983	1980	1.26
Washington, DC	1985	1970	1.08
Florida	1985	1988	-0.53
Georgia	1985	1983	0.37
Hawaii	1995	1986	-0.89
Iowa	1991	1994	-1.43
Idaho	1985	1970	1.08
Illinois	1986	1988	-0.71
Indiana	1986	1989	-0.89
Kansas	1992	1987	-1.07
Kentucky	1984	1990	-0.53
Louisiana	1987	1988	-0.89
Massachusetts	1983	1984	0.55
Maryland	1985	1970	1.08
Maine	1978	1975	2.16
Michigan	1986	1987	-0.53
Minnesota	1986	1993	-0.89
Missouri	1986	1990	-0.89
Mississippi	1988	1986	-0.71
Montana	1993	1990	-1.43
North Carolina	1985	1970	1.08
North Dakota	1991	1987	-1.07
Nebraska	1990	1985	-0.71
New Hampshire	1987	1987	-0.71
New Jersey	1986	1977	0.90
New Mexico	1989	1991	-1.43
Nevada	1985	1970	1.08
New York	1982	1976	1.62
Ohio	1985	1979	1.08
Oklahoma	1987	1988	-0.89
Oregon	1986	1985	-0.17
Pennsylvania	1986	1982	0.37
Rhode Island	1984	1970	1.26
South Carolina	1986	1970	0.90
Tennessee	1985	1985	0.01
Texas	1987	1988	-0.89
Utah	1984	1981	0.90
Virginia	1985	1978	1.08
Vermont	1988	1970	0.55
Washington	1987	1985	-0.35
Wisconsin	1987	1990	-1.07
West Virginia	1988	1987	-0.89
Wyoming	1987	1988	-0.89

Notes: The intra-state and inter-state deregulation years have a correlation of 0.46. Deregulation measure is the average of the number of years during which a state is in the process of deregulating between 1979 and 1989, according to inter-state deregulation and intra-state deregulation definitions. That is, Dereg. measure is defined as the standardized value of $.5 \sum_{j \in \{inter, intra\}} \min(\max(1989 - DeregYear_j, 0), 10)$. Intra-state deregulation dates for states that deregulated intra-state branching before 1970 are truncated at 1970.

Table 3.2: Summary Statistics

	N	Mean	Median	SD
Years deregulation	49	2.82	3.00	1.94
Years dereg. intra	49	4.92	4.00	4.19
Dereg. measure	49	-0.02	-0.35	1.01
Dereg. measure (1983 dummy)	49	0.45	0.00	0.50
Δ_{82-89} HH Debt to income	49	0.21	0.20	0.09
Δ_{82-89} HH leverage index	49	-0.06	-0.35	1.19
Δ_{82-89} ln(House prices)	49	0.37	0.30	0.33
Δ_{89-92} ln(House prices)	49	0.04	0.05	0.11
Δ_{82-89} Unemployment	49	-4.09	-3.80	1.88
Δ_{89-92} Unemployment	49	1.77	1.70	1.40
Δ_{82-89} ln(Real GDP per capita)	49	0.17	0.22	0.17
Δ_{89-92} ln(Real GDP per capita)	49	-0.01	-0.01	0.05
Δ_{82-89} ln(Housing unit permits)	49	0.14	0.35	0.81
Δ_{89-92} ln(Housing unit permits)	49	0.03	0.04	0.46
Δ_{82-89} ln(Total employment)	49	0.20	0.22	0.12
Δ_{89-92} ln(Total employment)	49	0.03	0.04	0.07
Δ_{82-89} ln(Tradable employment)	49	0.02	0.06	0.12
Δ_{89-92} ln(Tradable employment)	49	-0.04	-0.04	0.09
Δ_{82-89} ln(Non-tradable employment)	49	0.23	0.24	0.11
Δ_{89-92} ln(Non-tradable employment)	49	0.03	0.04	0.08
Δ_{82-89} ln(Construction employment)	49	0.20	0.30	0.31
Δ_{89-92} ln(Construction employment)	49	-0.05	-0.01	0.25
Δ_{89-92} ln(Retail sales)	19	0.10	0.10	0.06
Δ_{84-89} ln(Loan appl. volume)	49	2.39	2.24	0.99
Δ_{84-89} ln(Loan appl. number)	49	1.78	1.75	0.55
Δ_{82-89} ln(Total loans)	49	0.58	0.56	0.41
Δ_{82-89} ln(Commercial and industrial loans)	49	0.42	0.42	0.48
Δ_{82-89} ln(Household loans)	49	0.72	0.69	0.36
Δ_{82-89} ln(Consumer loans)	49	0.70	0.71	0.46
Δ_{82-89} ln(CPI) (Del Negro)	48	0.24	0.23	0.04
Δ_{82-89} ln(CPI Tradables)	25	0.12	0.12	0.02
Δ_{82-89} ln(CPI Non-Tradables)	25	0.24	0.22	0.06
Δ_{82-89} ln(Average wages)	49	1.24	-0.75	7.57
Δ_{82-89} ln(Resid. wages)	49	-0.52	-1.07	7.99
Δ_{82-89} ln(Tradable resid. wages)	49	-1.44	-2.04	9.05
Δ_{82-89} ln(Non-tradable resid. wages)	49	0.32	1.87	10.23
Δ_{82-89} ln(Construction resid. wages)	49	-4.02	-7.40	12.25

Notes: Dereg. measure is defined in Table 3.1. Household loans subsume the call report item Loans to Individuals and Real Estate Loans. Commercial and industrial loans are based on the call report item Commercial and Industrial Loan. Consumer loans are based on the call report item Loans to Individuals and subsume home-equity loans starting in 1987. Δ_{82-89} HH leverage index represents the first principal component of Δ_{82-89} Debt-to-income, Δ_{84-89} ln(Loan appl. volume), and Δ_{82-89} ln(Consumer loans).

Table 3.3: Deregulation and the Rise in Leverage from 1982 to 1989

	(1) Δ_{82-89} Debt to income	(2) Δ_{84-89} Loan appl. volume	(3) Δ_{84-89} Loan appl. number	(4) Δ_{82-89} Total loans	(5) Δ_{82-89} C&I loans	(6) Δ_{82-89} HH loans	(7) Δ_{82-89} Con. loans	(8) Δ_{82-89} HH leverage index
Panel A: Base Line								
Dereg. measure	0.0405**	0.416*	0.193*	0.190**	0.236**	0.136*	0.233**	0.742**
	(0.0115)	(0.159)	(0.0876)	(0.0579)	(0.0619)	(0.0543)	(0.0600)	(0.147)
R^2	0.210	0.182	0.128	0.217	0.250	0.147	0.269	0.398
Panel B: Lagged Dependent Variable Controls								
Dereg. measure	0.0296**	0.187**			0.167*	0.137*	0.219**	
	(0.0101)	(0.0485)			(0.0624)	(0.0558)	(0.0576)	
R^2	0.477	0.439			0.425	0.314	0.375	
Observations	49	49	49	49	49	49	49	49

Notes: This table presents state-level regressions of growth in leverage from 1982 to 1989 on the deregulation measure: $\Delta_{82-89} y_s = \alpha + \beta d_s + \epsilon_s$. The Δ_{84-89} Loan application number and Δ_{84-89} Loan application volume variables are computed using HMDA flows. The growth rate is calculated based on the mean flow between 1981-1983 and the mean flow between 1984-1988. Household loans (HH loans) comprise the call report items "Real Estate Loans" and "Loans to Individuals". Consumer loans (Con. loans) are based on the call report item "Loans to Individuals" and subsume home-equity loans starting in 1987. Commercial and industrial loans (C&I loans) and total loans follow their corresponding definitions in the call report. The Δ_{82-89} HH leverage index represents the first principal component of Δ_{82-89} Debt-to-income, Δ_{84-89} Loan appl. volume, and Δ_{82-89} Consumer loans. Specification in panel B control for the one-year changes in the dependent variable between 1978 and 1982. Heteroskedasticity robust standard errors in parentheses. +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Table 3.4: Deregulation and the Household Leverage Index from 1982 to 1989

	Δ_{82-89} HH leverage index						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dereg. measure	0.700**	0.680**	0.524**	0.777**	0.699**	0.349*	0.525**
	(0.151)	(0.166)	(0.154)	(0.137)	(0.174)	(0.170)	(0.188)
Oil Exposure '85	-0.137*					-0.428**	
	(0.0521)					(0.148)	
Oil Empl. '82	-8.573*					-29.04**	
	(3.725)					(5.999)	
Forbearance		0.201				-0.0635	
		(0.150)				(0.157)	
Northeast region			1.332*			1.412*	
			(0.516)			(0.554)	
South region			0.284			0.677	
			(0.233)			(0.414)	
West region			0.0985			0.224	
			(0.336)			(0.499)	
Debt to income$_{1982}$				-0.905		-2.319	
				(1.508)		(2.050)	
Δ_{82-89} Real GDP per Capita				-0.560		3.617**	
				(0.582)		(1.185)	
Unemployment$_{1982}$				-0.0920		-0.0110	
				(0.0633)		(0.0606)	
Δ_{82-89} C&I loans							0.918*
							(0.400)
R^2	0.503	0.416	0.524	0.439	0.483	0.766	0.500
Demographic controls					✓	✓	
Observations	49	48	49	49	49	48	49

Notes: This table presents regressions of the Δ_{82-89} HH leverage index on the deregulation measure and various controls. Δ_{82-89} HH leverage index represents the first principal component of Δ_{82-89} Debt-to-income, Δ_{84-89} Loan appl. volume, and Δ_{82-89} Consumer loans. Oil exposure 1985 represents the share of the state's oil production after excluding federal production. This share is further normalized by the state's population in 1985. Oil employment 1982 is the state's share of employment in the oil industry. Commercial and industrial loans (C&I loans) follows its corresponding definition in the call report. Demographic controls are the fraction of people in urban neighborhood, fraction black, fraction hispanic, fraction with a high school degree, and fraction with college degree, based on the 1980 census. Heteroskedasticity robust standard errors in parentheses. +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Table 3.5: Deregulation and Amplification in Boom and Bust

	Boom: Change from 82 to 89				Bust: Change from 89 to 92			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Controls	None	Lagged Dep. Var.	Oilshock	Demographics & Forbearance	None	Lagged Dep. Var.	Oilshock	Demographics & Forbearance
				Panel A: Unemployment				
Dereg. measure	-0.597*	-0.833**	-0.214	-0.425*	0.877**	0.820**	0.781**	0.765**
	(0.225)	(0.162)	(0.216)	(0.205)	(0.137)	(0.138)	(0.157)	(0.106)
R^2	0.104	0.678	0.419	0.422	0.405	0.440	0.473	0.582
				Panel B: Total Employment				
Dereg. measure	0.0531**	0.0630**	0.0170	0.0480**	-0.0278**	-0.0301**	-0.0292**	-0.0217+
	(0.0147)	(0.0158)	(0.0110)	(0.0168)	(0.00970)	(0.00858)	(0.00902)	(0.0111)
R^2	0.193	0.332	0.723	0.214	0.181	0.240	0.358	0.452
				Panel C: Real GDP per capita				
Dereg. measure	0.0615*	0.0375**	0.0425**	0.0417	-0.0225**	-0.0197**	-0.0199**	-0.0211*
	(0.0290)	(0.0112)	(0.0101)	(0.0313)	(0.00765)	(0.00666)	(0.00502)	(0.00848)
R^2	0.134	0.871	0.861	0.380	0.218	0.472	0.524	0.383
				Panel D: House prices				
Dereg. measure	0.186**	0.186**	0.149**	0.191**	-0.0424**	-0.0323*	-0.0455**	-0.0438*
	(0.0397)	(0.0370)	(0.0469)	(0.0492)	(0.0133)	(0.0125)	(0.0161)	(0.0173)
R^2	0.325	0.506	0.384	0.468	0.150	0.433	0.153	0.313
				Panel E: Housing unit permits				
Dereg. measure	0.277**	0.283**	0.0280	0.216*	-0.225**	-0.226**	-0.154*	-0.142*
	(0.0861)	(0.102)	(0.0612)	(0.0878)	(0.0577)	(0.0629)	(0.0589)	(0.0620)
R^2	0.148	0.330	0.671	0.305	0.246	0.308	0.360	0.351
Observations	49	49	49	48	49	49	49	48

Notes: This table presents regressions of changes in real outcomes from 1982 to 1989 (column 1-4) and 1989 to 1992 (columns 5-8) on the deregulation measure. The column labeled "Oilshock" controls for a state's oil production share after excluding federal production normalized by population and the oil industry's 1982 employment share. Column 4 and 8 uses only 48 observations as there is no information available for forbearance in D.C. Demographic controls include the fraction urban, fraction black, fraction hispanic, fraction with high school, and fraction with college, based on the 1980 census. Panel D columns 2 and 6 use two lagged dependent variables due to data availability. Alaska is dropped from Panel D as it is a large outlier. Heteroskedasticity robust standard errors in parentheses. +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Table 3.6: Deregulation and Amplification: Estimating Beta

	(1) Real GDP growth	(2) Real GDP p.c. growth	(3) Unemp. Change	(4) Total Empl. Growth	(5) House price growth	(6) Housing unit growth
Panel A: Boom-Bust Cycle 1982-89 & 1989-92						
GDP growth	0.734**	0.875**	-1.735**	0.769**	1.171**	-1.552
	(0.103)	(0.0845)	(0.100)	(0.121)	(0.312)	(1.035)
Dereg. measure	-0.00858**	-0.00955**	0.0113**	-0.0114**	-0.0201**	-0.0747**
	(0.00284)	(0.00253)	(0.00174)	(0.00385)	(0.00585)	(0.0272)
Dereg. measure x GDP growth	0.539**	0.453**	-0.463**	0.466**	1.304**	2.526*
	(0.102)	(0.0870)	(0.0908)	(0.133)	(0.303)	(1.133)
R^2	0.369	0.481	0.802	0.409	0.379	0.154
Panel B: Boom-Bust Cycle 1975-79 & 1979-82						
GDP growth	1.030**	0.981**	-1.355**	1.302**	2.327**	
	(0.110)	(0.0938)	(0.0771)	(0.0792)	(0.173)	
Dereg. measure	0.00315	0.00328	-0.00312+	0.000828	0.00485	
	(0.00600)	(0.00478)	(0.00174)	(0.00292)	(0.00352)	
Dereg. measure x GDP growth	-0.164	-0.140	0.0117	-0.149+	-0.377*	
	(0.133)	(0.114)	(0.0870)	(0.0797)	(0.171)	
R^2	0.378	0.489	0.795	0.645	0.630	
Panel B: Boom-Bust Cycle 1970-73 & 1973-75						
GDP growth	0.969**	0.919**	-0.420**	0.379**		
	(0.134)	(0.120)	(0.0511)	(0.0974)		
Dereg. measure	-0.00110	-0.00154	0.00293	-0.00101		
	(0.00896)	(0.00720)	(0.00248)	(0.00809)		
Dereg. measure x GDP growth	-0.188	-0.186	-0.00976	-0.106		
	(0.179)	(0.158)	(0.0605)	(0.130)		
R^2	0.401	0.462	0.501	0.131		
Observations	98	98	98	98	98	

Notes: This table presents regressions of the form: $\Delta y_{sb} = \alpha + \beta X_b \cdot d_s + \gamma \Delta X_b + \delta d_s + \epsilon_{sb}$. The equation is estimated in changes using two periods, the boom and the bust (i.e. $b = \{boom, bust\}$). The dependent variables in Panel A are defined as the growth rate from 1983 to 1989 (boom) and 1989 to 1992 (bust), with the exception of unemployment, which is measured as the change from 1982 to 1989 and 1989 to 1992. Panels B and C present placebo regressions for earlier cycles. The variable ΔX_b is the change in aggregate GDP growth excluding state i. The coefficient on the interaction between the deregulation measure and the aggregate cycle variable, β, measures how a state's cyclicality varies with the deregulation measure. House price growth (column 4) and housing unit permit growth (column 5) are missing in some periods due to data availability. Standard errors are clustered at the state level. +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Table 3.7: Deregulation and Change in Employment by Industry from 1982 to 1989

	Δ_{82-89} Total employment	Δ_{82-89} Empl. tradables	Δ_{82-89} Empl. non-tradables	Δ_{82-89} Empl. construction	Δ_{82-89} Industry-level employment			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dereg. measure	0.0531**	0.00237	0.0564**	0.161**	0.0378*	-0.0206	-0.0181	-
	(0.0147)	(0.0174)	(0.0134)	(0.0404)	(0.0155)	(0.0215)	(0.0212)	-
Dereg. measure								
x other						0.0715**	0.0676**	0.0687**
						(0.0231)	(0.0229)	(0.0226)
x non-tradables						0.0890**	0.0866**	0.0874**
						(0.0238)	(0.0235)	(0.0232)
x construction						0.184**	0.182**	0.183**
						(0.0395)	(0.0400)	(0.0396)
Unit of Obs.	State	State	State	State	State x 2 digit Ind.	State x 2 digit Ind.	State x 2 digit Ind.	State x 2 digit Ind.
2 Digit Ind. FE							✓	✓
State FE								✓
R^2	0.193	0.000	0.256	0.276	0.004	0.023	0.446	0.478
Observations	49	49	49	49	3,762	3,762	3,762	3,762

Notes: This table reports regressions of employment growth from 1982 to 1989 by industry on the deregulation measure. The employment industry categorization is based on the SIC industries, where tradables: $2000 \leq$ sic ≤ 3900, sic $= 20001$, and sic $= 30001$; non-tradables: $5200 \leq$ sic ≤ 5900; construction: $1500 \leq$ sic ≤ 1700. Columns 1-4 report regressions at the state level for each industry categorization separately. Columns 5-8 report regressions of employment growth at the state by two digit industry level. In columns 6-8 the deregulation measure is interacted with industry category, with tradable employment being the omitted category. Standard errors are heteroskedasticity robust (columns 1-4) or clustered at the state level (columns 5-8). +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Table 3.8: Deregulation and Employment Growth from 1982 to 1989 by Establishment Size

	(1) 1 to 9	(2) 10 to 49	(3) 50 to 99	(4) 100+
Panel A: Tradable Employment Growth, 1982-89				
Dereg. measure	0.0118	0.0284	-0.0181	-0.00385
	(0.0539)	(0.0353)	(0.0302)	(0.0268)
R^2	0.001	0.017	0.007	0.001
Observations	48	49	49	49
Panel B: Non-tradable Employment Growth, 1982-89				
Dereg. measure	0.0434**	0.0637**	0.0522^{+}	0.0253
	(0.00830)	(0.0131)	(0.0281)	(0.0302)
R^2	0.324	0.314	0.087	0.015
Observations	49	49	49	49
Panel C: Construction Employment Growth, 1982-89				
Dereg. measure	0.0992**	0.189**	0.182**	0.125^{+}
	(0.0318)	(0.0463)	(0.0625)	(0.0667)
R^2	0.189	0.293	0.183	0.064
Observations	49	49	49	49

Notes: This table reports regressions of employment growth from 1982 to 1989 by industry and establishment size on the deregulation measure. Panels A, B, and C show separate regressions for tradable, non-tradable, and construction industries. Columns 1-4 present estimates separately by establishment size in terms of number of employees (1 to 9 employees, 10 to 49, 50 to 99, and 100 or greater). Standard errors are heteroskedasticity robust. +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Table 3.9: Deregulation and Consumer Price Inflation from 1982 to 1989

			Special Aggregates		
	(1) Δ_{82-89} All items (Del Negro)	(2) Δ_{84-89} All items	(3) Δ_{84-89} Non-tradables	(4) Δ_{84-89} Tradables	(5) Δ_{84-89} Non-tradables or Tradables
Dereg. measure	1.780**	2.334**	4.017**	0.303	0.303
	(0.482)	(0.513)	(0.777)	(0.459)	(0.463)
Dereg. measure × NT					3.714**
					(0.821)
Dummy Non-tradables					11.94**
					(0.878)
R^2	0.261	0.434	0.476	0.021	0.807
Unit of obs.	State	State	State	State	State × NT-T
Observations	48	25	25	25	50

Notes: This table presents regressions of CPI inflation on the deregulation measure. Inflation measures in columns 2-5 are state-level aggregates computed using the BLS's MSA-level indexes and are thus only available for 26 states. Columns 2-5 exclude Alaska, which is a large outlier in the sample. Tradable and non-tradable CPI inflation are defined at the BLS "Commodities" and "Services" Special Aggregates, respectively. Heteroskedasticity robust standard errors in parentheses. +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Table 3.10: Deregulation and Wage Growth from 1982 to 1989

	Aggregate Wage Growth		By Gender		By Industry		
	(1) Average Wages	(2) Residualized Wages	(3) Male Res. Wages	(4) Female Res. Wages	(5) Tradable Res. Wages	(6) Non-Tradable Res. Wages	(7) Construction Res. Wages
Dereg. measure	4.007**	4.249**	4.364**	3.638**	2.911*	4.735**	5.232**
	(0.888)	(0.994)	(1.013)	(0.878)	(1.366)	(1.304)	(1.618)
R^2	0.288	0.291	0.299	0.255	0.106	0.221	0.188
Observations	49	49	49	49	49	49	49

Notes: This table presents regressions of state level wage growth on the deregulation measure. State level wages are estimated from the CPS Outgoing Rotation Group. The dependent variable in column 1 is the change in log average hourly wages. Column 2 uses the change in log residualized hourly wages, where residual wages are estimate by regressing log wages on age, education, and race dummies separately for males and females. Columns 3 and 4 present separate regressions for residualized wages of male and female workers. Columns 5-7 report wage growth separately for workers in the tradable, non-tradable, and construction sectors, where sectors are defined using the same definition as employment. Heteroskedasticity robust standard errors in parentheses. +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Table 3.11: Placebo Regressions of Credit, CPI, and Employment Growth on Deregulation in Previous Expansions

