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WHAT HAPPENED: FINANCIAL FACTORS IN THE GREAT RECESSION

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ABSTRACT

Since the onset of the Great Recession, an explosion of both theoretical and empirical research has investigated how the financial crisis emerged and how it was transmitted to the real sector. The goal of this paper is to describe what we have learned from this new research and how it can be used to understand what happened during the Great Recession. In the process, we also present some new evidence on the role of the household balance sheet channel versus the disruption of banking. We examine a panel of quarterly state level data on house prices, mortgage debt and employment along with a measure of banking distress. Then exploiting both panel data and time series methods, we analyze the contribution of the house price decline versus the banking distress indicator to the overall decline in employment during the Great Recession. We confirm a common finding in the literature that the household balance sheet channel is important for regional variation in employment. However, we also find that the disruption in banking was central to the overall employment contraction

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At least since the Great Depression, major economic calamities have altered the course of research in macroeconomics. The recent global financial crisis is no exception. At the onset of the crisis, the workhorse macroeconomic models assumed frictionless financial markets. These frameworks were thus not able to anticipate the crisis, nor analyze how the disruption of credit markets changed what initially appeared like a mild downturn into the Great Recession. Since that time, an explosion of both theoretical and empirical research has investigated how the financial crisis emerged and how it was transmitted to the real sector. The goal of this paper is to describe what we have learned from this new research and how it can be used to understand what happened during the Great Recession. In the process, we also present some new empirical work.

This paper is organized into three main parts. We begin with an informal description of the basic theory and concepts, including new developments. This work emphasizes the role of borrower balance sheets in constraining access to credit when capital markets are imperfect. Much of the pre-crisis research focused on constraints facing non-financial firms. The events of the Great Recession, however, necessitated shifting more attention to balance sheet constraints facing households and banks. In addition, the crisis brought into sharp relief the need to capture the nonlinear dimension of the financial collapse, prompting a new wave of research.

The next section describes the main events of the financial crisis through the lens of the theory. To tell the story we also make use of the new wave of empirical research that has sharpened our insights into how the crisis unfolded. In this regard, the literature has been somewhat balkanized with some work focusing on household balance sheets and others emphasizing banks. We argue that a complete description of the Great Recession must take account of the financial distress facing both households and banks and, as the crisis unfolded, non-financial firms as well.

We then present some new evidence on the role of the household balance sheet channel versus the disruption of banking. We examine a panel of quarterly state level data on house prices, mortgage debt and employment along with a measure of banking distress. Then exploiting both panel data and time series methods, we analyze the contribution of the house price decline versus the banking distress indicator to the overall decline in employment during the Great Recession. We confirm a common finding in the literature that the household balance sheet channel is important for regional variation in employment. However, we also find that the disruption in banking was central to the overall employment contraction.

Background Theory and Basic Concepts

In this section, we describe how contemporary macroeconomic models capture the interaction between the financial and real sectors (for recent surveys, see Gertler and

Kiyotaki 2011; Brunnermeier, Eisenbach and Sannikov 2013). Though the models differ in detail, they share several key features: The strength of a borrower's balance sheet, measured by the value of assets net of debt (or "net worth"), affects access to credit and thus the ability to spend. In turn, financial crises are periods where borrower balance sheets contract sharply, leading to a significant disruption of credit flows. Significant declines in spending and economic activity then follow.

Much of the early literature focused on the effect of balance sheet constraints on non-financial firms. However, as Bernanke and Gertler (1995) note, the theory applies equally well to households and banks. Indeed, financial distress arose in all three sectors in the recent crisis, as we will elaborate.