	(1) Δ Total loans	(2) Δ C&I loans	(3) Δ HH loans	(4) Δ Con. loans	(5) Δ CPI (Del Negro)	(6) Δ Empl. tradables	(7) Δ Empl. non-tradables	(8) Δ Empl. construction
Panel A: Boom Period 1975-1979								
Dereg. measure	-0.00109	0.000888	-0.00172	0.00138	-0.00817**	-0.00832	-0.0128	-0.0743*
	(0.000724)	(0.00143)	(0.00109)	(0.00130)	(0.00271)	(0.0139)	(0.0118)	(0.0314)
R^2	0.034	0.010	0.040	0.027	0.179	0.008	0.026	0.125
Observations	49	49	49	49	48	49	49	49
Panel B: Boom Period 1970-1973								
Dereg. measure					0.00334*	-0.0271+	-0.0102	-0.0150
					(0.00148)	(0.0144)	(0.00983)	(0.0203)
R^2					0.126	0.083	0.026	0.011
Observations					48	49	49	49
Panel C: Boom Period 1962-1969								
Dereg. measure						0.00327	0.0445	0.0279
						(0.0318)	(0.0309)	(0.0436)
R^2						0.000	0.067	0.010
Observations						48	48	48
Panel D: Boom Period 1962-1967								
Dereg. measure						0.0190	0.0393	0.0212
						(0.0344)	(0.0329)	(0.0543)
R^2						0.010	0.055	0.004
Observations						47	47	47

Notes: The table reports regressions of credit growth, inflation, and employment growth in previous expansions on the deregulation measure. Panel A columns 1-4 use the change from 1976 to 1979 due to data availability. Heteroskedasticity robust standard errors in parentheses. +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Table 3.12: Deregulation and Change in Employment by Industry from 1989 to 1992

	Δ_{89-92} Tot. emp.	Δ_{89-92} Emp. tradables	Δ_{89-92} Emp. non-trad.	Δ_{89-92} Emp. constr.	Δ_{89-92} Industry-level employment			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dereg. measure	-0.0278**	-0.0322*	-0.0313*	-0.128**	-0.0435*	-0.0438*	-0.0422*	-
	(0.00970)	(0.0140)	(0.0116)	(0.0329)	(0.0162)	(0.0188)	(0.0184)	-
Dereg. measure								
x other						0.00386	0.00135	0.000297
						(0.0192)	(0.0190)	(0.0187)
x non-tradables						0.00814	0.00654	0.00612
						(0.0140)	(0.0136)	(0.0134)
x construction						-0.0742**	-0.0758**	-0.0762**
						(0.0253)	(0.0250)	(0.0244)
Unit of Obs.	State	State	State	State	State x 2 digit Ind.	State x 2 digit Ind.	State x 2 digit Ind.	State x 2 digit Ind.
2 Digit Ind. FE							✓	✓
State FE								✓
R^2	0.181	0.140	0.166	0.264	0.005	0.009	0.468	0.500
Observations	49	49	49	49	3,816	3,816	3,816	3,816

Notes: This table reports regressions of employment growth from 1989 to 1992 by industry on the deregulation measure. The employment industry categorization is based on the SIC industries, where tradables: $2000 \leq$ sic ≤ 3900, sic $= 20001$, and sic $= 30001$; non-tradables: $5200 \leq$ sic ≤ 5900; construction: $1500 \leq$ sic ≤ 1700. Columns 1-4 report regressions at the state level for each industry categorization separately. Columns 5-8 report regressions of employment growth at the state by two digit industry level. In columns 6-8 the deregulation measure is interacted with industry category, with tradable employment being the omitted category. Standard errors in parentheses are heteroskedasticity robust (columns 1-4) or clustered at the state level (columns 5-8). +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Table 3.13: Deregulation, Non-Performing Loans and Employment from 1989 to 1992

	NPL ratio total loans 1990	NPL ratio HH loans 1990	Δ_{89-92} Total Employment		
	(1)	(2)	(3)	(4)	(5)
Dereg. measure	0.00866**	0.0111**			
	(0.00245)	(0.00248)			
NPL ratio total loans 1990			-2.610**		-3.206**
			(0.332)		(0.882)
NPL ratio HH loans 1990				-1.982*	
				(0.784)	
NPL ratio C&I loans 1990				-0.382	
				(0.595)	
R^2	0.225	0.320	0.532	0.504	0.504
Specification	OLS	OLS	OLS	OLS	IV
Observations	49	49	49	49	49

Notes: This table shows the relation between banking deregulation, non-performing loans in 1990, and employment growth from 1989 to 1992. The NPL ratio of total loans in 1990 is defined as total non-performing loans relative to total loans in 1990, based on the corresponding call report items. The NPL ratio of HH loans in 1990 is the non-performing loans ratio for the aggregate of real estate and individual loans in 1990. The 1990 NPL ratio of total loans in column 5 is instrumented with the deregulation measure. Standard errors in parentheses are heteroskedasticity robust. +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Table 3.14: Household Leverage and the Bust from 1989 to 1992

	Δ_{89-92} Unemployment	Δ_{89-92} Total employment	Δ_{89-92} Real GDP per capita	Δ_{89-92} House prices	Δ_{89-92} Retail sales	Δ_{89-92} Housing unit permits
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Base Case						
Δ_{82-89} HH leverage index	0.889**	-0.0380**	-0.00970	-0.0556**	-0.0393**	-0.265**
	(0.111)	(0.00592)	(0.00580)	(0.0109)	(0.0111)	(0.0402)
R^2	0.575	0.467	0.056	0.357	0.424	0.482
Panel B: Controls						
Δ_{82-89} HH leverage index	0.861**	-0.0289**	-0.0198*	-0.0582**	-0.0329+	-0.201**
	(0.152)	(0.00693)	(0.00748)	(0.0136)	(0.0183)	(0.0516)
Δ_{82-89} C&I loans	0.0627	-0.0113	-0.0218	-0.0644+	-0.0484	0.0881
	(0.427)	(0.0194)	(0.0209)	(0.0381)	(0.0381)	(0.144)
Δ_{82-89} Housing unit permits	-0.397	0.0121	0.0209	0.0588*	-0.0874+	-0.205+
	(0.318)	(0.0145)	(0.0156)	(0.0284)	(0.0424)	(0.108)
Δ_{82-89} Real GDP per capita	1.673	-0.273**	0.160*	-0.221	0.0192	-0.0918
	(1.600)	(0.0727)	(0.0785)	(0.143)	(0.231)	(0.541)
Δ_{82-89} Unemployment	-0.242*	0.00219	0.00738	-0.00298	-0.0157	0.00165
	(0.0990)	(0.00450)	(0.00486)	(0.00884)	(0.0122)	(0.0335)
Δ_{82-89} Total employment	-1.607	0.247**	-0.0349	0.340*	0.444+	-0.366
	(1.645)	(0.0747)	(0.0807)	(0.147)	(0.211)	(0.556)
R^2	0.655	0.683	0.319	0.564	0.624	0.629
Observations	49	49	49	49	19	49

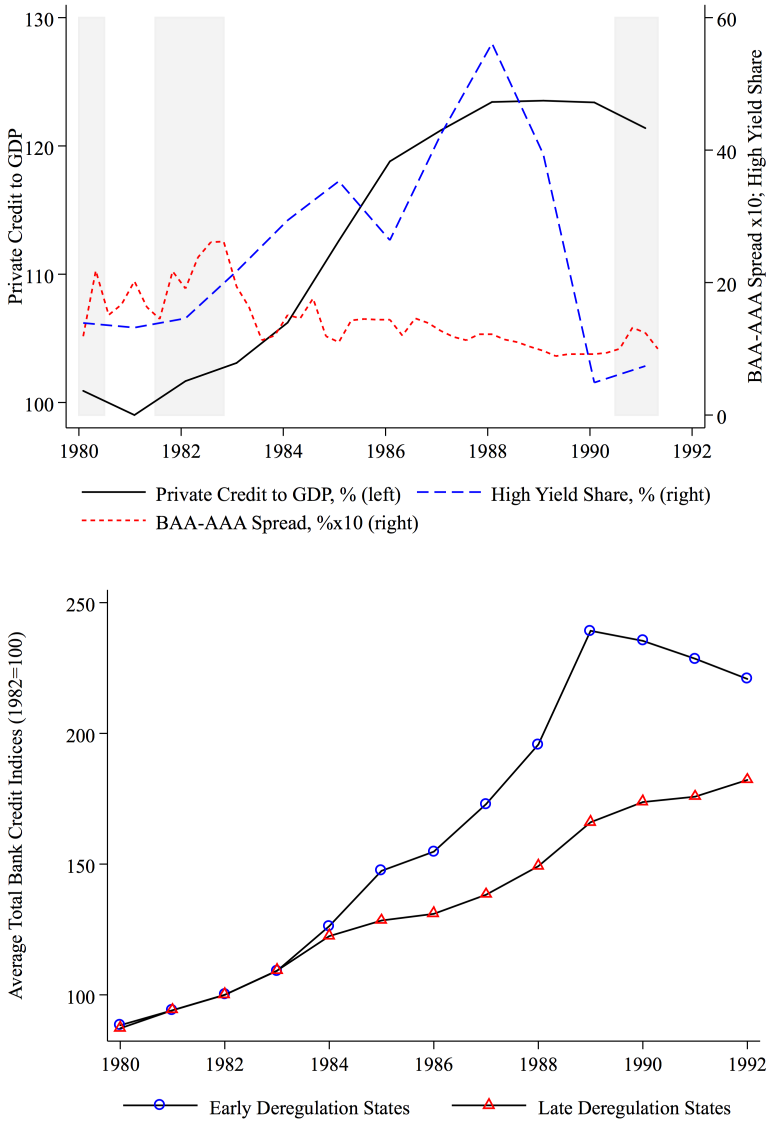
Notes: The table presents regressions of economic outcomes from 1989 to 1992 on the rise in household leverage and several other predictors from 1982 to 1989. Δ_{82-89} HH leverage index represents the first principal component of Δ_{82-89} Debt-to-income, Δ_{84-89} Loan appl. volume, and Δ_{82-89} Consumer loans. Standard errors in parentheses are heteroskedasticity robust. +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Table 3.15: Credit Supply Shocks, Employment, and Prices: The Eurozone Experience

	Small Decline in Spread (N=5)	Large Decline in Spread (N=6)
Sovereign spread change, 1996-99	-0.14	-1.71
Employment growth, 2002-07	4.41	7.80
Tradable empl. growth, 2002-07	-4.62	-6.79
Non-tradable empl. growth, 2002-07	5.47	12.20
Construction empl. growth, 2002-07	5.04	13.38
Inflation, 2002-07	9.86	11.88
Nominal wage growth, 2002-07	12.79	16.84
Employment growth, 2007-10	0.73	-2.63

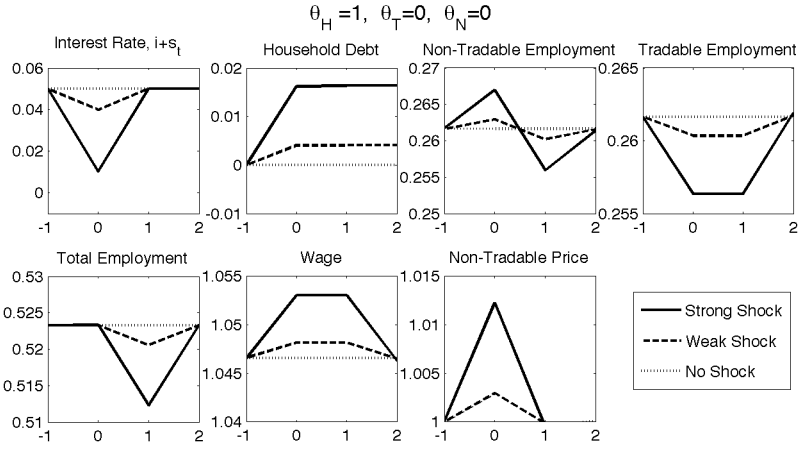
Notes: This table displays average growth in employment, prices, and wages separately for Eurozone countries with small and large declines in the sovereign spread leading up to the introduction of the euro. The small decline category (first column) includes Austria, Belgium, Germany, France, and Italy, and the large decline group is Denmark (ERM II), Finland, Greece, Netherlands, Spain, and Portugal. Data on employment by industry from the OECD is not available for Ireland.

Figure 3.1: Aggregate Credit Supply: Private Credit to GDP, Baa-Aaa Spread, and High Yield Share of Corporate Debt Issuance

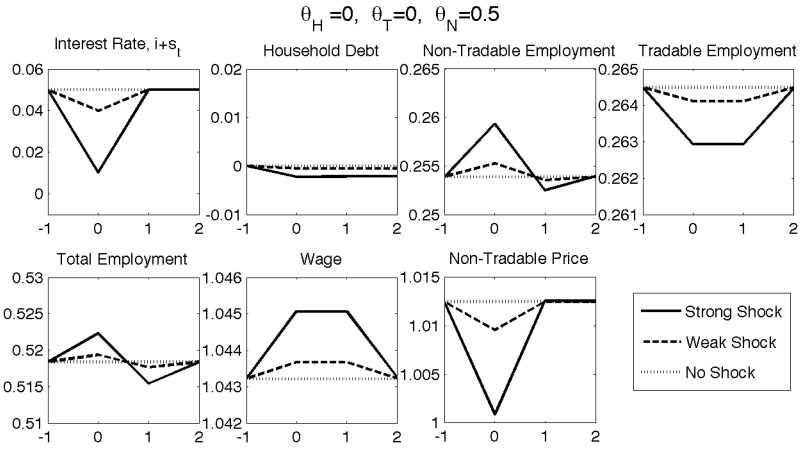


Notes: The top panel shows time series plots of the private credit to GDP ratio (left axis), Baa-Aaa spread (right axis), and the high year share (HYS) of corporate debt issuance from Greenwood and Hanson (2013) (right axis). The Baa-Aaa spread is multiplied by ten to have a similar range as the HYS. Shaded bars represent NBER recession dates. The bottom panel shows average of total bank credit indices (normalized to 100 for each state in 1982) across early and late deregulation states. Total bank credit is the sum of household loans and commercial and industrial loans in the Call Reports. Early deregulation states are defined as states that deregulated intra- or inter-state restrictions in 1983 or earlier, and late deregulation states are states that began the deregulation process after 1983.

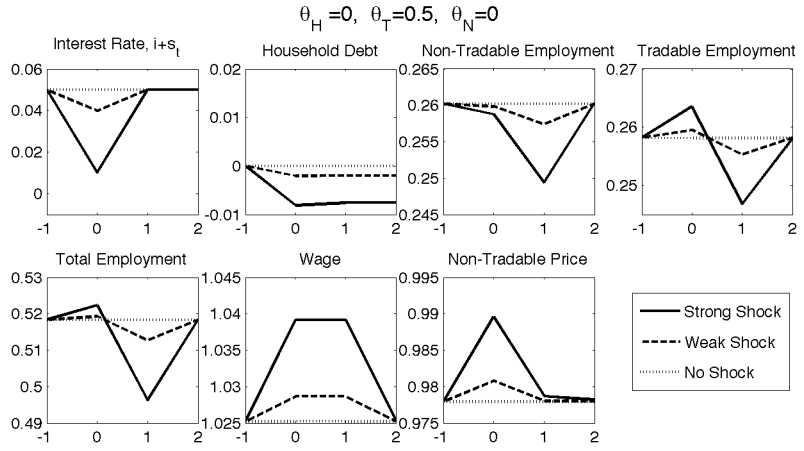
Figure 3.2: Model Predictions



(a) Credit Supply Shock through Local Demand, $\theta_H > 0$, $\theta_T = \theta_N = 0$

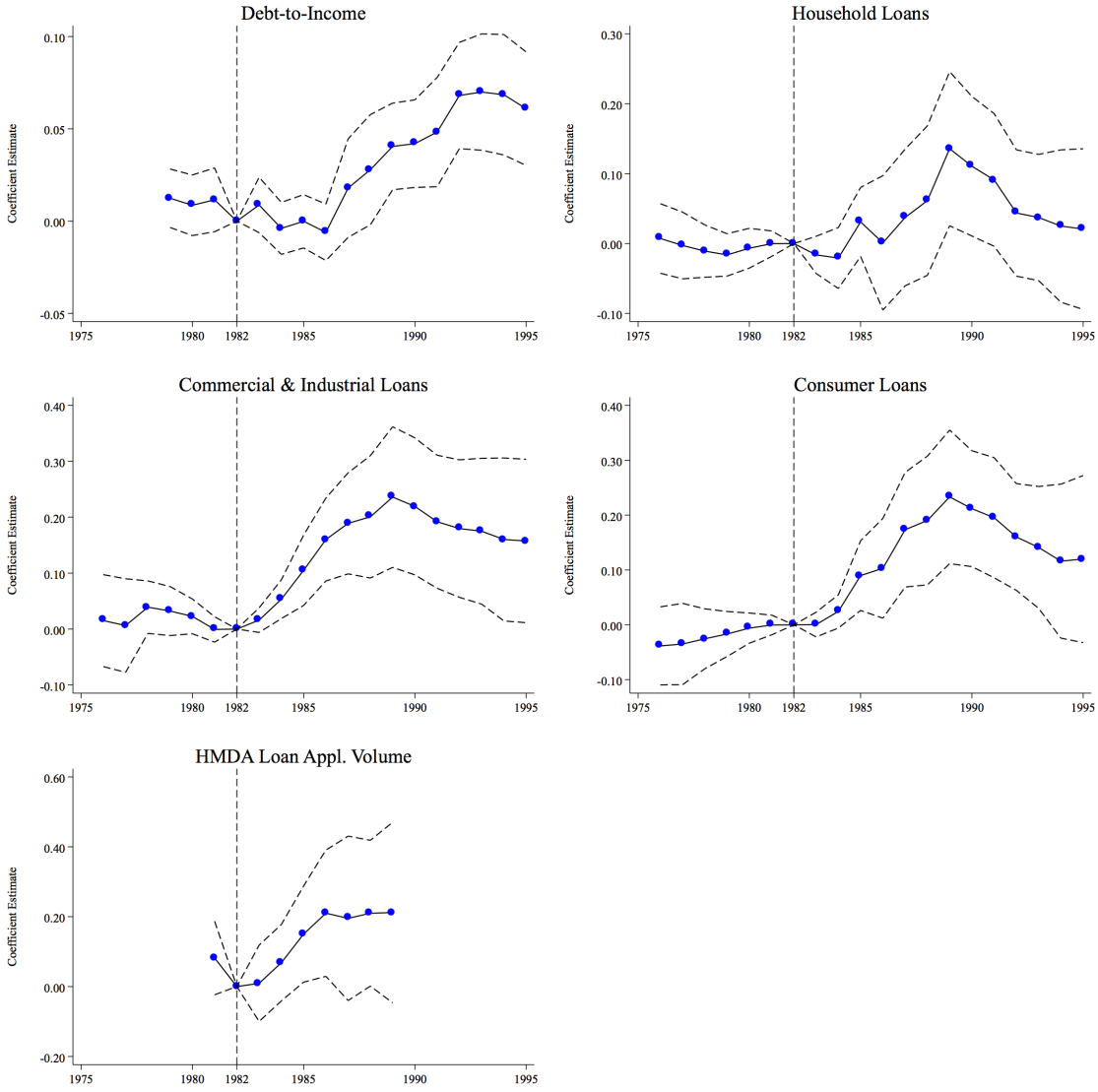


(b) Credit Supply Shock through Non-Tradable Supply, $\theta_N > 0$, $\theta_H = \theta_T = 0$



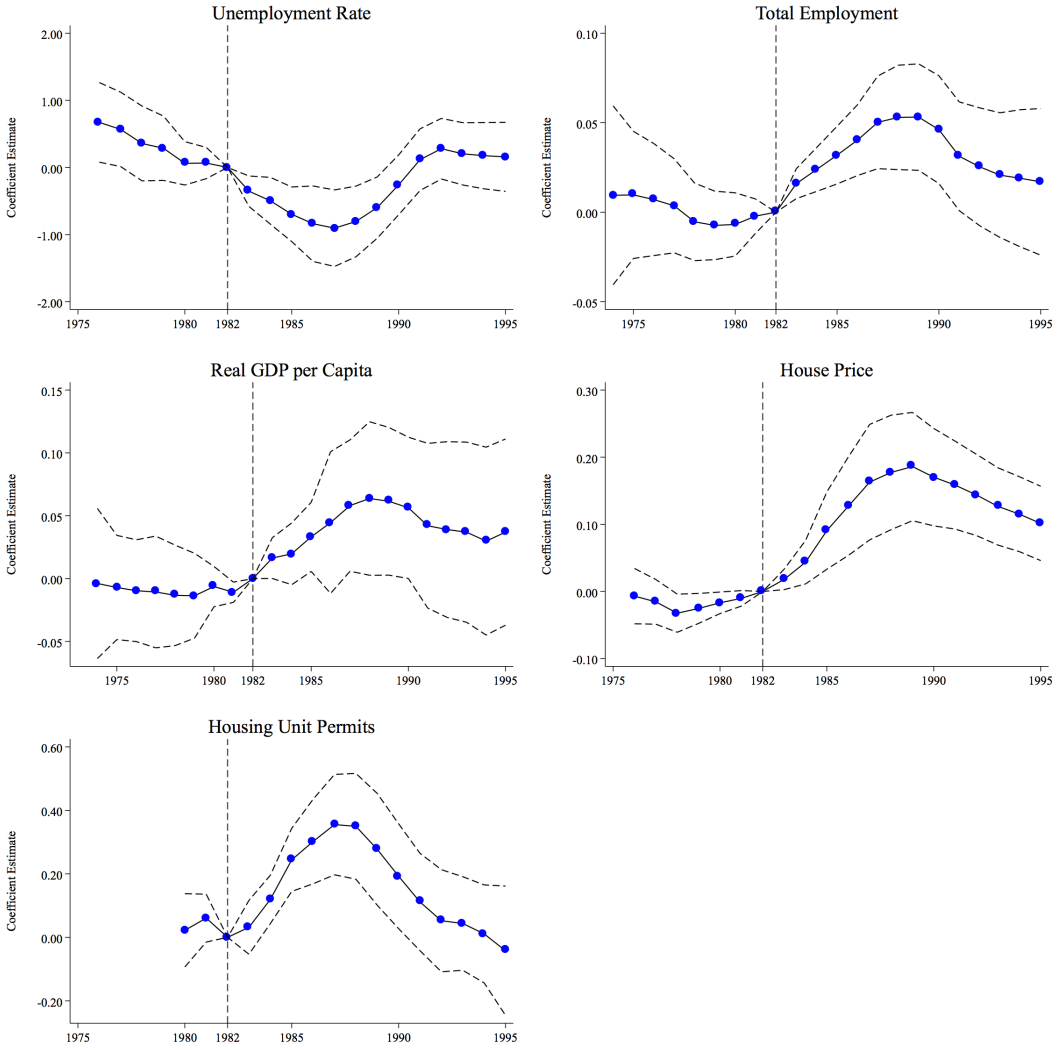
(c) Credit Supply Shock through Tradable Supply, $\theta_T > 0$, $\theta_H = \theta_N = 0$

Figure 3.3: Credit Growth and Deregulation



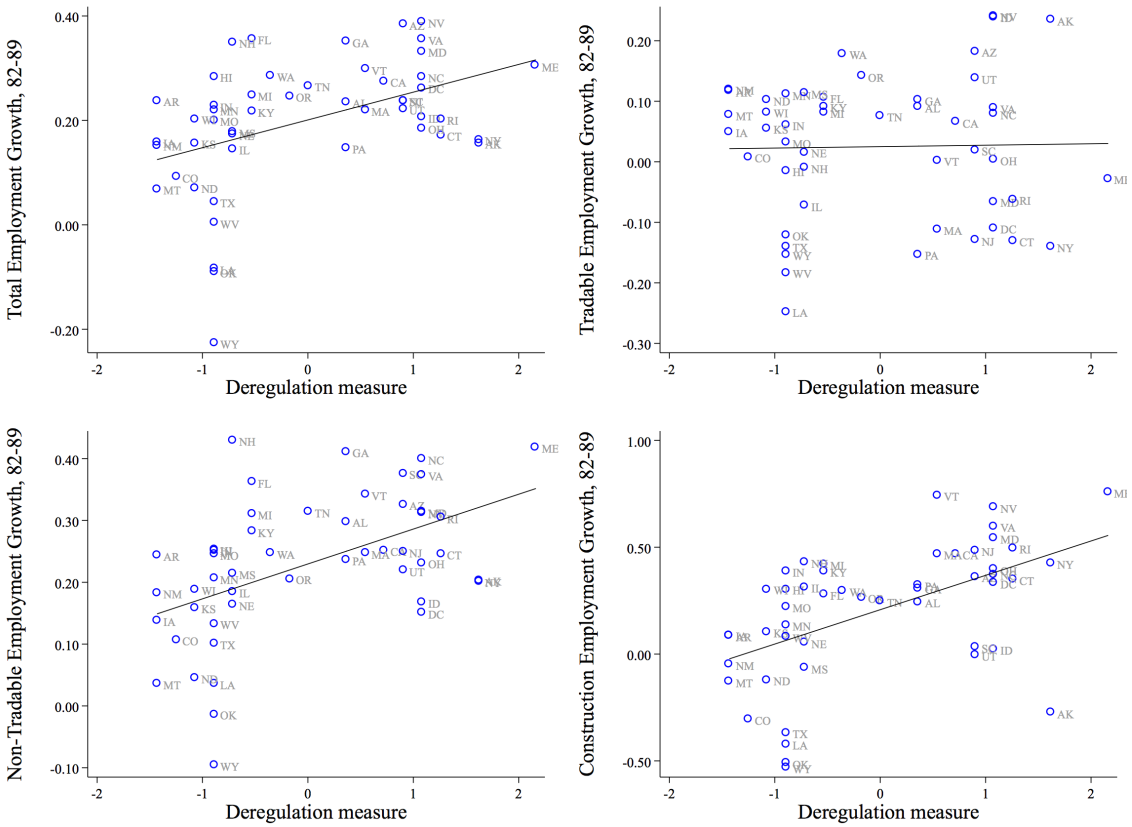
Notes: This figure presents estimates of $\{\beta_y\}$ from $y_{st} = \alpha_s + \alpha_t + \sum_{y \neq 1982} \mathbb{1}_{t=y} d_s \beta_y + \epsilon_{st}$, where d_s is the deregulation measure. Dashed lines represent 95% confidence intervals from standard errors clustered at the state level. Household loans is based on the call report item "Loans to Individuals" and "Real Estate Loans". Commercial and industrial loans are based on the call report item "Commercial and Industrial Loan". Consumer loans are based on the call report item "Loans to Individuals" and subsume home-equity loans starting in 1987.

Figure 3.4: Deregulation and Unemployment, Real GDP per Capita, House Prices, and Housing Units



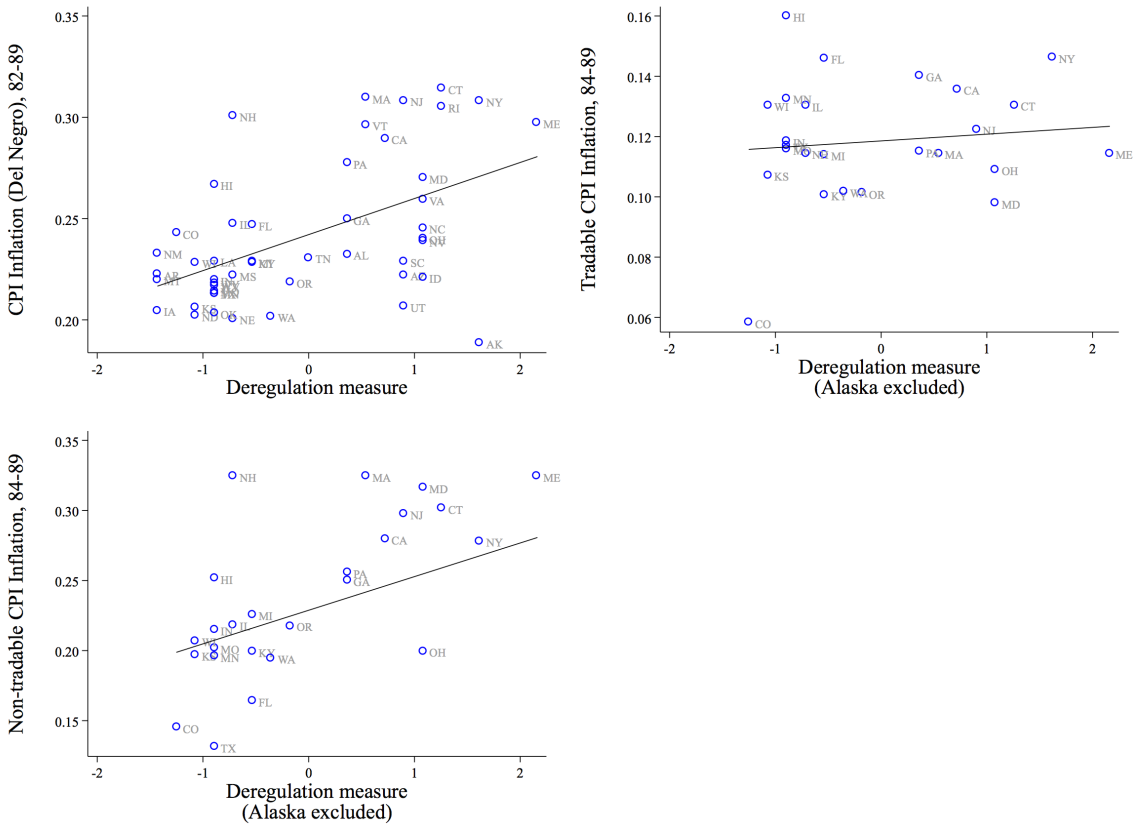
Notes: This figure presents estimates of $\{\beta_y\}$ from $y_{st} = \alpha_s + \alpha_t + \sum_{y \neq 1982} \mathbb{1}_{t=y} d_s \beta_y + \epsilon_{st}$, where d_s is the deregulation measure and y_{st} is the state unemployment rate, log total employment, log real GDP per capita, log house prices, or log housing units. Dashed lines represent 95% confidence intervals from standard errors clustered at the state level.

Figure 3.5: Deregulation and Employment Growth, 1982-1989



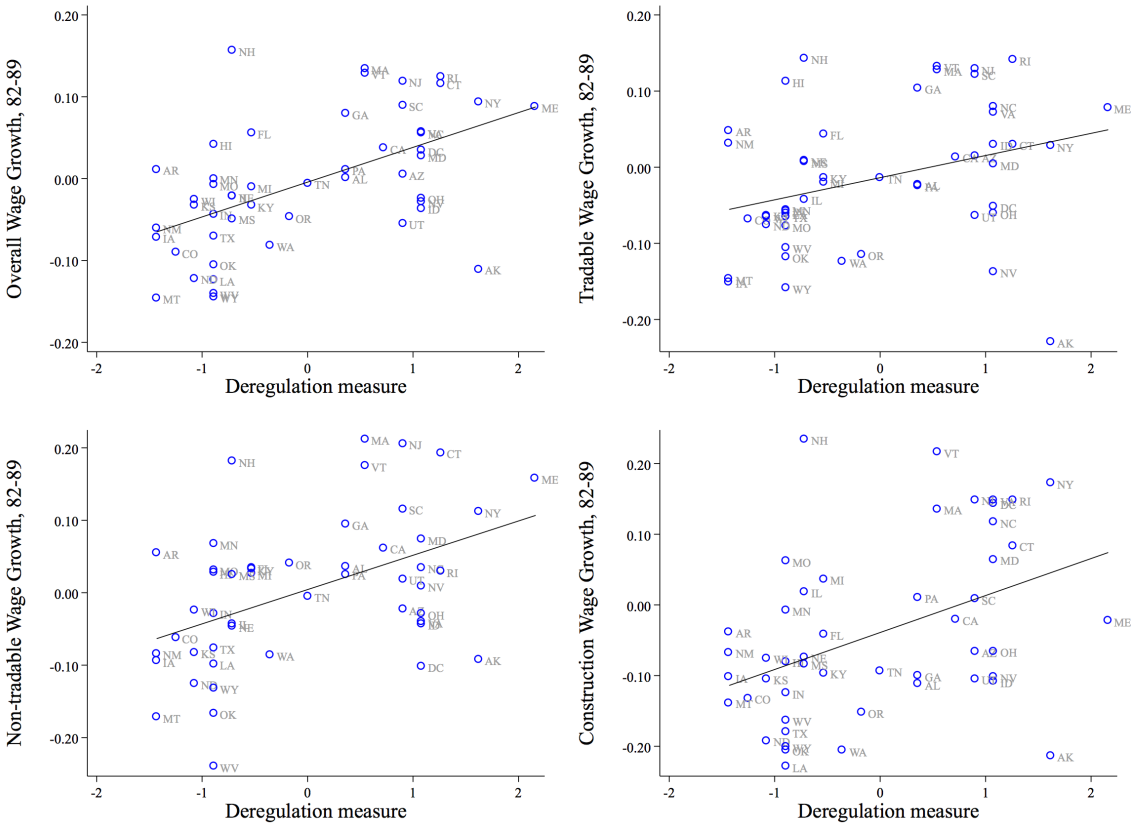
Notes: This figure presents scatterplots of the deregulation measure on employment growth by industry from 1982 to 1989.

Figure 3.6: Inflation and Deregulation



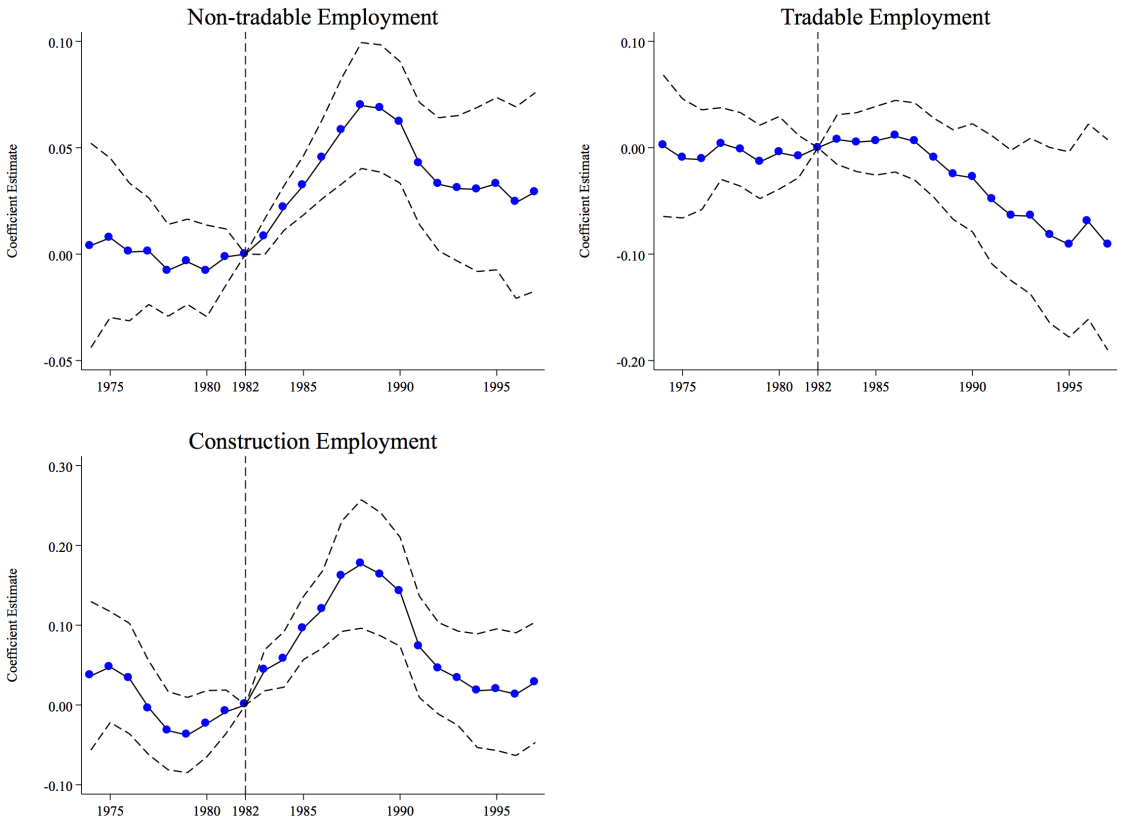
Notes: This figure presents scatter plots of the CPI inflation from 1982 (1984) to 1989 on the deregulation measure. The top-right and bottom-left panels show inflation for tradables ("Commodities") and non-tradables ("Services") for 25 states for which this measure is available (excluding Alaska).

Figure 3.7: Wage Growth and Deregulation



Notes: This figure presents scatter plots of wage growth from 1982 to 1989 against the deregulation measure. Wages are deflated by the aggregate CPI-U-RS (but not by state price indexes).

Figure 3.8: Deregulation and Employment by Industry over the Full Cycle



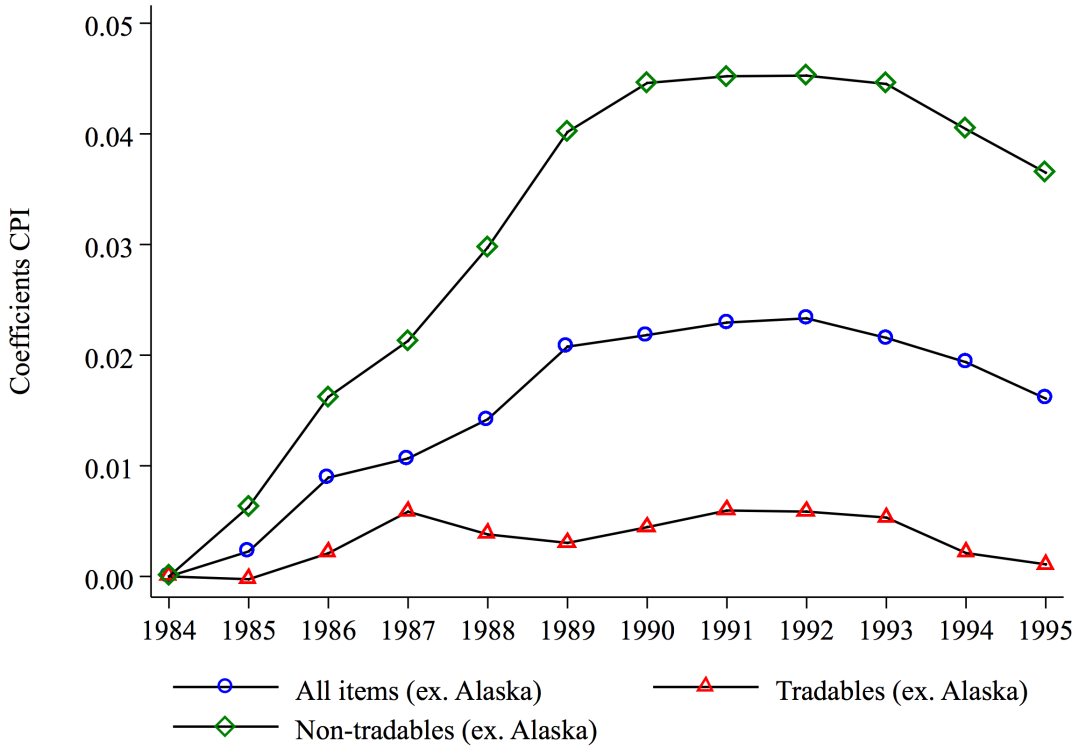
Notes: This figure presents estimates of $\{\beta_y\}$ from $e_{st} = \alpha_s + \alpha_t + \sum_{y \neq 1982} \mathbb{1}_{t=y} d_s \beta_y + \epsilon_{st}$, where d_s is the deregulation measure and e_{st} is log non-tradable, tradable, or construction employment. Dashed lines represent 95% confidence intervals from standard errors clustered at the state level.

Figure 3.9: Deregulation and Wages by Industry over the Full Cycle



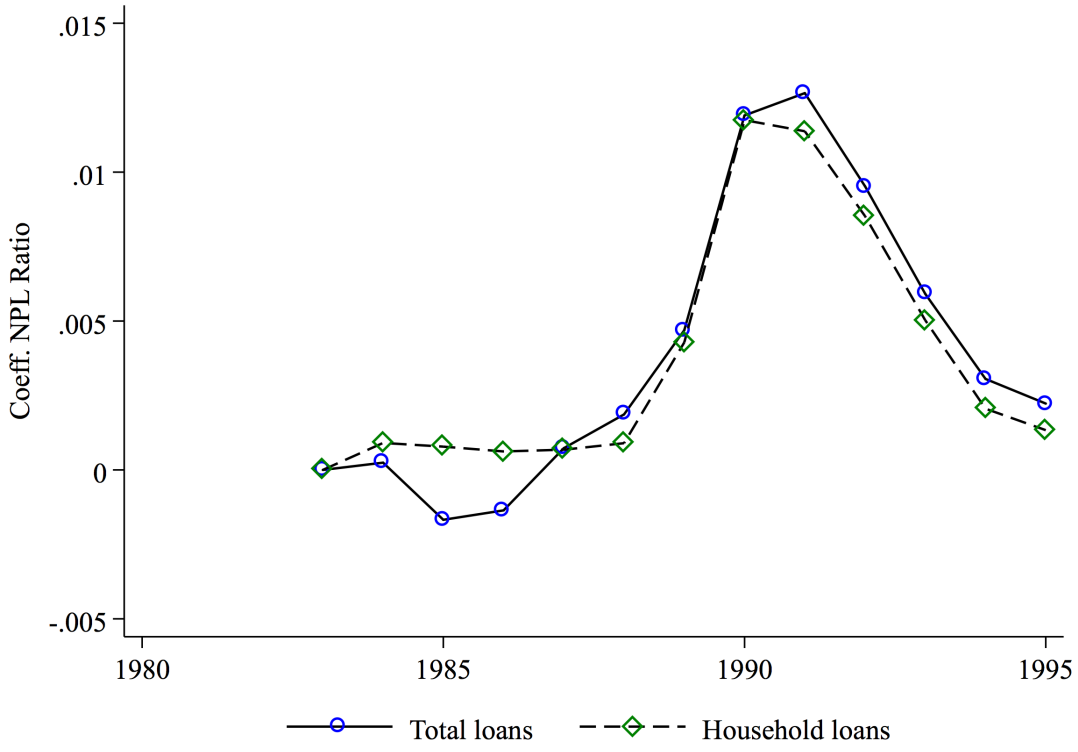
Notes: This figure presents estimates of $\{\beta_y\}$ from $w_{st} = \alpha_s + \alpha_t + \sum_{y \neq 1982} \mathbb{1}_{t=y} d_s \beta_y + \epsilon_{st}$, where d_s is the deregulation measure and w_{st} is log residualized state wages. Dashed lines represent 95% confidence intervals from standard errors clustered at the state level.