The External Finance Premium

The connection between balance sheet strength and credit access arises when frictions impede borrowing and lending. Absent such frictions, a borrower's financial strength is irrelevant to the real investment decision (in an application of the Miller/Modigliani theorem). As a result, with perfect markets the cost of raising funds externally equals the opportunity cost of lending out internal funds.[1]

A common way to make financial market frictions endogenous is to introduce an agency problem between borrowers and lenders. There are two basic approaches: either postulating some type of informational asymmetry that leads creditors to be more informed than borrowers, or assuming that it is costly for creditors to enforce certain contractual commitments made by borrowers. In either scenario, borrowers potentially can gain at the expense of lenders by acting dishonestly. Accordingly, rational lenders in this setting will impose constraints on the terms of lending, like credit limits, collateral requirements, and bankruptcy contingencies. Overall, the agency problem makes raising funds externally more expensive than using internal funds, which Bernanke and Gertler (1989) call the "external finance" premium. Indeed, we will argue that an elevated external finance premium is a common feature of financial crises.

Measurement of the external finance premium depends on the details of the agency problem. In many instances, it can be measured as an explicit wedge between borrowing and lending rates due to factors such as costs of evaluating and monitoring borrowers or a "lemons" premium arising when borrowers are likely better informed about their credit-worthiness than are lenders. In other cases, where there is non-price rationing due to some form of credit limit, covenant restriction, or collateral requirement, the external finance premium is measured as the difference between the "shadow" borrowing rate and

[1] By external funds we refer to imperfectly collateralized borrowing. Perfectly collateralized borrowing is effectively the same as using internal funds.

the lending rate. The shadow borrowing rate is the borrower's marginal return to investing. In either case, the external finance premium adds to the cost of capital.[2]

Key to the behavior of the external finance premium is the behavior of the borrower's balance sheet. In a situation with agency problems, a stronger balance sheet enables the borrower either to self-finance a greater fraction of an investment or to provide more collateral to guarantee the debt. This basic prediction—that credit access improves with the strength of the balance sheet—is characteristic of many real-world financial arrangements, including restrictions that borrowers post down payments, post collateral and meet certain financial ratios. In any of these cases, a borrower who is able to take a larger stake in the outcome of the investment will have a reduced level of agency conflict with the lender. The external finance premium declines as a consequence.

The Financial Accelerator/Credit Cycle Mechanism and Crises

The link between borrower balance sheets and the external finance premium leads to mutual feedback between the financial sector and real activity. A weakening of balance sheets raises the external finance premium, reducing borrowing, spending and real activity. The decline in real activity reduces cash flows and asset prices, which weakens borrower balance sheets, and so on. This kind of adverse feedback loop was captured originally by the financial accelerator model of Bernanke and Gertler (1989) and Bernanke, Gertler and Gilchrist (1999) and the credit cycle model of Kiyotaki and Moore (1997).[3] Many contemporary models of financial crises have evolved from this approach.

With a sufficient deterioration of balance sheets, a full-blown financial crisis emerges as external finance premia rise to the point where borrowers are induced to curtail spending sharply. In fact, this combination of weak balance sheets and high external finance premia is characteristic of major financial crises. A rough proxy for the external finance premium is the interest rate spread between the return on a private debt instrument, such as a corporate bond, a mortgage, or commercial paper, and a similar maturity government bond. These spreads tend to widen across the board during crises and did so dramatically during the recent crisis.

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[2] It might seem that an alternative approach is to examine the behavior of credit aggregates and then consider the forecasting power of these aggregates for real activity. However, this approach cannot disentangle whether demand or supply is driving the movement in these quantities. Loan demand is likely to vary positively with real activity, leading to a positive correlation between credit quantities and output. Thus, procyclical variation in credit aggregates can arise even when financial market frictions are absent. We do not mean to suggest that the behavior of credit aggregates is uninformative about financial conditions. They can reveal the risk exposure of different sectors, as measured by the degree of leverage. But a measure of the quantity of credit alone does not tell us is how tight or loose financial constraints are.

[3] Providing motivation for this direction was Bernanke's (1983) classic analysis of the role of financial factors in the Great Depression.