Figure 3.10: Tradable and Non-Tradable Prices over the Full Cycle



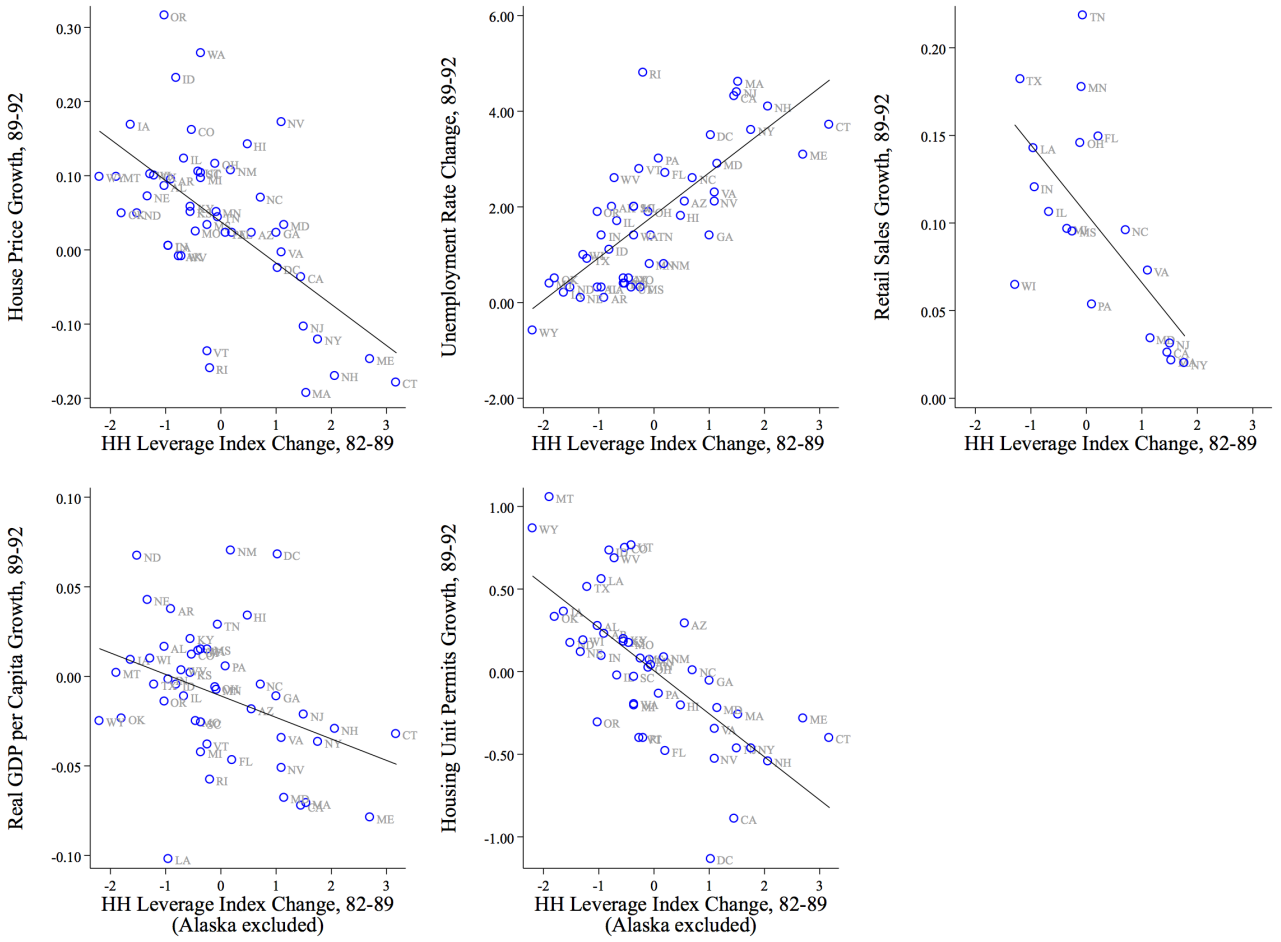
Notes: This figure presents estimates of $\{\beta_y\}$ from $\ln CPI_{st} = \alpha_s + \alpha_t + \sum_{y \neq 1983} \mathbb{1}_{t=y} d_s \beta_y + \epsilon_{st}$, where d_s is the deregulation measure and $\ln CPI$ is the the log of the state CPI for all items, tradables ("Commodities"), or non-tradables ("Services").

Figure 3.11: NPL Ratios



Notes: This figure presents estimates of $\{\beta_y\}$ from $NPL_{st} = \alpha_s + \alpha_t + \sum_{y \neq 1983}[\mathbb{1}_{t=y} d_s \beta_y + \mathbb{1}_{t=y} op_s \gamma_y + \mathbb{1}_{t=y} oe_s \delta_y] + \epsilon_{st}$, where d_s is the deregulation measure, op_s is the oil production of state s as of total oil production adjusted for federal production and population size in 1985, oe_s the employment in the oil sector as a share of total employment in 1982, and NPL_{st} is the non-performing loan ratio for household or total loans.

Figure 3.12: Household Credit Boom and the Subsequent Recession



Notes: This figure presents scatter plots of the change in various outcomes from 1989 to 1992 against the Δ_{82-89} HH leverage index.

Appendix A

Supplementary Material for Chapter 1

A.1 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 (1.7). 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 1.7 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 (1.8). 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 1.9 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:

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

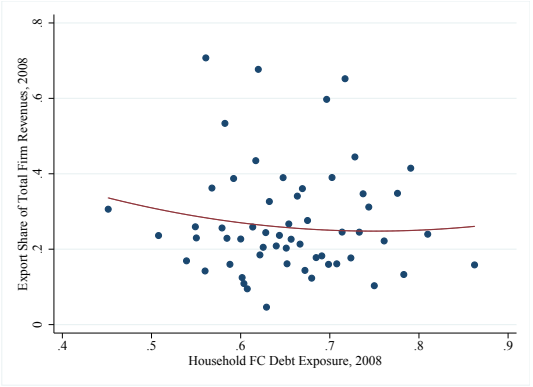
Firms with a higher share of debt in foreign currency tend to be larger, faster growing, more export intensive, and more likely to be in manufacturing. Standard errors are clustered at the subregion level (175 units). +,*,** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

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

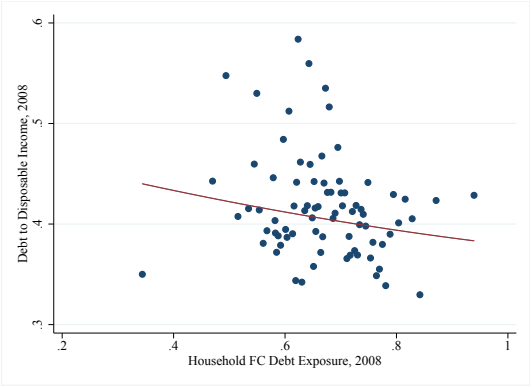
	Inv.-Capital Change, 08-10		Sales Growth, 08-10		Employment Growth, 08-10		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Firm FC debt to assets	-15.0**	-15.6**	1.55	3.06**	4.57**	0.94	9.37+
	(1.21)	(1.23)	(1.04)	(0.91)	(0.65)	(0.63)	(5.51)
HH FC debt share, s_{z08}^{FC}		-7.39+		-13.3**		-14.1**	-12.2**
		(4.45)		(4.12)		(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.

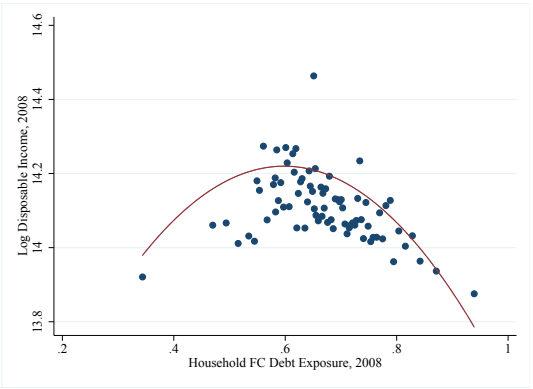
Figure A.1: Correlation of Household Foreign Currency Exposure with Key Observables



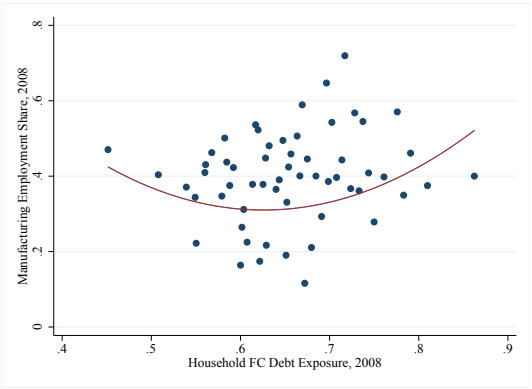
(a) Export exposure



(b) Debt to disposable income



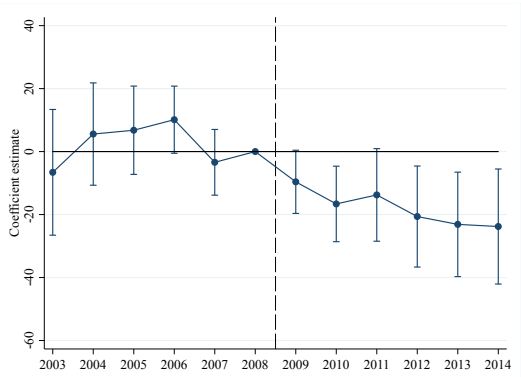
(c) Disposable income per capita



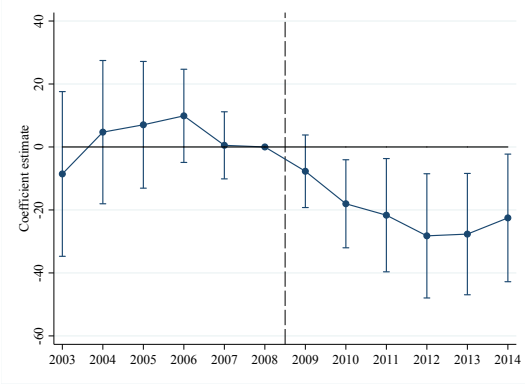
(d) Manufacturing employment share

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}.

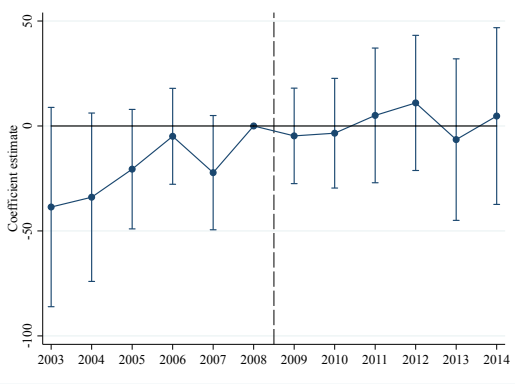
Figure A.2: Foreign Currency Debt Exposure and Settlement Employment



(a) Total Employment



(b) Employment: Non-Exporters



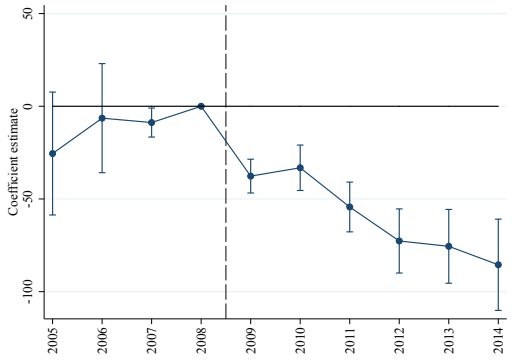
(c) Employment: Exporters

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.

A.2 Data Appendix

A.2.1 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.[1]

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

[1]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.

loans remain current is severe drawback for this methodology because default rates were very low before the 2008 crisis.[2]

Accuracy of the Imputation within the Credit Registry

As an first test of the accuracy of the annuity model, Figure A.2.1 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 A.2.2 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 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.

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,

[2]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.

Figure A.2.2 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 A.2.2 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.

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.[3] 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 A.2.2).

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

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.[4] 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 1.5 and 1.6, 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}

[4]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.

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

$$x_{bz} = x_z^{3b} \left(\frac{\overline{x}_b}{\overline{x}^{3b}} \right). \tag{A.1}$$

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.[5] 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:

$$\tilde{s}_{z08}^{FC} = \frac{\sum_c \mathcal{E}_{08}^c D_{z08}^{*c} + \mathcal{E}_{08}^{chf} \hat{D}_{z08}^{prepaid}}{D_{z08} + \sum_{c \in C} \mathcal{E}_{08}^c D_{z08}^{*c} + \mathcal{E}_{08}^{chf} \hat{D}_{z08}^{prepaid}}. \tag{A.2}$$

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

[5]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.

Repayment Program. Refinancing in LC loans accounted for 33.0% of the participation in the 2011 ERP (approximately HUF 349.4 bn),[6] so the volume of refinancing provides an alternative indication of how intensively 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.[7] 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 A.2.2 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 A.2.3 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.

[6]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.

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

We also obtained data on the total prepayment for each bank in our sample, and Figure A.2.4(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 A.2.5 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).

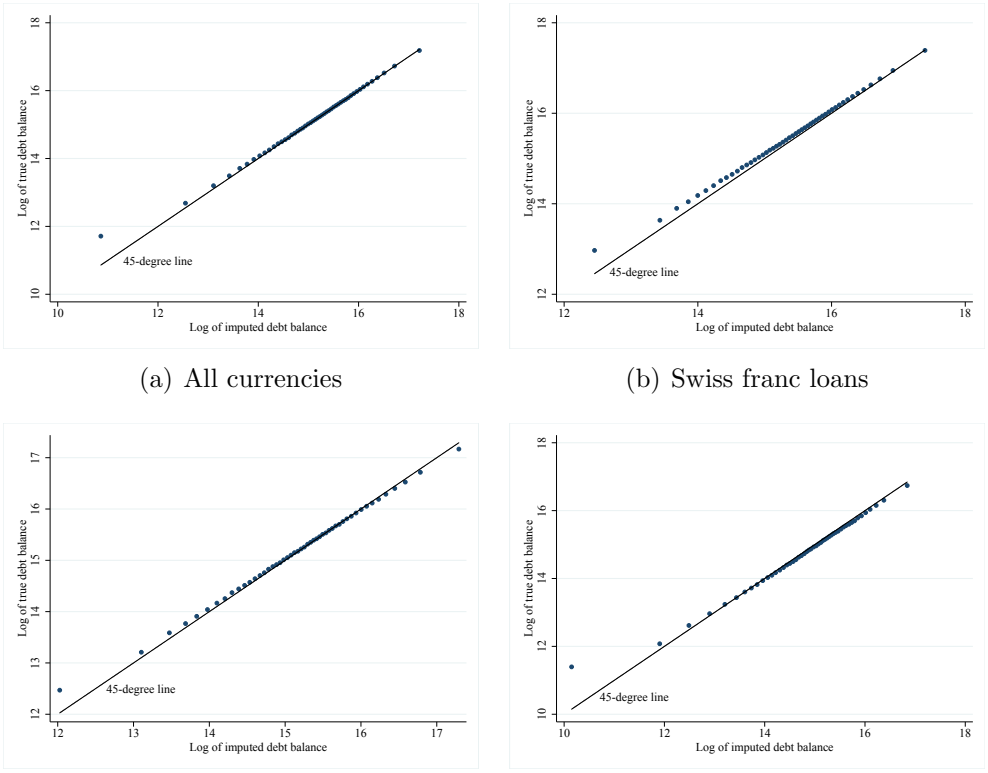
Effect of Controlling for the Early Repayment Program on the Main Results. Table A.2.3 presents robustness tests for the main results using the two adjusted foreign currency exposure variables. For convenience we also report the baseline results. The point estimates are quantitatively quite similar to 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.

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 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 A.2.1: Validation of Imputation Procedure: Binned Bivariate Means of Imputed and Actual Loan Balance in 2012



(a) All currencies

(b) Swiss franc loans

(c) Euro loans

(d) Forint loans

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

Table A.2.1: Regressions of True Loan Balance in 2012:12 on Imputed Balance

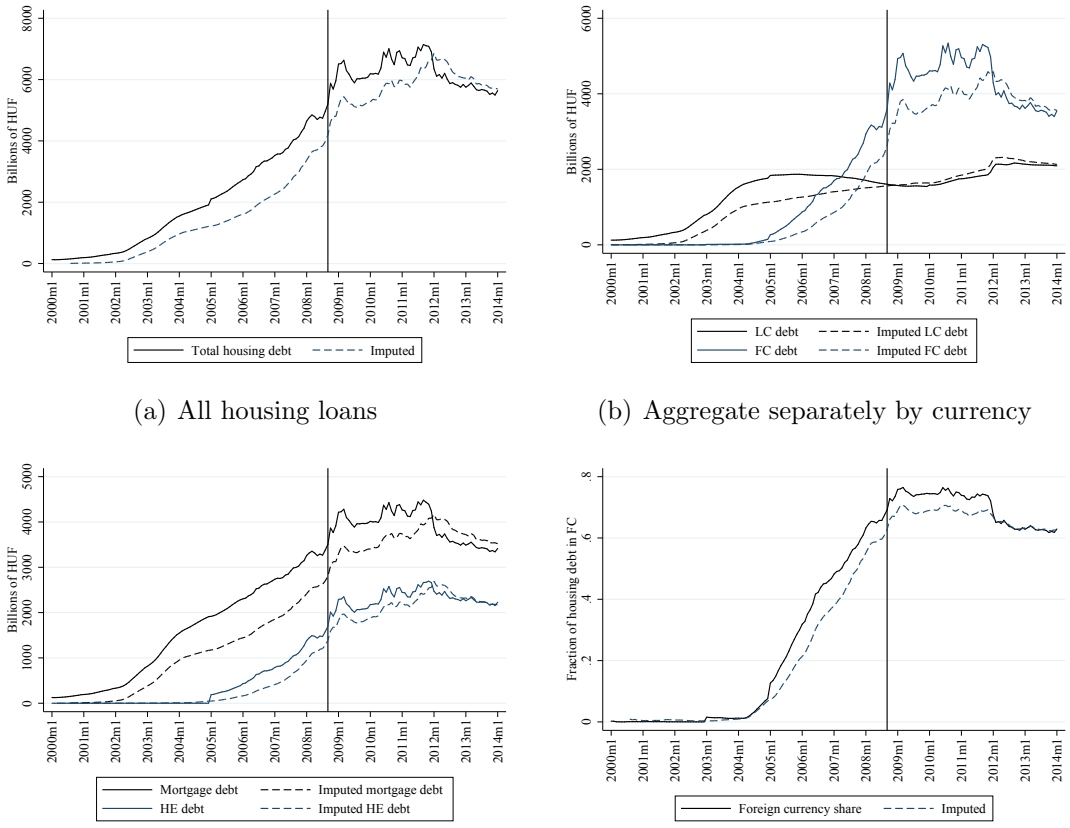
	Dependent variable: true balance in 2012:12, $\ln(D_{it})$						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Imputed balance, $\ln(\widetilde{D}_{it})$	0.873	0.890	0.840	0.871	0.916	0.835	0.930
	(0.00039)	(0.00048)	(0.00067)	(0.00053)	(0.0010)	(0.00060)	(0.0020)
Constant	1.942	1.672	2.471	2.088	1.290	2.411	1.259
	(0.0059)	(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 A.2.2: 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 A.2.2: Comparison of Imputed Aggregate Debt and Flow of Funds



(a) All housing loans

(b) Aggregate separately by currency

(c) Aggregate separately by loan type

(d) Foreign currency share of housing debt

Notes: 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).

Figure A.2.3: Early Repayment Program Adjustment and Aggregate FC Debt

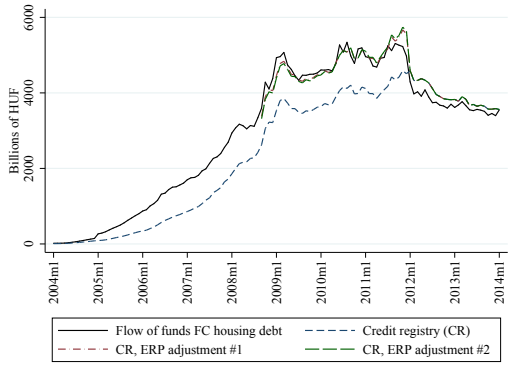
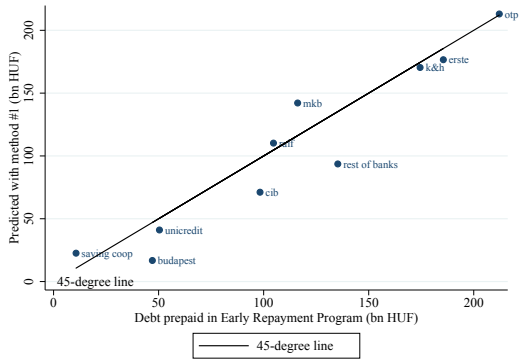
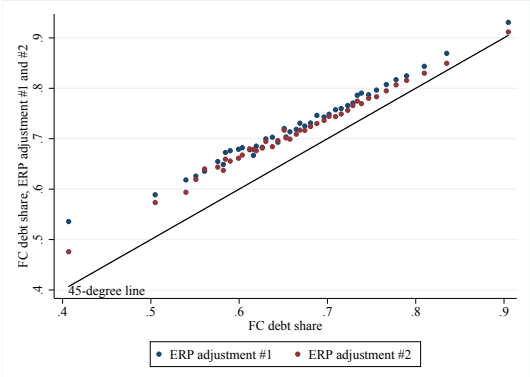


Figure A.2.4: Method #1 Predicted and Actual 2011 Early Repayment Program Debt Reduction by Bank



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 A.2.5: Original and ERP Adjusted FC Debt Shares



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

Table A.2.3: 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.

A.2.2 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.

A.3 Debt Revalaution in an Open Economy Model

A.3.1 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.[8] Specifically, to be consistent with our empirical setting, the household has access to risk-free debt

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

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.[9] 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

$$mc_t = -\nu + w_t - p_{H,t} - a_H, \quad \nu \equiv -\ln(1+\tau). \tag{A.3}$$

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 pro-

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

ducer price index is the standard Dixit-Stiglitz aggregate over varieties j: $P_{H,t} = \left(\int_0^1 P_{H,t}(j)^{1-\epsilon} dj\right)^{\frac{1}{1-\epsilon}}$. Define the effective terms of trade as the price of foreign goods relative to the price of home goods, $S_t = \frac{P_{F,t}}{P_{H,t}}$, and the effective real exchange rate as $\mathcal{Q}_t = \frac{\mathcal{E}_t P_t^*}{P_t} = \frac{P_{F,t}}{P_t}$, given producer currency pricing.