This earlier literature focused largely on constraints faced by non-financial firms. In the recent crisis, however, it was mainly highly leveraged households and highly leveraged banks that were initially vulnerable to financial distress. Thus, motivated by the seminal empirical work of Mian and Sufi (2014) and Mian, Rao and Sufi (2013), studies like Eggertsson and Krugman (2012), Justiniano, Primiceri and Tambalotti (2015), and Guerreri and Lorenzoni (2017) incorporated balance sheet constraints on households. The distress in financial markets induced others like Gertler and Kiyotaki (2011), He and Krishnamurthy (2013), and Brunnermeier and Sannikov (2014) to incorporate balance sheet constraints on banks. The financial accelerator mechanism remains operative, but the transmission of the crisis through the different sectors of the economy is much closer to what actually occurred. [4]

The Role of Leverage

The exposure of the economy to a financial crisis is closely related to the degree to which borrowers rely on debt. The higher the fraction of financing that is debt, as opposed to equity, the more sensitive the balance sheet becomes to fluctuations in asset prices. For example, consider a borrower that self-finances an asset versus one who self-finances ten percent and issues debt to finance the rest. A ten percent decline in the asset values will leave the former with a ten percent reduction in net worth, while the latter will be completely wiped out.

The lead-up to the Great Recession saw an unprecedented rise in leverage in both the household and banking sectors. Household leverage was largely in the form of mortgage debt, occurring in the context of a dramatic boom in housing prices (Jorda, Schularick and Taylor (2017)). Both investment banks and commercial banks financed the increase in mortgage holdings by mostly short-term debt of their own. That the bank debt was mostly short term also made the system vulnerable to runs, as we discuss shortly. By 2006, the financial positions of both households and banks were highly vulnerable to the decline in house prices that would soon follow.

[4] Readers interested in some additional examples of macro modelling of financial crises might also look at Geanakoplos (2009), Jerman and Quadrini (2012), Christiano, Motto and Rostagno (2014), and Arellano, Bai and Kehoe (2016).,For an early attempt to capture the effects of house prices, see Iacoviello (2005). Also, while the modern literature has formalized this theory of financial crises, some of the ideas have an earlier pedigree. For example, Irving Fisher's (1933) debt-deflation theory of the Great Depression held that the weakening of borrower balance sheets stemming from the sharp price deflation during the early 1930s was a significant factor driving the depth and duration of the Depression. The deflation weakened balance sheets because most debts were in nominal terms.

Nonlinear Effects of Financial Crises

Financial crises are highly nonlinear events. (See, e.g., Krishnamurthy, Nagel, and Orlov 2014). The crises features sharp increases in credit spreads and sharp contractions in asset prices and output. However, booms do not experience any symmetric countermovement of these variables. Further, the sharp contraction of the economy during a financial crisis often occurs in without any immediate large non-financial shock to the economy, as was the case for the US economy in the last few months of 2008.

The earlier generation of financial accelerator models (Bernanke, Gertler, and Gilchrist, 1999) considered loglinear approximations around a deterministic steady state and thus could not capture nonlinear dynamics. Recent literature has addressed the issue in a variety of ways. For example, Mendoza (2010) and He and Krishnamurthy (2015) introduce nonlinearity by allowing balance sheet constraints that bind only during recessions, not booms. To put it another way, the economy during a boom behaves to a large extent as if it had frictionless financial markets. However, a negative disturbance can move the economy into a region where the constraints are binding, amplifying the effect of the shock on the downturn. In a related approach, Brunnermeier and Sannikov (2014) develop a framework where for precautionary reasons, borrowers reduce spending by more in response to a contraction in the balance sheet than they increase it in response to a strengthening of similar magnitude. These kind of asymmetries can help account for why, during the recent recession, household consumption responded more strongly to contractions in house prices that weakened household balance sheets than to the earlier run-up in housing prices.

More recently, Gertler, Kiyotaki, and Prestipino (2017) develop a framework with bank runs as the key source of nonlinearity. The key element here is whether financial institutions like investment banks are able to roll over their short-term loans. Within this model, in normal times where banks have healthy balance sheets, lenders are confident that even if other creditors do not rollover, the bank has the resources to honor its debt. However, in downturns where bank balance sheets have weakened, lenders can no longer be certain their deposits are safe if other creditors were to withdraw. As a consequence, a self-fulfilling roll-over panic becomes possible, which generates a highly nonlinear rise in credit spreads and contraction in asset prices and output.