Home CPI can be log-linearized as

$$p_t = (1-\alpha)p_{H,t} + \alpha p_{F,t} = p_{H,t} + \alpha s_t \Rightarrow \pi_t = \pi_{H,t} + \alpha \dot{s}_t. \tag{A.4}$$

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

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

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

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

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

$$Y_t = C_t S_t^{\alpha}\left[(1-\alpha) + \alpha\Theta^{-1}\right], \tag{A.5}$$

which can be log-linearized as

$$y_t = c_t + \alpha s_t - \alpha\theta. \tag{A.6}$$

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

$$y_t = c^*_t + s_t + (1-\alpha)\theta. \tag{A.7}$$

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 (A.6) 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 (A.6) 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 (A.4), 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 (A.3) as

$$mc_t = -\nu + (w_t - p_t) + (p_t - p_{H,t}) - a_H \tag{A.8}$$

$$= -\nu + (1+\varphi)y_t + \alpha\theta - (1+\varphi)a_H \tag{A.9}$$

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

$$y_t^n = a_H + \frac{\nu - \mu}{1+\varphi} - \frac{\alpha\theta}{1+\varphi}. \tag{A.10}$$

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

$$\tilde{mc}_t = (1+\varphi)\tilde{y}_t + \alpha\theta. \tag{A.11}$$

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

$$\dot{\pi}_{H,t} = \rho\pi_{H,} - \lambda\tilde{mc}_t, \quad \lambda = \rho_\delta(\rho + \rho_\delta) \tag{A.12}$$

which, using (A.11), can be rewritten as

$$\dot{\pi}_{H,t} = \rho\pi_{H,} - \kappa\tilde{y}_t - \lambda\alpha\theta, \quad \kappa = \lambda(1+\varphi). \tag{A.13}$$

Initial Flexible Price Steady State. In the initial steady state $\theta = 0$. Moreover, we assume $a_H = c^* = 0$. From (A.7) and (A.10), the natural level of output and terms of trade are simply $y^n = 0, s^n = 0$.

A.3.2 Consequences of a household debt revaluation

As discussed in section 3.2, 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 $\bar{D}^* + \bar{D} = 0$, $\bar{D}^* > 0$.[10] The economy is in the natural 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:

$$\dot{\pi}_{H,t} = \rho \pi_{H,t} - \kappa y_t + \lambda \rho \Delta e D^* \tag{A.14}$$

$$\dot{y}_t = i_t - \pi_{H,t} - \rho \tag{A.15}$$

$$y_0 = -\frac{1-\alpha}{\alpha} \rho \Delta e D^* + \Delta e. \tag{A.16}$$

Equation (A.14) is the standard New-Keynesian Phillips curve, adjusted for the wealth effect of the debt revaluation. Equation (A.15) is the dynamic IS curve. Given

[10] 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.

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 (A.16) 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.[11]

Analytical Solution. We can write the system in (A.14)-(A.15) 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:

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

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

$$\dot{z}_1 = \overline{\nu} z_1 + \frac{\lambda \rho \Delta e D^*}{\nu - \overline{\nu}} \tag{A.17}$$
$$\dot{z}_2 = \nu z_2 + \frac{\lambda \rho \Delta e D^*}{\overline{\nu} - \nu} \tag{A.18}$$
$$\tag{A.19}$$

The general solution is

$$z_{1t} = b_1 e^{\overline{\nu} t} - \frac{\lambda \rho \Delta e D^*}{\nu - \overline{\nu}} \frac{1}{\overline{\nu}} \tag{A.20}$$
$$z_{2t} = b_2 e^{\nu t} - \frac{\lambda \rho \Delta e D^*}{\overline{\nu} - \nu} \frac{1}{\nu}, \tag{A.21}$$

[11] 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.

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

$$X_t = \begin{bmatrix} -\nu e^{\nu t} b_2 \\ b_2 e^{\nu t} - \frac{\lambda \rho \Delta e D^*}{\nu - \overline{\nu}} \left(\frac{1}{\overline{\nu}} - \frac{1}{\nu} \right) \end{bmatrix} \tag{A.22}$$

To obtain b_2, we use the initial condition (A.16)

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

The output response to the exchange rate shock is then of the form provided in the main text (1.1)

$$\begin{aligned} y_t &= \left(-\frac{1-\alpha}{\alpha} e^{\nu t} - (1 - e^{\nu t}) \frac{\lambda}{\nu - \overline{\nu}} \left(\frac{1}{\overline{\nu}} - \frac{1}{\nu} \right) \right) \rho \Delta e D^* + \Delta e \cdot e^{\nu t} \\ y_t &= \left(-\frac{1-\alpha}{\alpha} e^{\nu t} + (1 - e^{\nu t}) \frac{1}{1+\varphi} \right) \rho \Delta e D^* + \Delta e \cdot e^{\nu t} \\ y_t &= \beta_t \Delta e D^* + \gamma_t \Delta e \end{aligned} \tag{A.23}$$

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.

Appendix B

Supplementary Material for Chapter 2

B.1 Tables and Figures

Table B.1.1: Summary of Countries in the Sample and Key Statistics

Country	Years	Average Δd^{HH}	Average Δd^{HH}	Std. dev. Δd^{F}	Std. dev. Δd^{F}
Australia	1977-2012	2.23	1.00	2.55	4.40
Austria	1995-2012	0.71	1.98	1.26	2.91
Belgium	1980-2012	0.82	3.09	1.13	6.47
Canada	1969-2012	1.42	1.00	2.37	3.54
Czech Republic	1995-2012	1.24	-0.85	1.71	5.46
Denmark	1994-2012	3.72	2.52	3.96	5.96
Finland	1970-2012	1.12	0.87	3.04	7.55
France	1977-2012	1.08	1.10	1.20	2.41
Germany	1970-2012	0.51	0.23	1.79	1.65
Greece	1994-2012	3.22	1.98	2.25	2.43
Hong Kong	1990-2012	1.21	1.88	2.68	10.40
Hungary	1989-2012	0.52	2.06	3.41	5.34
Indonesia	2001-2012	0.96	-0.22	0.77	1.83
Ireland	2002-2012	5.02	14.11	7.97	15.63
Italy	1960-2012	0.70	0.52	1.55	2.98
Japan	1964-2012	0.92	0.14	1.77	4.39
Korea, Rep.	1962-2012	1.71	1.74	2.22	5.83
Mexico	1994-2012	0.20	-1.07	0.86	2.12
Netherlands	1990-2012	3.62	0.95	2.75	4.10
Norway	1975-2012	1.17	1.37	3.42	5.89
Poland	1995-2012	1.91	1.37	2.03	2.59
Portugal	1979-2012	2.57	1.18	2.51	7.22
Singapore	1991-2012	1.78	-0.21	2.88	5.28
Spain	1980-2012	1.78	1.64	2.64	5.01
Sweden	1980-2012	1.11	3.66	2.66	8.47
Switzerland	1999-2012	0.95	0.76	3.27	4.01
Thailand	1991-2012	1.99	-0.85	3.32	7.86
Turkey	1986-2012	0.72	0.66	1.19	3.51
United Kingdom	1976-2012	1.73	1.66	2.44	4.27
United States	1960-2012	0.75	0.54	2.14	1.76

Notes: This table lists the 30 countries in the sample and the years covered in the main regressions. The last four columns report the mean and standard deviation of the changes in household debt to GDP and non-financial firm debt to GDP for each country.

Table B.1.2: Average U.S. High-yield Share between $t-3$ to $t-1$ as an Instrument for U.S. Credit Expansion

	OLS	First stage			IV		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	$\Delta_3 y_{it+3}$	$\Delta_3 d_{it-1}^{Private}$	$\Delta_3 d_{it-1}^{HH}$	$\Delta_3 d_{it-1}^{HH}$	$\Delta_3 y_{it+3}$	$\Delta_3 y_{it+3}$	$\Delta_3 y_{it+3}$
Avg HYS, t-3 to t-1		0.214**	0.167*	0.167*			
		(0.0669)	(0.0704)	(0.0729)			
$\Delta_3 d_{it-1}^{Private}$					-0.507+		
					(0.263)		
$\Delta_3 d_{it-1}^{HH}$	-0.441**					-0.650*	-0.644+
	(0.158)					(0.310)	(0.333)
Distributed Lag in Δy				✓			✓
F statistic		10.26	5.632	5.271			
R^2	.22	.234	.26	.273	.023	.17	.217
Observations	46	46	46	46	46	46	46

Notes: This table shows instrumental variables time series regressions for the United States using the average high yield share during over $t-3$ to $t-1$ as an instrument for the expansion in private or household debt to GDP between $t-4$ and $t-1$. The high yield share is from Greenwood and Hanson (2013) and is defined as the share of non-financial corporate bond issuance in each year with a high yield rating from Moody's. Columns (4) and (7) include three real GDP growth lags, $\Delta y_{it-1}, \Delta y_{it-2}$, and Δy_{it-3}, as controls. Newey-West HAC standard errors in parentheses with a truncation parameter of 6.

Table B.1.3: Household Debt Expansion Predicts Downward Forecast Revision

	Revision of $t+2$ Growth Forecast		Revision of $t+3$ Growth Forecast	
	(1) $rev^{IMF}_{t+2\|t,t+1}$	(2) $rev^{OECD}_{t+2\|t,t+1}$	(3) $rev^{IMF}_{t+3\|t,t+1}$	(4) $rev^{IMF}_{t+3\|t+1,t+2}$
$\Delta_3 d^{HH}_{it-1}$	-0.027*	-0.037+	-0.011*	-0.043**
	(0.013)	(0.021)	(0.0043)	(0.016)
$\Delta_3 d^{F}_{it-1}$	-0.0077	-0.0049	-0.0019	-0.0021
	(0.0087)	(0.0067)	(0.0037)	(0.0073)
Country Fixed Effects	✓	✓	✓	✓
R^2	0.038	0.041	0.012	0.060
Observations	484	473	484	484

Notes: This table reports regressions GDP forecast *revisions* on the expansion in household and non-financial firm debt to GDP. Columns 1 and 2 report results for the revisions in the forecast of $t+2$ growth made between t and $t+1$, $rev^{f}_{t+2|t,t+1} = \Delta y^{f}_{t+2|t+1} - \Delta y^{f}_{t+2|t}$. In Column 3 the dependent variable is the revision between t and $t+1$ of the $t+3$ growth forecast, while in column 4 the dependent variable is the revision between $t+1$ and $t+2$ of the same $t+3$ growth forecast. Reported R^2 values are from within-country variation. Standard errors in parentheses are dually clustered on country and year. +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Table B.1.4: Alternative Hypotheses and Robustness to Other Known Predictors of GDP Growth

	Consumption or Residential Investment Booms			Real Exchange Rate	Time Trends	Corporate Credit Spread			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	$\Delta_3 y_{it+3}$	$\Delta_3 y_{it+3}$	$\Delta_3 y_{it+3}$	$\Delta_3 y_{it+3}$	$\Delta_3 y_{it+3}$	$\Delta_1 y_{it+1}$	$\Delta_1 y_{it+1}$	$\Delta_3 y_{it+3}$	$\Delta_3 y_{it+3}$
$\Delta_3 d^{HH}_{it-1}$	-0.325**	-0.401**	-0.385**	-0.316**	-0.207**	-0.0457*	-0.0447**	-0.249**	-0.250**
	(0.0778)	(0.108)	(0.0992)	(0.0783)	(0.0767)	(0.0210)	(0.0152)	(0.0704)	(0.0705)
$\Delta_3 d^{F}_{it-1}$	-0.0484	-0.0347	-0.0314	-0.0333	-0.0603+	-0.0337+	-0.0220+	-0.0486	-0.0343
	(0.0357)	(0.0547)	(0.0494)	(0.0391)	(0.0314)	(0.0183)	(0.0129)	(0.0376)	(0.0323)
$\Delta_3 (C/Y)_{it-1}$	-0.0350								
	(0.208)								
$\Delta_3 (C^{dur}/Y)_{it-1}$		0.794							
		(0.524)							
$\Delta_3 \frac{I^{res}}{Y}_{it-1}$			-0.424						
			(0.416)						
$\Delta_3 reer_{it-1}$				-0.0220					
				(0.0366)					
spr^{corp}_{it}							-1.220**		-1.476**
							(0.302)		(0.392)
spr^{corp}_{it-1}							0.413*		0.232
							(0.205)		(0.461)
Country Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓	✓
Distributed Lag in Δy	✓	✓	✓	✓	✓	✓	✓	✓	✓
Country-specific Time Trends					✓				
R^2	0.148	0.186	0.194	0.120	0.443	0.0504	0.194	0.104	0.158
Observations	684	425	548	606	695	487	487	451	451

Notes: This table reports robustness to controlling for other known predictors of GDP growth in our main single equation specification. Columns 1-3 control for the change in the consumption to GDP ratio, the change in the durable consumption to GDP ratio, and the change in the residential investment to GDP ratio from $t-4$ to $t-1$, respectively. Column 4 includes the change in the log real effective exchange rate from $t-4$ to $t-1$. The real effective exchange rate is from the BIS's "Effective exchange rate indices" dataset. Column 5 controls for country-specific time trends, and columns 6-9 include the corporate bond spread in year t and $t-1$. All columns include country fixed effects and three lags of GDP growth ($\Delta y_{it-1}, \Delta y_{it-2}$, and Δy_{it-3}). Reported R^2 values are from within-country variation. Standard errors in parentheses are dually clustered on country and year. +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Table B.1.5: Root Mean Squared Errors of Pseudo Out-Of-Sample GDP Growth Forecasts, 2000-2012

Forecast Horizon	IMF	OECD	VAR	AR	RW
1 year	2.33	2.06	2.69	2.86	3.22
2 years	2.73	2.79	2.81	2.97	3.69
3 years	2.90		2.95	3.07	3.81
4 years	2.97		2.94	3.18	3.74
5 years	2.94		3.04	3.20	3.93

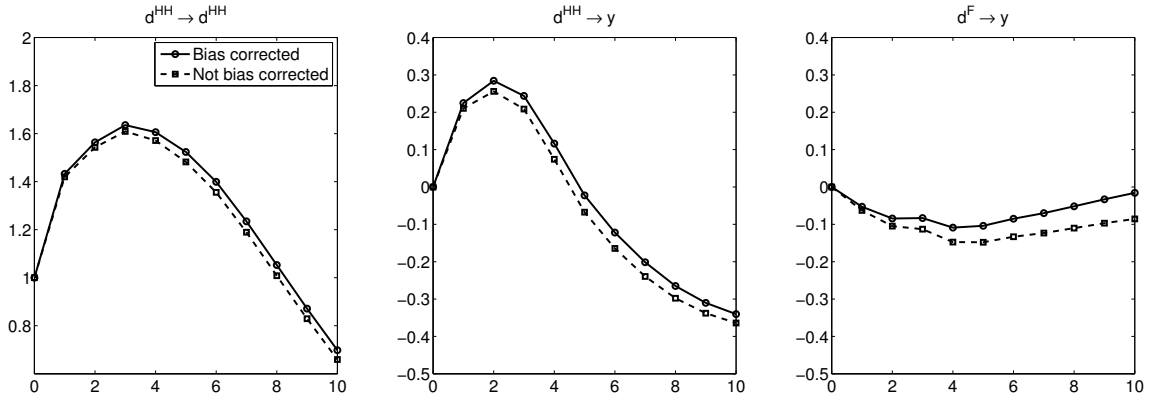
Notes: This table shows the root means squared errors from pseudo out-of-sample forecasts of one-year GDP growth over the following five years. Root mean squared forecast errors from the IMF and OECD are computed using realized growth in year t reported in year $t+2$ reports. VAR forecasts refer to forecasts from a three variable VAR using real GDP growth, the change in household debt to GDP, and the change in non-financial firm debt to GDP. The VAR is estimated on the pooled sample. AR forecasts refer to forecasts from an autoregressive model of GDP growth estimated on the pooled sample. Both VAR and AR models include five lags. RW forecasts refer to forecasts from a random walk model (no change).

Table B.1.6: Global Household and Firm Debt and Global Growth: Robustness

	Dependent var.: global avg. $\Delta_3 y_{t+3}$				Dependent var.: global agg. $\Delta_3 y_{t+3}$	
	(1)	(2)	(3)	(4)	(5)	(6)
Global $\Delta_3 d^{HH}_{t-1}$	-0.406^{+}	-0.589*	-0.807**	-0.687**		
	(0.235)	(0.275)	(0.203)	(0.220)		
Global $\Delta_3 d^{F}_{t-1}$	-0.0149	0.0646	-0.164	-0.0613		
	(0.129)	(0.173)	(0.126)	(0.149)		
Global agg. $\Delta_3 d^{HH}_{t-1}$					-0.594*	-0.316
					(0.288)	(0.272)
Global agg. $\Delta_3 d^{F}_{t-1}$					0.0552	0.101
					(0.144)	(0.222)
Trend	-0.195**	-0.172*	-0.794**	-0.882**		
	(0.0523)	(0.0752)	(0.133)	(0.145)		
Trend^2			0.0126**	0.0157**		
			(0.00321)	(0.00356)		
Sample	Full	Pre 2006	Full	Pre 2006	Full	Pre 2006
Distributed lag in Δy	✓	✓	✓	✓	✓	✓
Test for equality of β_{HH} and β_F, p-value	.195	.0342	.0138	.0375	.0756	.3634
R^2	.586	.542	.7	.728	.246	.132
Observations	46	40	46	40	46	40

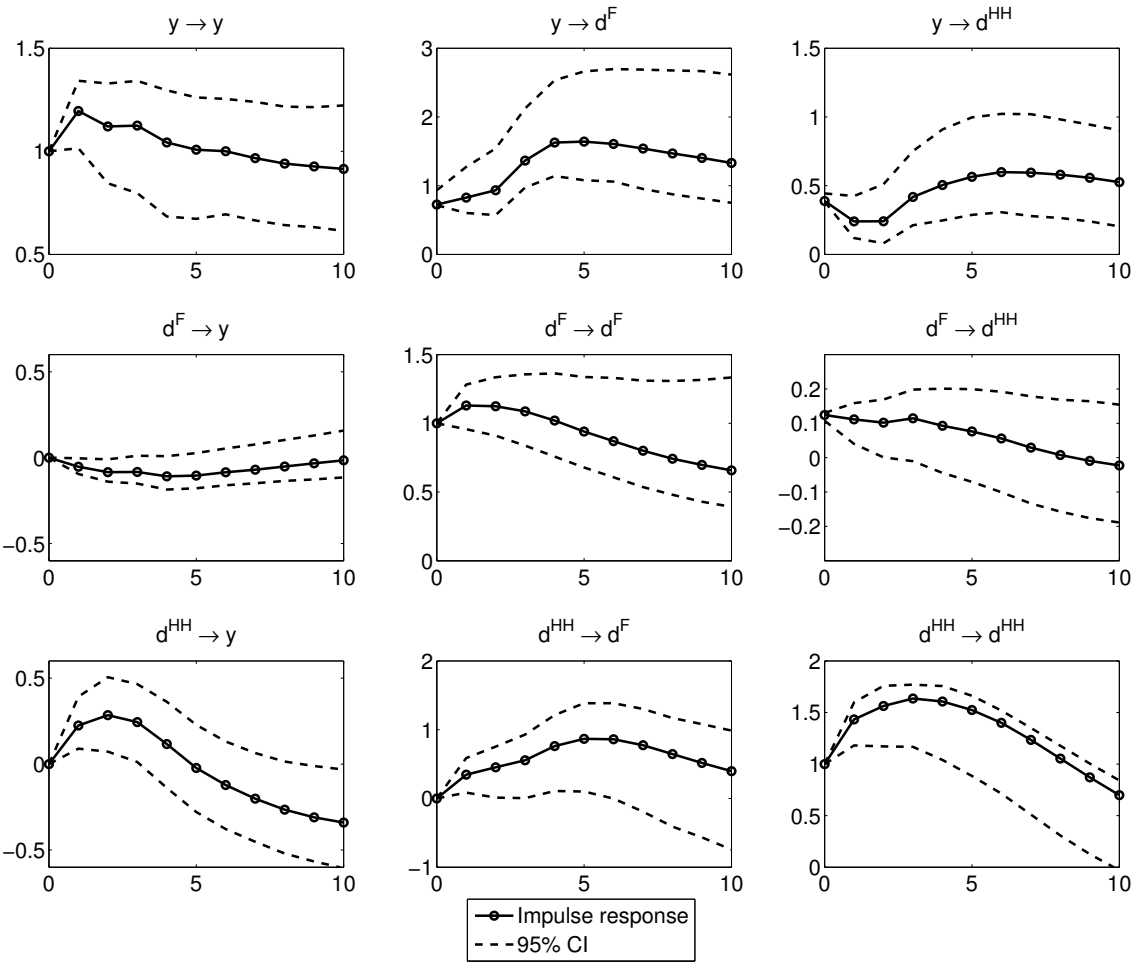
Notes: This table reports several robustness tests for the global time series regressions in Table 13. Columns 1-4 control for a linear or a quadratic trend in the specification in Table 13 for the full and pre-2006 samples. Columns 5-6 compute the global variables by summing the dollar levels of all variables and then computing each variable based on the summed global aggregate. Each column includes three lags in the global one-year change in log GDP, computed using the relevant aggregation method. Newey-West standard errors in parentheses are computed with 6 lags. +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Figure B.1.1: Baseline and Bias Corrected VAR Impulse Responses



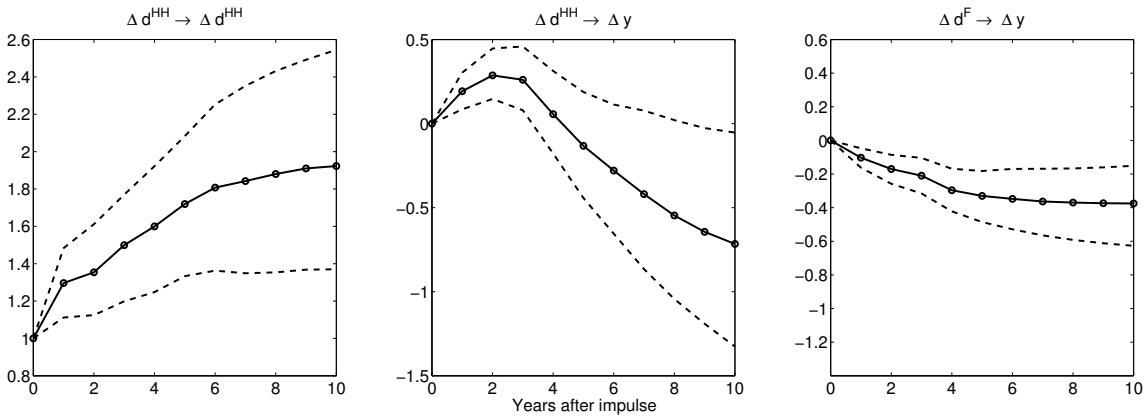
Notes: This figure presents uncorrected and bias corrected impulse responses from a three variable recursive VAR in log real GDP, firm debt to lagged GDP, and household debt to lagged GDP. The dash line is from the baseline VAR, and the solid line is the impulse response from the VAR corrected for Nickell bias using an iterative bootstrap bias correction procedure. Specifically, the procedure iterates on the VAR coefficients until the VAR estimates from pseudo-samples constructed with the bias-corrected coefficients is sufficiently close to the (biased) OLS estimates.