Interdependence of Household, Firm, and Bank Balance Sheets

In analyzing the dynamics of a financial crisis, it is critical to account for the interdependence of balance sheets across sectors. Figure 1 illustrates the interconnection between household, firm and bank balance sheets. (We simplify for expositional purposes). For households, assets consist of housing and financial assets. Liabilities are

loans from banks and net worth. Bank assets are loans to households and loans to firms. Bank liabilities are deposits and equity. In turn, loans along with equity are on the liability side of firm balance sheets, while assets consist of capital.

Clearly, the balance sheet position of one sector of the economy will also affect others. Household debt—and mortgage debt in particular—typically surges prior to a financial crisis (for example, Mian, Sufi, and Verner 2017; Schularick and Taylor 2012). The origins of the Great Recession similarly involved a surge in mortgage lending and a boom in house prices and housing construction. As the house price boom began to reverse, household balance sheets weakened and consumption growth fell.

But mortgages also appear on the asset side of bank balance sheets. Indeed, the lion's share of the growth in mortgages since the late 1990s was created by securitized mortgage loans, which were absorbed by a huge expansion of the thinly capitalized and lighted regulated shadow banking sector. When banks (broadly defined) are subject to financial distress, the flow of credit is impeded to the broad spectrum of non-financial borrowers, including firms as well as households.

The Relevance of Constraints on Monetary Policy

The severity of a financial crisis depends critically on the behavior of monetary policy. When monetary policy is free to respond, a central bank can (at least partially) offset the effect of the crisis on the cost of credit by reducing interest rates. Conversely, when the hands of monetary policy are tied, the crisis is much more likely to spin out of control. The evidence is consistent with this insight. For example, for emerging market economies in the post-World War II period, full-blown financial crises were more likely to occur in countries operating under fixed exchange rates, where monetary policy was not free to adjust, as opposed to countries operating under flexible rates (Kaminsky and Reinhart 1999). Similarly, Eichengreen (1992) and others have shown that during the Great Depression era, countries that freed up their monetary policy by abandoning the gold standard early in the crisis experienced much milder downturns than those that delayed.

For the recent financial crisis, the relevant constraint on monetary policy was the zero lower bound on the nominal interest rate. As financial conditions deteriorated and the economy began contracting in fall 2008, the Federal Reserve quickly reduced short term interest rates, reaching effectively zero by December 2008. From that point on, the Fed's conventional tool was no longer available. The zero lower bound also constrained the other major central banks, including the European Central Bank and the Bank of England. Of course, the Bank of Japan. had a much longer experience with the zero lower bound going back to the 1990s.

All of these central banks, led by the Federal Reserve, introduced a variety of unconventional monetary policies to circumvent the constraints of the zero lower bound. The most visible of these policies was large scale asset purchases ("quantitative easing") which the Fed introduced after the peak of the crisis in early 2009. This paper is not the place to go into detail on these policies: for a formal analysis of how unconventional monetary policy affects the economy, see Gertler and Karadi (2011) and Curdia and Woodford (2011). However, these unconventional monetary policy interventions are widely credited for helping mitigate the severity of the financial crisis.

The Financial Crisis through the Lens of the Theory

In this section, we use the theory outlined in the previous section as an organizing framework to identify the role of financial factors in the unfolding of the Great Recession. In particular, we identify how and when balance sheet constraints in each of the three sectors—households, banks and firms—become relevant. For much of the background material, we rely on Bernanke (2010, 2015), Gorton (2010), Adrian and Shin (2010) and Gertler, Kiyotaki and Prestipino (2016).

Buildup of Vulnerabilities

The prelude to the financial crisis was an extraordinary housing boom, featuring a dramatic run up in house prices, residential construction and mortgage debt. A variety of factors triggered the boom, including a secular decline in long-term interest rates, a relaxation of lending standards, and widespread optimism about future increases in house prices. In addition, increased securitization of mortgages permitted greater separation of the origination function of mortgage lending from the funding role. Lightly regulated shadow banks began to displace commercial banks as the primary funders of mortgage-related securities. One example is the rise of asset-backed commercial paper conduits which held securitized assets such as mortgages and car loans and funded these assets by issuing short term (for example, 30-day) commercial paper. The cost of mortgage finance declined, because these shadow banks did not face the same capital requirements or regulatory oversight as commercial banks.