Figure B.1.2: Full Set of Impulse Response Functions from a Recursive VAR in Real GDP, Non-financial Firm Debt, and Household Debt



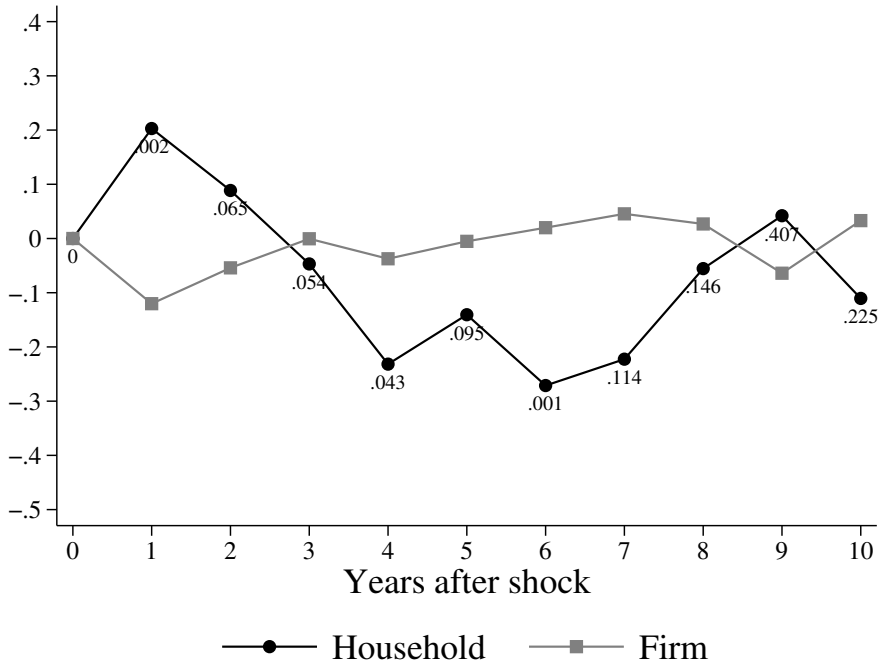
Notes: This figure presents impulse responses from a three variable recursive VAR in log real GDP, firm debt to lagged GDP, and household debt to lagged GDP. The shocks are identified using a Cholesky decomposition with real GDP ordered first and household debt last. The impulse responses are from a VAR in levels with country fixed effects estimated on the 30 country sample. The reduced form VAR coefficient estimates are corrected for Nickell bias using an iterative bootstrap procedure. Dash lines represent 95% confidence intervals that account for contemporaneous cross-country residual correlation and are computed by resampling cross-sections of residuals using the wild bootstrap.

Figure B.1.3: Cumulative Responses to Debt Shocks from a Recursive VAR in First Differences



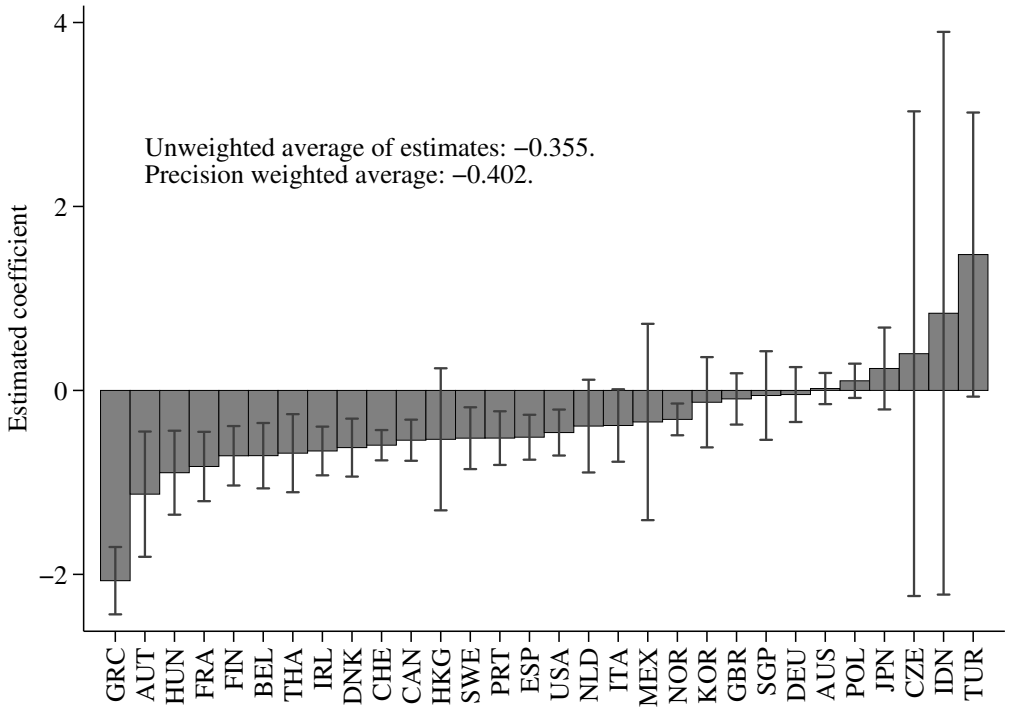
Notes: This figure shows cumulative impulse responses to household and firm debt to GDP shocks from a three variable VAR in real GDP growth, the change in firm debt to GDP, and the change in household debt to GDP. The impulse responses are identified using a Cholesky decomposition with the ordering $\left[\Delta \ln Y_{it}, \Delta d_{it}^{F}, \Delta d_{it}^{HH}\right]$. The VAR in first differences is estimated without country fixed effects. Dash lines represent 95% confidence intervals that account for contemporaneous cross-country residual correlation and are computed by resampling cross-sections of residuals using the wild bootstrap.

Figure B.1.4: Test of Equality between the Response of Annual GDP Growth to Household and Firm Debt Shocks



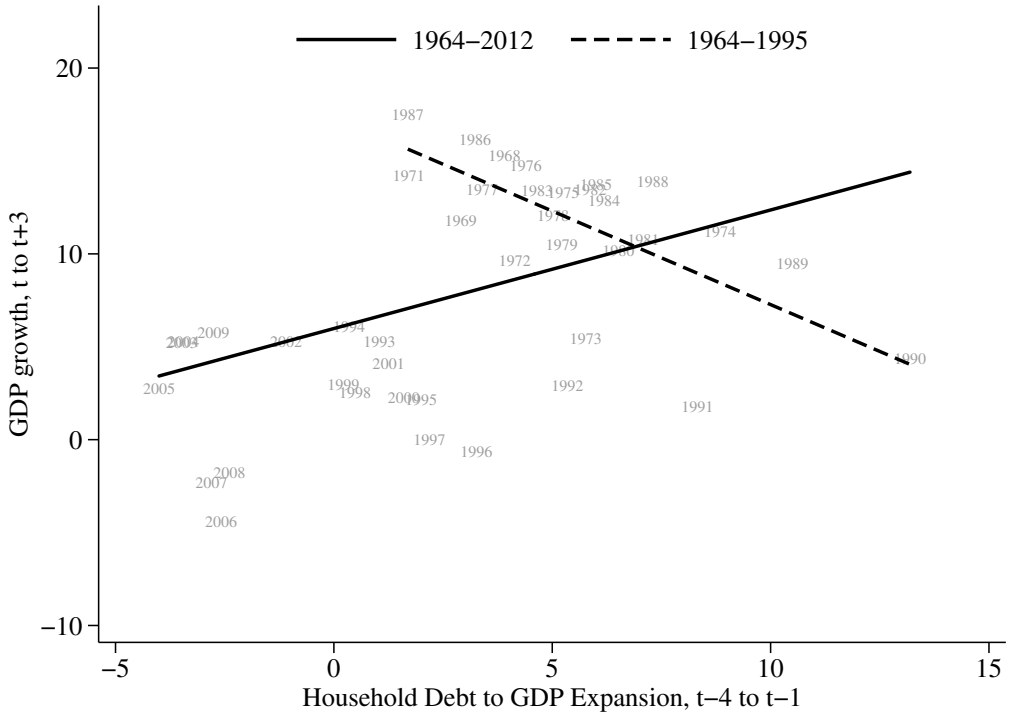
Notes: This figure plots impulse responses for one-year GDP growth from Jordà (2005) local projections estimated in first differences. The specification is: $\Delta y_{it+h-1} = \alpha_i^h + \sum_{j=1}^{5} \beta_{HH,j}^h \Delta d_{it-j}^{HH} + \sum_{j=1}^{5} \beta_{F,j}^h \Delta d_{it-j}^F + \sum_{j=1}^{5} \delta_j^h \Delta y_{it-j} + u_{it+h-1}^h$, for horizons $h = 1, ..., 10$. At each horizon we report the p-value for the two-sided test of equality between the household and firm debt local projection impulse response coefficients ($H_0 : \beta_{HH,1}^h = \beta_{F,1}^h$ against $H_A : \beta_{HH,1}^h \neq \beta_{F,1}^h$).

Figure B.1.5: Estimates of $\beta_{HH,i}$ for Each Country



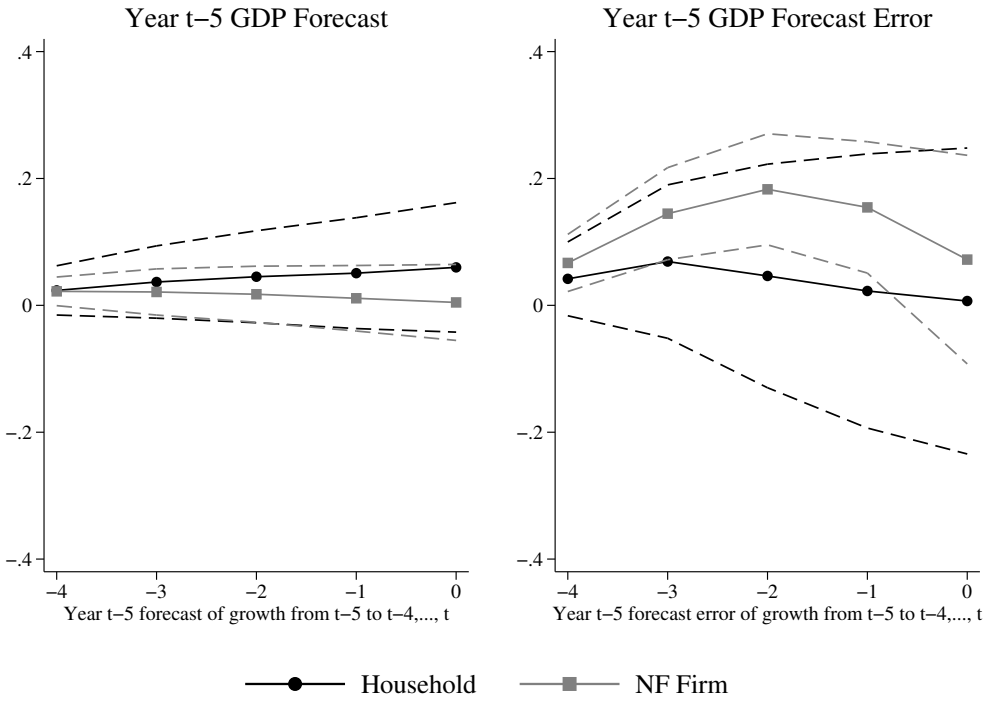
Notes: This figure plots $\beta_{HH,i}$ from the time series regression, $y_{it+3} - y_{it} = \beta_0 + \beta_{HH,i}\Delta_3 d^{HH}_{it-1} + \sum_{j=1}^{3} \gamma_j \Delta y_{it-j} + \epsilon_{it}$, estimated separately for each country i in the sample. Regressions for Ireland (IRL) and Indonesia (IDN) control for $\Delta_3 y_{it-1}$ instead of a distributed lag in GDP growth as a consequence of the limited degrees of freedom. The unweighted average of the estimates refers to the raw average of the coefficients in the figure, and the precision weighted average is the average weighted by the inverse of the squared standard error. Bands around the estimates represent 95% confidence intervals.

Figure B.1.6: Household Debt Expansion and Growth: The Case of Japan



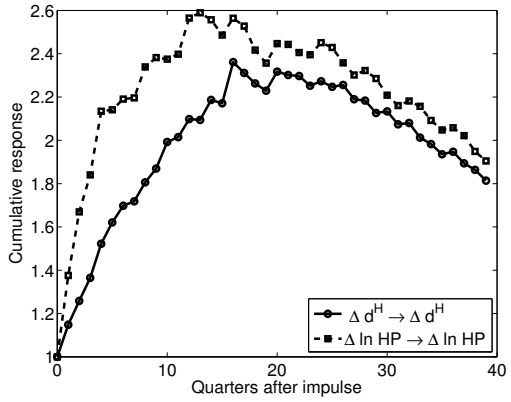
Notes: Japan represents an interesting case and helps reveal the difficulty in specifying a "timing" of the recessionary effects of a household debt boom. This figure plots the relationship between GDP growth from t to $t+3$ and the expansion in household debt to GDP from $t-4$ to $t-1$ for Japan. Each point refers to year t. The solid black line is the least squares fit for the whole period (1964-2012), while the dash line shows the least squares fit for 1964-1995. The figure shows that the relation between the change in household debt to GDP ratio and subsequent growth for Japan is negative and strong if we use a sample period of 1964 to 1995, which includes the beginning of the lost decades period. But after 1995, the Japanese economy continued to exhibit very low growth, and household debt was shrinking during this period of anemic growth, inducing a positive relation. Related to this observation, controlling for lagged GDP growth mitigates the positive coefficient for Japan when using the full sample period.

Figure B.1.7: Debt Expansions and Preceding IMF Forecasts

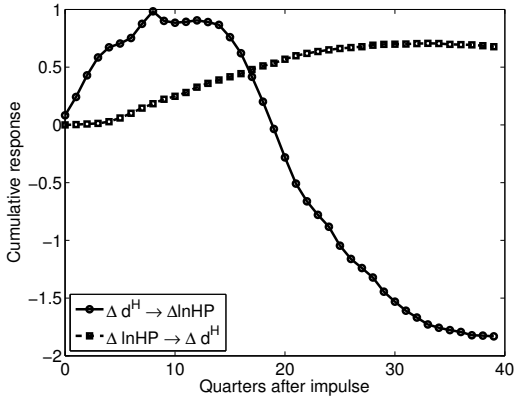


Notes: The left panel plots coefficient estimates from: $\Delta_h y^{IMF}_{it-5+h|t-5} = \alpha^h_i + \beta^h_{HH}\Delta_3 d^{HH}_{it-1} + \beta^h_F \Delta_3 d^F_{it-1} + \epsilon_{it}$, where $\Delta_h y^{IMF}_{t+h-5|t-5}$ is the IMF forecast of growth from $t-5$ to $t-5+h$ made in year $t-5$. The right panel shows estimates from the same equation where the dependent variable is the forecast error. Dash lines represent 95% confidence intervals, computed using standard errors dually clustered on country and year.

Figure B.1.8: Impulse Responses from a Bivariate VAR in Household Debt to GDP and Real House Prices



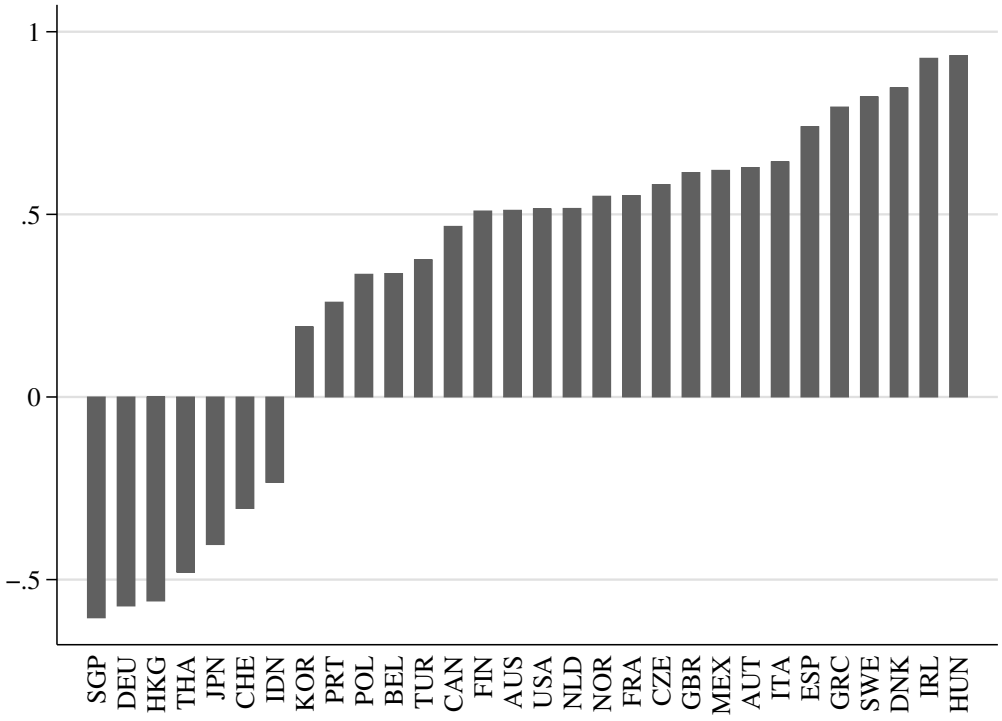
(a) Responses to Own Shocks



(b) Responses to Other Variable Shock

Notes: The figure shows cumulative impulse responses from a bivariate VAR in the change in household debt to GDP and the change in log real house prices using quarterly data. The shocks are orthogonalized using a Cholesky decomposition with household debt ordered first. Consistent with the lag length used for the three-variable VAR, this VAR is estimated with 20 lags.

Figure B.1.9: Correlation with World Household Debt Cycle



Notes: This figure shows the correlation between the three-year household debt to change for country i and the average change for all countries excluding i: $\text{corr}\left(\left(\Delta_3 d^{HH}\right)_{it}, \frac{1}{N-1}\sum_{j\neq i}\left(\Delta_3 d^{HH}\right)_{jt}\right)$.

B.2 Data Appendix

Household debt and non-financial firm debt. Household and non-financial firm debt are from the BIS's "Long series on credit to the private non-financial sector" database. See text for details on the private debt to GDP variables.

National accounts. National accounts data are from the World Bank's World Development Indicators (WDI) database. We use annual data in current and constant prices from the WDI on GDP, Y, household consumption, C, gross capital formation, I, and government consumption, G. We supplement WDI data on total household consumption with data on household consumption expenditure on durable goods, C^{dur}, and non-durable goods, C^{nondur}, from the OECD and national statistical offices.[1] We also collect data on investment by type of good from the OECD.

Exports, imports, and the current account. Data on exports, X, and imports, M, in current prices are from the OECD or International Monetary Fund's International Financial Statistics (IFS) database, depending on data availability. Net exports is the difference between exports and imports, $NX = X - M$. Current account series, CA, are from the OECD or IFS.

Disaggregated exports and imports. In addition to overall exports and imports, we construct variables for consumption and non-consumption (capital and intermediate) trade using disaggregated trade data from the NBER-UN World Trade database (from 1962-2000) and UN Comtrade (from 2000-2012). We aggregate four digit SITC revision 2 trade flows into consumption, capital, and intermediate imports and exports following the Basic Economic Categories classification scheme from UN Comtrade. With consumption exports and imports, XC and MC, we construct the share of consumption in total exports and imports, s^{XC} and s^{MC}.

Unemployment rate. Data on national unemployment rates, u, are from the OECD harmonized unemployment rate database, where possible. For countries where the OECD harmonized unemployment rate is series is short or missing, we use unemployment rate data from the IFS, other OECD series, or national central banks. The harmonized unemployment rate is measured by applying the same definition of unemployment across OECD member countries to obtain estimates that are more internationally comparable. However, since we focus on changes in the unemploy-

[1] These series are available for 23 of the 30 countries in the sample. Information on durable and non-durable consumption is missing for Hong Kong, Indonesia, Singapore, Switzerland, Thailand, Thailand, and Turkey. The OECD decomposes final consumption expenditure of "households on the territory" into non-durable, semi-durable, durable, and services consumption.

ment rate, level differences in definitions that are constant over time will not bias the results.

Sovereign and credit spreads. The sovereign spread, *spr*, is constructed as the difference between the 10-year government bond yield and the 10-year U.S. Treasury yield. Government 10-year bonds yields are from Global Financial Data (code "IG-ISO-10"). The real sovereign spread is the nominal spread minus the difference in CPI inflation rates.

The mortgage-sovereign spread, spr_t^{MS}, is the difference between the mortgage lending rate and the 10-year government bond yield. The mortgage lending rate is from Global Financial Data (code "IL-ISO-M"). For Denmark we use the yield on 10 year mortgage bonds instead of the mortgage lending rate ("INDNK10D"), and for Sweden we use the yield on 5 year mortgage bonds from GFD ("INSWE5D"). For Japan we use the interest rate on building society mortgages from Datastream, and for Korea we use the 5 year mortgage bond yield from the Bank of Korea via Datastream. The sample includes a mortgage-sovereign spread for 26 countries out of 30 countries.[2] The mortgage lending rate refers to the rate on fixed or variable rate loans for home purchase, depending on the prevalent contract in each country. Maturity typically ranges from 5 to 30 years.

Corporate credit spreads, spr_t^{corp}, are constructed as the difference between the corporate bond yield and the 10-year government bond yield. For 15 countries the corporate bond yield series are from Global Financial Data (code "IN-ISO").[3] For 6 other countries we obtained series on the corporate lending rate from Global Financial Data (code "IL-ISO").[4] For the United States the corporate credit spread is the Baa-Aaa spread (average of Q4 monthly values).

All interest rate series are aggregated to annual series by taking quarterly averages of daily, weekly, or monthly rates and using the fourth quarter value. For eurozone countries, we use the Germany 10-year government bond yield as the benchmark rate.[5]

Professional GDP growth forecasts and forecast errors. We use GDP growth forecasts and forecast errors from the IMF *World Economic Outlook* (WEO) Historical Forecasts Database and from print editions of the *OECD Economic Outlook*. Fore-

[2]The mortgage sovereign spread is missing for Hong Kong, Indonesia, Thailand, and Turkey.

[3]The 15 countries are Australia, Austria, Belgium, Canada, Denmark, Germany, Italy, Japan, Korea, Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom.

[4]These countries are Finland, France, Greece, Ireland, Poland, and Portugal.

[5]Specifically, we use the German 10-year government bond yield for Austria, Belgium, Finland, France, Germany, Ireland, Italy, Netherlands, Portugal, and Spain starting in 1999 and for Greece starting in 2001.

casts from the *OECD Economic Outlook* are hand-collected. Forecast errors are defined as the difference between realized and forecasted growth. To construct forecast errors we use realized GDP growth for year t reported in year $t+2$. This allows us to compare forecasts with realized growth rates based on proximate vintages of data.[6] The WEO Historical Database reports forecasts for growth up to the five year horizon since 1990. We supplement this information with IMF one-year ahead forecasts for the G7 countries from 1972 onward. One-year and two-year ahead forecasts from the *OECD Economic Outlook* are available since 1973 and 1987, respectively.

Government debt to GDP. The government debt to GDP ratio, GD/Y, is from the IMF's Historical Public Debt Database (Abbas et al. (2010)). To construct changes in government debt to GDP, we do not take differences across breaks in the series.

Real house prices. Real house prices, HPI, are constructed from the BIS's "Long series on nominal residential property prices." These series cover 20 countries in our sample and start in 1970 or 1971.[7] Annual growth in real house prices are constructed from changes in fourth quarter values, deflated by the CPI.

Real effective exchange rates. Real effective exchange rates, $REER$, are from the BIS's "Effective exchange rate indices" database. We use the narrow indices, which extend back to 1964 for 24 countries in our sample.[8] An increase in the index indicates an appreciation.

Exchange rate regime. Information on the *de facto* exchange rate regime is from Reinhart and Rogoff (2004), updated to 2010 in Ilzetzki et al. (2010). We define "Fixed regimes" as arrangements with a coarse classification code equal to 1 (currency boards, a pre-announced horizontal band that is narrower than or equal to $\pm 2\%$, or a de facto peg). "Intermediate regimes" are defined as arrangements with a classification code of 2 or 3 (crawling pegs, crawling bands, managed floating, moving bands, etc.).

[6] All results based on forecast errors are robust to using realized GDP growth from the WDI instead of the WEO Historical Database or the *OECD Economic Outlook*.

[7] The countries without house price series from the BIS are Austria, Czech Republic, Greece, Hungary, Indonesia, Mexico, Poland, Portugal, Singapore, and Turkey.

[8] Countries without REER series are Czech Republic, Hungary, Indonesia, Poland, Thailand, and Turkey.

B.3 Simple Model of Permanent Income Shocks and Credit Demand

In this section we summarize a simple model where household debt expands today in anticipation of higher income tomorrow. Consider a small open economy with exogenously given output and a continuum of infinitely lived households. Output y_t follows a stochastic process with $\psi_t^{t+j} = E_t \Delta y_{t+j}$ representing the expected change in income j periods forward at time t. Unanticipated changes in income can be driven by shocks such as technology shocks, natural resource discovery, or terms of trade shocks. Households face no borrowing constraints and maximize,

$$E_0 \sum_{t=0}^{\infty} \beta^t u(c_t).$$

There is a risk-free one period bond that can be traded internationally with each household facing a sequential budget constraint,

$$c_t + (1+r)d_{t-1} = y_t + d_t, \tag{B.1}$$

and a no-Ponzi game constraint,

$$\lim_{j \to \infty} E_t \frac{d_{t+j}}{(1+r)^j} = 0. \tag{B.2}$$

The Euler equation of this problem can be written as $u'(c_t) = \beta(1+r)E_t u'(c_{t+1})$. Assuming $\beta(1+r) = 1$ and quadratic utility with $U(c) = -\frac{1}{2}(c - \overline{c})^2$ with $c \leq \overline{c}$, makes marginal utility linear and hence consumption a random walk with $c_t = E_t c_{t+1}$. Iterating forward (B.1) and using (B.2) and $c_t = E_t c_{t+1}$, we get that consumption equals expected permanent income $E_t y_t^p$ minus interest payments on outstanding debt $r d_{t-1}$ in equilibrium,

$$c_t = E_t y_t^p - r d_{t-1} = \frac{r}{(1+r)} E_t \sum_{j=0}^{\infty} \frac{y_{t+j}}{(1+r)^j} - r d_{t-1}. \tag{B.3}$$

Plugging $c_t = E_t y_t^p - r d_{t-1}$ into equation (B.1), we can write down the change in debt at time t in terms of the present value of expected changes in future income:

$$\Delta d_t = \sum_{j=1}^{\infty} \frac{\psi_t^{t+j}}{(1+r)^j}. \tag{B.4}$$

Productivity shocks thus generate a positive relation between the change in debt and subsequent output growth. Growth in debt is driven by higher demand for credit in response to expected future income growth and a desire to smooth consumption.

Appendix C

Supplementary Material for Chapter 3

C.1 Tables and Figures

Table C.1.1: Robustness: Deregulation Measure

	(1) Δ_{82-89} Debt to income	(2) Δ_{84-89} Loan appl. volume	(3) Δ_{84-89} Loan appl. number	(4) Δ_{82-89} Total loans	(5) Δ_{82-89} C&I loans	(6) Δ_{82-89} HH loans	(7) Δ_{82-89} Con. loans	(8) Δ_{82-89} HH leverage index
Panel A: Years Inter-state Deregulation								
Years inter-state	-0.0121**	-0.131^{+}	-0.0564	-0.0422*	-0.0512*	-0.0282	-0.0553**	-0.212**
	(0.00331)	(0.0703)	(0.0352)	(0.0208)	(0.0250)	(0.0175)	(0.0190)	(0.0674)
R^2	0.153	0.146	0.089	0.087	0.096	0.052	0.123	0.266
Panel B: Years Intra-state Deregulation								
Years intra-state	-0.00427*	-0.0288^{+}	-0.0122	-0.0219**	-0.0264**	-0.0158*	-0.0258**	-0.0699**
	(0.00160)	(0.0161)	(0.0102)	(0.00757)	(0.00760)	(0.00747)	(0.00927)	(0.0172)
R^2	0.142	0.053	0.031	0.176	0.191	0.122	0.201	0.215
Observations	49	49	49	49	49	49	49	49

Notes: This table presents regressions of credit growth from 1982 to 1989 on the inter- or intra-state deregulation year. Standard errors in parentheses are heteroscedasticity robust. +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Table C.1.2: Employment with China Exposure Control.

	(1) Δ_{82-88} Empl. Tradables	(2) Δ_{82-88} Empl. Non-Tradables	(3) Δ_{82-88} Empl. Construction	(4) Δ_{89-92} Empl. Tradables	(5) Δ_{89-92} Empl. Non-Tradables	(6) Δ_{89-92} Empl. Construction
Dereg. measure	0.00318	0.0579**	0.176**	-0.0372**	-0.0265*	-0.121**
	(0.0164)	(0.0118)	(0.0335)	(0.0109)	(0.00993)	(0.0297)
China exposure	0.00551	0.0624**	0.154**	-0.0377+	-0.0556**	-0.136**
	(0.0276)	(0.0212)	(0.0565)	(0.0196)	(0.0171)	(0.0486)
R^2	0.002	0.449	0.484	0.349	0.397	0.423
Observations	46	46	46	46	46	46

Notes: This table presents robustness to including "China Exposure" in the specification for employment growth in the boom and bust. The "China Exposure" variable is as defined in Autor et al. (2013). It is available for 46 states. Standard errors in parentheses are heteroscedasticity robust. +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Table C.1.3: Long Horizon Regressions

	(1) Δ_{82-95} Real GDP per capita	(2) Δ_{82-95} Total empl.	(3) Δ_{82-95} Empl. Non-Tradables	(4) Δ_{82-95} House prices	(5) Δ_{82-95} Empl. share
Panel A: Base Case					
Dereg. measure	0.0370	0.0170	0.0262	0.101**	-0.00214
	(0.0366)	(0.0202)	(0.0184)	(0.0273)	(0.00518)
R^2	0.037	0.015	0.040	0.235	0.004
Panel B: Lagged Dependent Variable Controls					
Dereg. measure	0.0186	0.0277	0.0173	0.114**	-0.00205
	(0.0124)	(0.0219)	(0.0204)	(0.0263)	(0.00388)
R^2	0.872	0.128	0.087	0.367	0.366
Panel C: Oil Shock Controls					
Dereg. measure	0.0198*	-0.0181	-0.000396	0.0659*	-0.00930+
	(0.00985)	(0.0209)	(0.0202)	(0.0321)	(0.00504)
R^2	0.906	0.273	0.194	0.365	0.291
Panel D: Demographic & Forbearance Controls					
Dereg. measure	0.0200	0.0241	0.0458*	0.112**	-0.00486
	(0.0401)	(0.0218)	(0.0178)	(0.0341)	(0.00380)
R^2	0.289	0.130	0.269	0.411	0.326
Panel E: All Controls					
Dereg. measure	0.00733	-0.00727	0.00263	0.0882*	-0.00903**
	(0.0122)	(0.0164)	(0.0172)	(0.0391)	(0.00244)
R^2	0.935	0.717	0.657	0.525	0.832
Observations	49	49	49	49	49

Notes: Employment share is defined as total employment/population Panel D and E comprises only 48 observations as there is no information available for forbearance in D.C. Regression specification: (1)-(4) $\Delta_{82-95} lny_s = \alpha + d_s\beta_1 + \boldsymbol{x_s}\boldsymbol{\beta} + \epsilon_s$ with heteroscedasticity robust standard errors; (5) $\Delta_{82-95} y_s = \alpha + d_s\beta_1 + \boldsymbol{x_s}\boldsymbol{\beta} + \epsilon_s$ with heteroscedasticity robust standard errors.

Table C.1.4: Deregulation and Real GDP per Capita & Employment Growth

Panel A: Real GDP per Capita Growth				
	Real GDP per capita growth		Real GDP per capita growth (WLS)	
	(1)	(2)	(3)	(4)
Intra-state dereg.	0.0173**	0.0133**	0.0214**	0.0185**
	(0.00460)	(0.00429)	(0.00444)	(0.00445)
Time FE	✓		✓	
State FE	✓	✓	✓	✓
Regional time FE		✓		✓
R^2	0.365	0.530	0.532	0.613
Panel B: Total Employment Growth				
	Total employment growth		Total employment growth (WLS)	
	(1)	(2)	(3)	(4)
Intra-state dereg.	0.0167**	0.0129**	0.0203**	0.0170**
	(0.00294)	(0.00309)	(0.00360)	(0.00347)
Time FE	✓		✓	
State FE	✓	✓	✓	✓
Regional time FE		✓		✓
R^2	0.536	0.625	0.628	0.671
Observations	767	736	767	736

Notes: Time horizon for panel regression is 1980-1995. Intra-state deregulation covariate assumes value 1 the year after the intra-state branching deregulation has taken place. The year of the intra-state branching deregulation is dropped. Delaware is excluded from all colums. Hawaii and Alaska are dropped from the sample in column (2) and (4). For the regional time fixed effects the sample is split into four main regions. Region 1 (Northeast) contains CT, MA, MD, ME, NH, NJ, NY, PA, RI, VT, and WV; Region 2 (South) contains AL, AR, DC, FL, GA, KY, LA, MS, NC, OK, SC, TN, TX, and VA; Region 3 (Midwest) contains IA, IL, IN, KS, MI, MN, MO, NE, ND, OH, SD, and WI; Region 4 (West) contains AZ, CA, CO, ID, MT, NM, NV, OR, UT, WA, and WY. Regression specification: (1) $\Delta_t lny_s = \alpha_s + \delta_t + d_{t,s}\beta_1 + \epsilon_{t,s}$ with heteroscedasticity robust standard errors; (2) $\Delta_t lny_s = \alpha_s + \gamma_{t,r} + d_{t,s}\beta_1 + \epsilon_{t,s}$ with heteroscedasticity robust standard errors; (3) $\Delta_t lny_s = \alpha_s + \delta_t + d_{t,s}\beta_1 + \epsilon_{t,s}$ with heteroscedasticity robust standard errors and weights according to real GDP in 1980; (4) $\Delta_t lny_s = \alpha_s + \gamma_{t,r} + d_{t,s}\beta_1 + \epsilon_{t,s}$ with heteroscedasticity robust standard errors and weights according to real GDP in 1980.

Table C.1.5: Deregulation and Total Loan & C&I Loan Growth

Panel A: Total Loan Growth				
	Total loan growth		Total loan growth (WLS)	
	(1)	(2)	(3)	(4)
Intra-state dereg.	0.0475**	0.0398**	0.0310+	0.0332*
	(0.0154)	(0.0147)	(0.0178)	(0.0143)
State FE	✓	✓	✓	✓
Time FE	✓		✓	
Regional time FE		✓		✓
R^2	0.180	0.438	0.241	0.436
Panel B: C&I + Commercial Real Estate Loan Growth				
	C&I loan growth		C&I loan growth (WLS)	
	(1)	(2)	(3)	(4)
Intra-state dereg.	0.0443**	0.0252*	0.0285+	0.0261+
	(0.0115)	(0.0117)	(0.0149)	(0.0144)
State FE	✓	✓	✓	✓
Time FE	✓		✓	
Regional time FE		✓		✓
R^2	0.314	0.420	0.401	0.492
Observations	767	736	767	736

Notes: Time horizon for panel regression is 1980-1995. Intra-state deregulation covariate assumes value 1 the year after the intra-state branching deregulation has taken place. The year of the intra-state branching deregulation is dropped. Delaware is excluded from all colums. Hawaii and Alaska are dropped from the sample in column (2) and (4). For the regional time fixed effects the sample is split into four main regions. Region 1 (Northeast) contains CT, MA, MD, ME, NH, NJ, NY, PA, RI, VT, and WV; Region 2 (South) contains AL, AR, DC, FL, GA, KY, LA, MS, NC, OK, SC, TN, TX, and VA; Region 3 (Midwest) contains IA, IL, IN, KS, MI, MN, MO, NE, ND, OH, SD, and WI; Region 4 (West) contains AZ, CA, CO, ID, MT, NM, NV, OR, UT, WA, and WY. The dependent variable C&I loan growth represents the growth of the aggregate of C&I loans and commercial real estate loans. Regression specification: (1) $\Delta_t lny_s = \alpha_s + \delta_t + d_{t,s}\beta_1 + \epsilon_{t,s}$ with heteroscedasticity robust standard errors; (2) $\Delta_t lny_s = \alpha_s + \gamma_{t,r} + d_{t,s}\beta_1 + \epsilon_{t,s}$ with heteroscedasticity robust standard errors; (3) $\Delta_t lny_s = \alpha_s + \delta_t + d_{t,s}\beta_1 + \epsilon_{t,s}$ with heteroscedasticity robust standard errors and weights according to real GDP in 1980; (4) $\Delta_t lny_s = \alpha_s + \gamma_{t,r} + d_{t,s}\beta_1 + \epsilon_{t,s}$ with heteroscedasticity robust standard errors and weights according to real GDP in 1980.

Table C.1.6: Real GDP per Capita Growth and Deregulation

	Real GDP per capita growth			
	(1)	(2)	(3)	(4)
Intra-state dereg.	0.0187**	0.0180**	0.0125*	0.0121*
	(0.00493)	(0.00507)	(0.00498)	(0.00505)
Inter-state dereg.	-0.00273	-0.00268	-0.00241	-0.00230
	(0.00535)	(0.00538)	(0.00526)	(0.00528)
-5y to intra-state dereg.		-0.00364		-0.00287
		(0.00553)		(0.00552)
+5y after intra-state dereg.		0.00173		-0.000529
		(0.00518)		(0.00504)
Share empl. mining			-0.396	-0.389
			(0.408)	(0.409)
Share empl. construction			0.274	0.276
			(0.426)	(0.427)
Share empl. manufacturing			-0.463	-0.478
			(0.371)	(0.372)
Share empl. transportation			1.755**	1.725**
			(0.522)	(0.526)
Share empl. trade			-1.188**	-1.194**
			(0.444)	(0.445)
Share empl. finance			-2.324**	-2.334**
			(0.556)	(0.557)
Share empl. services			-0.218	-0.224
			(0.388)	(0.389)
R^2	0.363	0.364	0.423	0.423
Year FE	✓	✓	✓	✓
State FE	✓	✓	✓	✓
Observations	751	751	751	751

Notes: Industry employment shares are based on the SIC industry classification. Regression specification: $\Delta_t lny_s = \alpha_s + \delta_t + \boldsymbol{x_s}\boldsymbol{\beta} + \epsilon_{t,s}$ with heteroscedasticity robust standard errors.

Table C.1.7: Idiosyncratic Volatility of State Employment Growth and Deregulation

	State employment growth idiosyncratic volatility, $\lvert\hat{\epsilon}_{st}\rvert$			
	(1) Total	(2) Tradable	(3) Non-tradable	(4) Construction
D_{st}	-0.00519^{+}	0.0000334	-0.00662*	-0.0129
	(0.00267)	(0.00353)	(0.00268)	(0.00828)
R^2	0.127	0.077	0.151	0.113
State FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
Observations	374	374	374	374

Notes: This table shows results from estimating: $|\hat{\epsilon}_{st}| = \alpha_s + \gamma_t + \beta D_{st} + u_{st}$. The left-hand-side variable $|\hat{\epsilon}_{st}|$ is the absolute value of residuals from a regression of employment growth on state and time fixed effects $\Delta \ln(Empl) = \alpha_s + \gamma_t + \epsilon_{st}$. D_{st} is a variable that takes on a value of 0 if a state has neither deregulated intra-state branching nor interstate banking, 1 if a state has adopted one form of deregulation, and 2 if a state has deregulated both restrictions. The estimation period is 1983-1991, and we omit the year of deregulation. Standard errors in parentheses are clustered at the state level.

Table C.1.8: Employment Growth Within State Estimates

	Δ Employment			
	(1) Total	(2) Tradable	(3) Non-tradable	(4) Construction
D_{st}	0.0108*	0.00432	0.0126**	0.0333^{+}
	(0.00479)	(0.00694)	(0.00425)	(0.0169)
R^2	0.537	0.456	0.485	0.370
State FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
Observations	515	515	515	515

Notes: This table shows results from estimating: $\Delta \ln(Empl_{st}) = \alpha_s + \gamma_t + \beta D_{st} + u_{st}$. D_{st} is a variable that takes on a value of 0 if a state has neither deregulated intra-state branching nor interstate banking, 1 if a state has adopted one form of deregulation, and 2 if a state has deregulated both restrictions. The estimation period is 1983-1991, and we omit the year of deregulation. Standard errors in parentheses are clustered at the state level.

Table C.1.9: Inflation and Deregulation

	Special Aggregates			Sub-categories: Major groups					
	(1) Δ_{84-89} All items	(2) Δ_{84-89} Non-trad.	(3) Δ_{84-89} Tradables	(4) Δ_{84-89} Apparel	(5) Δ_{84-89} Food & Beverages	(6) Δ_{84-89} Housing	(7) Δ_{84-89} Medical	(8) Δ_{84-89} Transport.	(9) Δ_{84-89} Other
Dereg. measure	1.450	2.400	0.224	0.867	1.412^{+}	1.740	3.047**	0.348	1.207^{+}
	(0.956)	(1.675)	(0.428)	(1.346)	(0.802)	(1.916)	(0.664)	(0.534)	(0.607)
R^2	0.139	0.131	0.013	0.014	0.153	0.061	0.365	0.016	0.106
Unit of obs.	State	State	State	State	State	State	State	State	State
Observations	26	26	26	26	26	26	26	26	26

Notes: Columns 1-3 present inflation regressions where we include Alaska, which is a larger outlier. Columns 4-9 present inflation by other sub-categories reported by BLS. Regression specification: (1)-(9) $\Delta_{84-89}\text{CPIInfl}_s = \alpha + d_s\beta_1 + \epsilon_s$ with heteroscedasticity robust standard errors.