The housing boom made both households and banks financially vulnerable. Figure 2 provides information on the household balance sheet over the ten-year period from 2004 through 2014. The shaded area is the time from peak to trough of the Great Recession and the vertical line marks the Lehmann Brothers bankruptcy, which is generally considered the epicenter of the financial collapse. The figure portrays two measures of household leverage: the ratio of household debt to income (the solid line) and the ratio of household debt to assets (the dashed line), where the latter includes the market values of

housing and financial wealth. From 2004:Q1 to the start of the recession, household debt to income increased roughly 25 percent, fueled mainly by the rapid increase in mortgage debt. Household asset values increased at roughly the same pace as the increase in mortgage debt mainly due to the rapid increase in house prices. The net effect is that the debt-to-assets ratio rose comparatively little until the start of the Great Recession.

By the end of 2007, households were vulnerable to the sharp decline in asset values that would follow. Housing prices peaked at the end of 2006 and then declined more than 25 percent. As a result, the aggregate household leverage ratio—measured by the ratio of debt to annual income—increased roughly 25 percent from early 2007 to the business cycle trough. Later in the recession toward the end of 2008, the decline in stock prices also contributed further to the rise in household leverage ratio. Of course, certain states like California and Florida experienced much sharper declines in house prices and increases in household leverage than the national average.

The deterioration of household balance sheets provided a channel through which declining house prices affected household spending and in turn economic activity. The weakening of the household balance sheet reduces access to credit, like home equity loans.[5] A substantial literature initiated by the seminal work of Mian, Rao and Sufi (2013) and Mian and Sufi (2014) has examined the role of the household balance sheet channel during the Great Recession. To identify the strength of this channel, this work exploits the regional variation in house prices and household balance sheets that we alluded to earlier. We return to this issue of estimating effects using regional variation later.

As vulnerabilities in household balance sheets materialized, corresponding vulnerabilities in bank balance sheets emerged as well. Shadow banks grew from intermediating less than 15 percent of credit in the early 1980s to roughly 40 percent on the eve of the Great Recession, an amount on par with commercial banks (for discussion, Gertler, Prestipino, and Kiyotaki 2017). Figure 3 provides information about the balance sheet behavior of publicly traded investment banks, a major component of the shadow banking sector. As the solid line shows, from 2004 to the start of the Great Recession these institutions increased their real debt levels by more than 50 percent, mostly as a consequence of financing the rapid expansion in securitized assets by borrowing in short term credit markets. Because these firms did not face the regulatory capital requirements of traditional banks and because they generally received high marks from the credit ratings agencies like Standard & Poor's, Moody's and Fitch, on the mortgage related

[5] The argument in the text requires imperfect financial markets. With perfect financial markets and the ability to borrow freely based on lifetime income, a drop in house prices does not induce a wealth effect on household spending, because the decline in house prices is offset by the decline in the cost of housing (assuming that the household continues to reside in the same neighborhood where house prices have declined).

securities that they held, the investment banks tended to operate with much higher leverage ratios than did the commercial banks. Prior to the Lehmann Brothers collapse in September 2008, investment banks operated at ratios of debt-to-equity of between 20 and 25, roughly three times the level of commercial banks. Other types of shadow banks, including asset-backed commercial paper issuers and finance companies, similarly operated with high leverage.

The increase in the quantity of mortgage debt was accompanied by a decline in the quality. As Bernanke (2015) notes, the riskiest mortgages were issued in 2005 and 2006, at the height of the house price boom. Mortgages that were clearly labeled as risky from the start included both "sub-prime" (issued primarily to low-income borrowers) and also "Alt A" (issued to speculators and/or households taking out second mortgages). In 2005 and 2006, the share of newly issued mortgages that could be classified a priori as risky rose to roughly 40 percent, up from 10 percent in 2002. A general relaxation of lending standards helped to fuel the increase. Also complicating matters is that roughly 30 percent of newly issued mortgages were issued at variable interest rates rate at a time when the Federal Reserve was in the midst of a tightening cycle, adding to their overall risk.