Table C.1.10: Deregulation and Wage and Price Phillips Curves in the Boom and Bust

	Wage Phillips Curve				CPI Phillips Curve			
	(1) u_{s1987}	(2) $\Delta_{82,89}$ Wages	(3) u_{s1992}	(4) $\Delta_{89,94}$ Wages	(5) u_{s1987}	(6) $\Delta_{82,89}$CPI	(7) u_{s1992}	(8) $\Delta_{89,94}$CPI
Dereg. measure	-0.718*		0.466*		-0.735*		0.439*	
	(0.286)		(0.194)		(0.292)		(0.195)	
u_{s1987}		-5.910**				-3.139**		
		(1.582)				(0.961)		
u_{s1992}				-2.182+				-0.0829
				(1.187)				(0.695)
Specification	First Stage	IV	First Stage	IV	First Stage	IV	First Stage	IV
R^2	0.122	.	0.0933	.	0.125	.	0.0828	0.0134
Observations	49	49	49	49	48	48	48	48

Notes: This table presents IV estimates of state-level wage and price Phillips curves in the expansion and contraction. Columns 1 shows the first state estimate of the unemployment rate in 1987 on the deregulation measure. Column 2 shows the second stage estimate of wage growth from 1982 to 1989 on the 1987 unemployment rate, instrumented with the deregulation measure. Columns 3 and 4 show the first stage and IV estimates for the bust, using the 1992 unemployment rate and wage growth from 1989 to 1994. We choose the 1987 and 1992 unemployment rates as representative of the peak and trough of the expansion and contraction. Columns 5-8 show the same specifications for state-level CPI inflation, which is missing for Washington, D.C. Standard errors in parentheses are heteroskedasticity robust. +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Table C.1.11: Robustness: Alternative Deregulation Measure and the Household Leverage Index from 1982 to 1989

	Δ_{82-89} HH leverage index						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dereg. measure (1983 dummy)	1.169**	1.213**	0.872**	1.379**	1.355**	0.465	0.869*
	(0.309)	(0.337)	(0.303)	(0.297)	(0.291)	(0.304)	(0.371)
Oil Exposure '85	-0.0560					-0.368*	
	(0.0443)					(0.136)	
Oil Empl. '82	-11.82**					-28.87**	
	(3.547)					(4.193)	
Forbearance		0.178				-0.0140	
		(0.159)				(0.158)	
Northeast region			1.489**			1.492**	
			(0.536)			(0.535)	
South region			0.345			0.895**	
			(0.246)			(0.305)	
West region			0.161			0.860*	
			(0.328)			(0.379)	
Debt to income$_{1982}$				-1.181		-2.708	
				(1.626)		(2.150)	
Δ_{82-89} Real GDP per Capita				-0.365		3.543**	
				(0.532)		(1.081)	
Unemployment$_{1982}$				-0.0665		-0.0434	
				(0.0702)		(0.0542)	
Δ_{82-89} C&I loans							1.017*
							(0.421)
R^2	0.430	0.336	0.478	0.351	0.326	0.693	0.451
Demographic controls					✓	✓	
Observations	49	48	49	49	49	48	49

Notes: This table presents a regressions of the Δ_{82-89} HH leverage index on the deregulation dummy, that assumes value 1 if state has allowed intrastate branching or/and interstate branching by 1983 or earlier and 0 otherwise, and various controls. Δ_{82-89} HH leverage index represents the first principal component of Δ_{82-89} Debt-to-income, Δ_{84-89} Loan appl. volume, and Δ_{82-89} Consumer loans. Oil exposure 1985 represents the share of the state's oil production after excluding federal production. This share is further normalized by the state's population in 1985. Oil employment 1982 is the state's share of employment in the oil industry. Commercial and industrial loans (C&I loans) follows its corresponding definition in the call report. Demographic controls are the fraction of people in urban neighborhood, fraction black, fraction hispanic, fraction with a high school degree, and fraction with college degree, based on the 1980 census. Heteroscedasticity robust standard errors in parentheses. +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Table C.1.12: Robustness: Alternative Deregulation Measure and Change in Employment by Industry from 1982 to 1989

	Δ_{82-89} Total employment	Δ_{82-89} Empl. tradables	Δ_{82-89} Empl. non-tradables	Δ_{82-89} Empl. construction	Δ_{82-89} Industry-level employment			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dereg. measure (1983 dummy)	0.100**	0.000303	0.103**	0.299**	0.0651*	-0.0419	-0.0359	-
	(0.0307)	(0.0348)	(0.0281)	(0.0776)	(0.0314)	(0.0449)	(0.0447)	-
Dereg. measure (1983 dummy) x non-tradables						0.167**	0.161**	0.161**
						(0.0497)	(0.0491)	(0.0487)
x construction						0.348**	0.342**	0.342**
						(0.0785)	(0.0793)	(0.0792)
x other						0.131*	0.123*	0.124*
						(0.0501)	(0.0494)	(0.0491)
Unit of Obs.	State	State	State	State	State x 2 digit Ind.	State x 2 digit Ind.	State x 2 digit Ind.	State x 2 digit Ind.
2 Digit Ind. FE							✓	✓
State FE								✓
R^2	0.169	0.000	0.209	0.235	0.003	0.021	0.444	0.477
Observations	49	49	49	49	3,762	3,762	3,762	3,762

Notes: This table reports regressions of employment growth from 1982 to 1989 by industry on the deregulation dummy, that assumes value 1 if state has allowed intrastate branching or/and interstate branching by 1983 or earlier and 0 otherwise. The employment industry categorization is based on the SIC industries, where tradables: $2000 \leq$ sic ≤ 3900, sic $= 20001$, and sic $= 30001$; non-tradables: $5200 \leq$ sic ≤ 5900; construction: $1500 \leq$ sic ≤ 1700. Columns 1-4 report regressions at the state level for each industry categorization separately. Columns 5-8 report regressions of employment growth at the state by two digit industry level. In columns 6-8 the deregulation measure is interacted with industry category, with tradable employment being the omitted category. Standard errors are heteroscedasticity robust (columns 1-4) or clustered at the state level (columns 5-8). +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Table C.1.13: Robustness: Alternative Deregulation Measure and Consumer Price Inflation from 1982 to 1989

			Special Aggregates		
	(1) Δ_{82-89} All items (Del Negro)	(2) Δ_{84-89} All items	(3) Δ_{84-89} Non-tradables	(4) Δ_{84-89} Tradables	(5) Δ_{84-89} Non-tradables or Tradables
Dereg. measure (1983 dummy)	3.715**	4.493**	7.684**	0.605	0.605
	(0.939)	(1.043)	(1.696)	(0.770)	(0.778)
Dereg. measure (1983 dummy) × NT					7.079**
					(1.815)
Dummy Non-tradables					8.924**
					(1.164)
R^2	0.279	0.421	0.457	0.022	0.801
Unit of obs.	State	State	State	State	State × NT-T
Observations	48	25	25	25	50

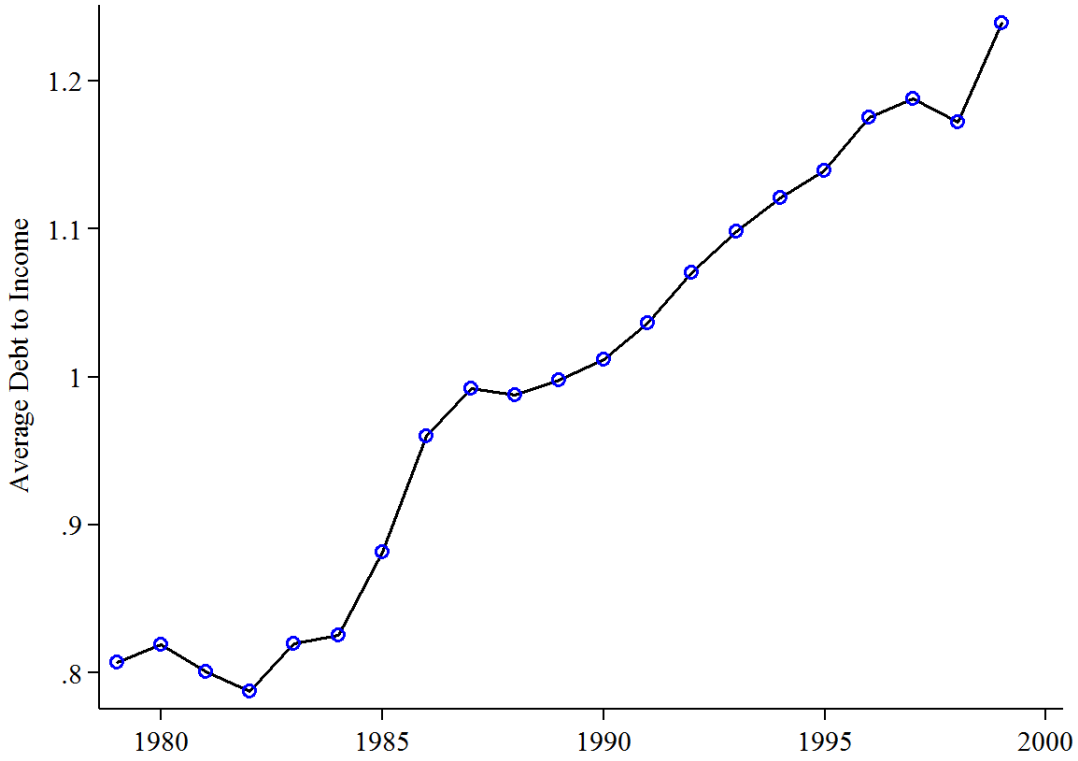
Notes: This table presents regressions of CPI inflation on the deregulation dummy, that assumes value 1 if state has allowed intrastate branching or/and interstate branching by 1983 or earlier and 0 otherwise. Inflation measures in columns 2-5 are state-level aggregates computed using the BLS's MSA-level indexes and are thus only available for 26 states. Columns 2-5 exclude Alaska, which is a large outlier in the sample. Tradable and non-tradable CPI inflation are defined at the BLS "Commodities" and "Services" Special Aggregates, respectively. Heteroscedasticity robust standard errors in parentheses. +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Table C.1.14: Robustness: Beta Analysis using Alternative Deregulation Measure

	(1) Real GDP growth	(2) Real GDP p.c. growth	(3) Unemp. Change	(4) Housing unit growth	(5) House price growth
Aggregate GDP Growth: 1982-89 & 1989-92					
GDP growth	0.280^{+}	0.499**	-1.352**	-3.382*	0.0586
	(0.152)	(0.129)	(0.166)	(1.422)	(0.301)
Dereg. measure (1983 dummy)	-0.0141*	-0.0157**	0.0208**	-0.123*	-0.0397**
	(0.00567)	(0.00487)	(0.00419)	(0.0527)	(0.0133)
Dereg. measure (1983 dummy) x GDP growth	0.984**	0.814**	-0.830**	3.933^{+}	2.412**
	(0.217)	(0.179)	(0.203)	(2.121)	(0.677)
R^2	0.350	0.460	0.791	0.114	0.334
Observations	98	98	98	98	98

Notes: This table presents regressions of the form: $\Delta y_{sb} = \alpha + \beta X_b \cdot d_s + \gamma \Delta X_b + \delta d_s + \epsilon_{sb}$. The equation is estimated in changes using two periods, the boom and the bust (i.e. $b = \{boom, bust\}$). The dependent variables are defined as the growth rate from 1983 to 1989 (boom) and 1989 to 1992 (bust), with the exception of unemployment, which is measured as the change from 1982 to 1989 and 1989 to 1992. The variable ΔX_b is the change aggregate GDP growth (1983 to 1989 and 1989 to 1992, panel C). All regressions are estimated using the alternative deregulation measure, which assumes value 1 if state has allowed intrastate branching or/and interstate branching by 1983 or earlier and 0 otherwise. The coefficient on the interaction between the deregulation dummy and the aggregate cycle variable, β, measures how a state's cyclicality over the 1982-92 cycle varies with the deregulation measure. Standard errors are clustered at the state level. +,*,** indicates significance at the 0.1, 0.05, 0.01 level, respectively.

Figure C.1.1: Average Debt to Income



Notes: Average debt to income is the mean of debt to income across all states in each year.

Figure C.1.2: The Rise in Household Debt to Income in the 1980s

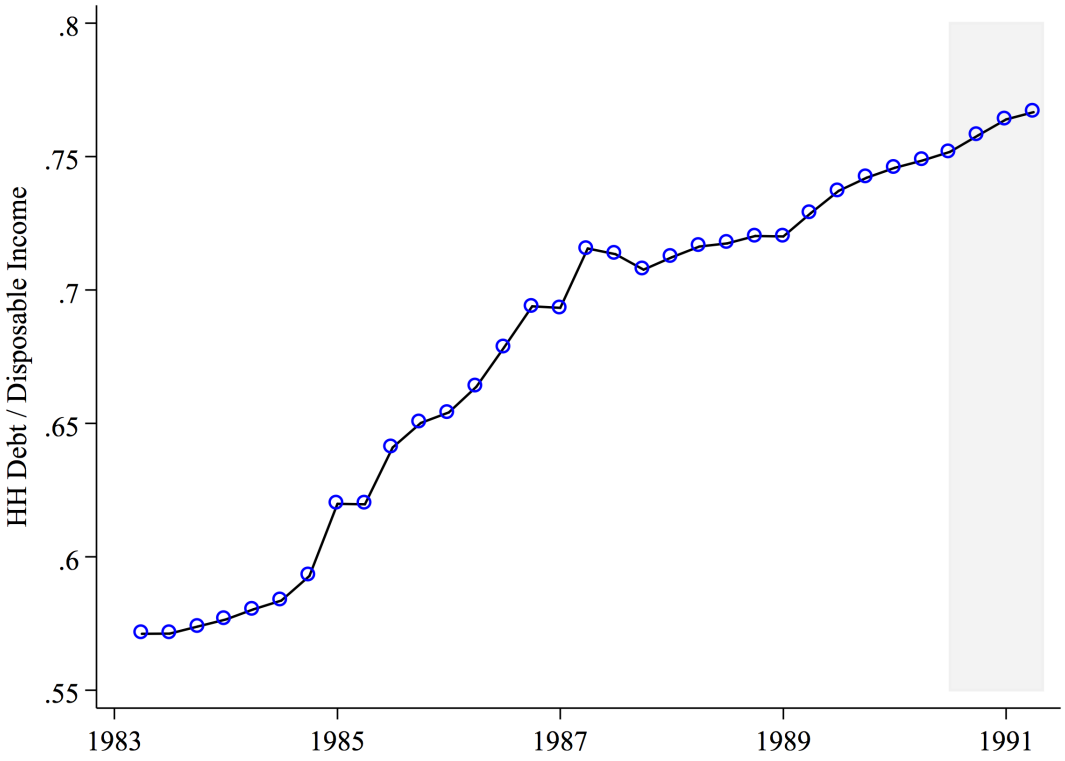
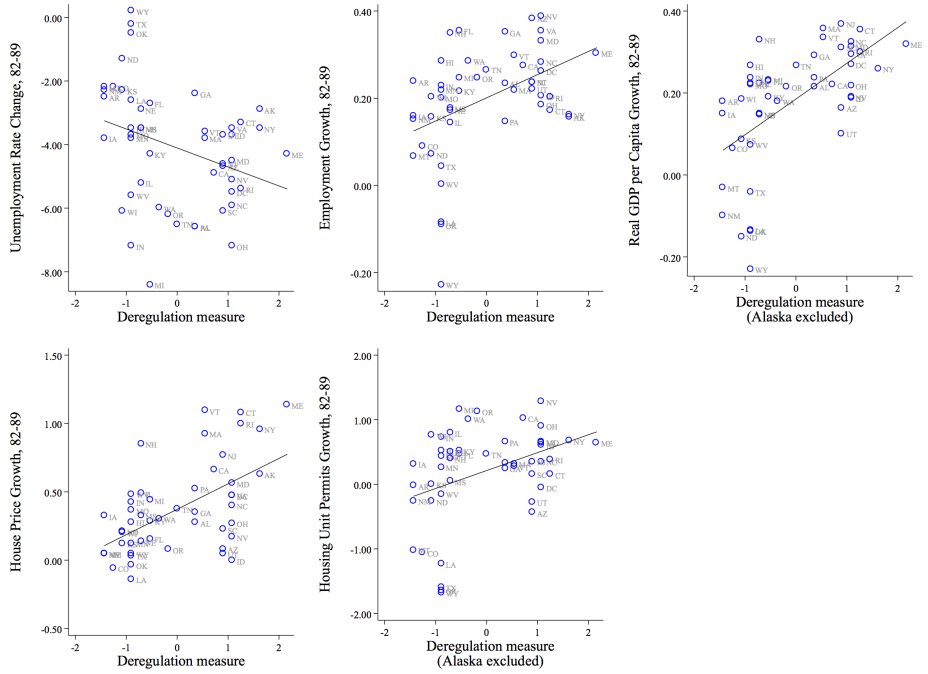
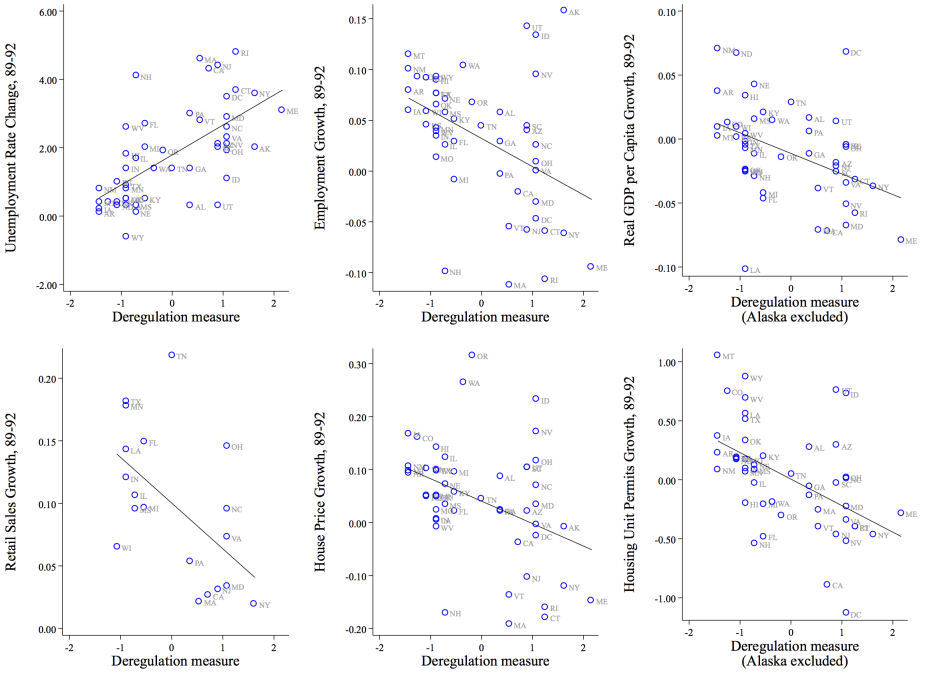


Figure C.1.3: Deregulation and the Boom and Bust: Cross-Sectional Evidence

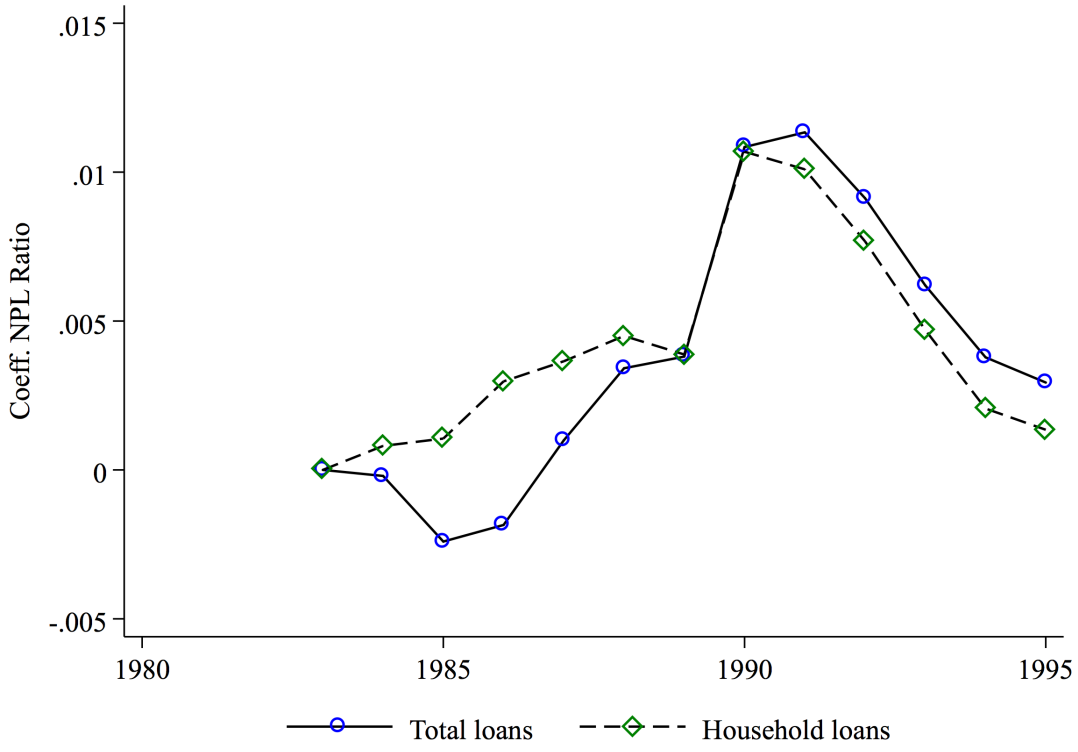


(a) Outcomes in the Boom, 1982 to 1989



(b) Outcomes in the Bust, 1989 to 1992

Figure C.1.4: NPL Ratios without Controls



Notes: This figure presents estimates of $\{\beta_y\}$ from $NPL_{st} = \alpha_s + \alpha_t + \sum_{y \neq 1983} \mathbb{1}_{t=y} d_s \beta_y + \epsilon_{st}$, where d_s is the deregulation measure and NPL_{st} is the non-performing loan ratio for household or total loans.

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