The Unraveling

A combination of declining house prices and increasing short-term interest rates led to an uptick in mortgage defaults in 2007, particularly on low-grade variable rate mortgages issued in 2005 and 2006. In July 2007, the investment bank Bear Stearns defaulted on two of its mutual funds that were exposed to mortgage risk. In August 2007, in the event largely considered to mark the beginning of the crisis, the investment bank BNP Paribas suspended withdrawals from funds that also had mortgage exposure risk.

Concern spread quickly about other financial institutions with mortgage risk exposure, particularly those relying heavily on short term funding. The asset-backed commercial paper market was an early target (as discussed in Kacperczyk and Schnabl 2010; Covitz, Liang and Suarez 2013). Again, intermediaries in this market funded securitized assets, including pools of mortgages, auto loans and credit card debt, and so on. They funded these assets by issuing short term commercial paper, using the assets as collateral. Concern about the quality of these assets, however, especially those with mortgage exposure, led suppliers of commercial paper (like money market funds) to either tighten the terms of credit or withdraw from the market completely. The value of asset-backed commercial paper outstanding fell from a peak of $1.2 trillion in June 2007 to $800 billion by the following December.

The way in which the contraction of the asset-backed commercial paper market transmitted to the real economy can be described in terms of the theory presented in the previous section. The reduction in the perceived collateral value of the securities held by asset-backed commercial paper issuers weakened their balance sheets and raised the cost of access to the commercial paper market. Interest rates on asset-backed commercial paper increased relative to similar maturity Treasury Bill rates. Other terms of lending, such as collateral requirements, tightened as well. The increase in funding costs faced by issuers of asset-backed commercial paper in turn raised the cost of credit for mortgages, auto loans, and other types of borrowing that made use of securitized lending.

The collapse of the asset-backed commercial paper market led to the first significant spillover of financial distress to the real sector, contributing to the slowdown in residential investment, automobile demand and other types of spending that relied on this funding. Benmelech, Meisenzahl and Ramacharan (2017), for example, present evidence that tightening of credit conditions in this market alone accounted for roughly one-third of the overall decline in automobile spending during the crisis.

At the same time, the decline in house prices was weakening household balance sheets, placing downward pressure on consumer spending. In addition, the end of the housing boom meant a sharp drop in residential investment. These factors, along with the disruption of short-term credit markets like asset-backed commercial paper, were sufficient to move the US economy into recession at the end of 2007.

The Federal Reserve responded aggressively to the onset of the recession. It reduced the federal funds interest rate, and also undertook a variety of new measures designed to improve the availability of short-term credit. These measures included making it easier for commercial banks to obtain discount window credit and also making this credit available to investment banks (which had previously been unable to borrow in this way). The Federal Reserve also exchanged government bonds for highly rated private securities to boost the supply of (perfectly) safe assets that could be used to collateralize-short term borrowing. The most dramatic intervention involved the steps taken in the spring of 2008 to prevent solvency problems with Bear Stearns from further disrupting credit markets: The central bank provided funding for JP Morgan's acquisition of Bear Stearns using some of the latter's assets as collateral.

Collapse of the Financial and Real Sectors

Through the summer of 2008, the US economy continued to slow. However, the common perception at the time was that it would experience a downturn similar to the relatively moderate recession of 1990 - 1991, which also featured a banking crisis,

though one that involved commercial real estate and commercial banks rather than residential real estate and shadow banks.

In September 2008, however, the second and larger wave of financial distress hit. Lehmann Brothers, a much larger investment bank than Bear Stearns, was similarly exposed to mortgage related risk. A significant decline in the value of its securities holdings weakened its balance sheet and raised the risk to its short-term creditors, from whom it was obtaining virtually all its funding. The Reserve Primary Fund, a large money market mutual fund that held commercial paper issued by Lehmann, experienced a run that forced it into liquidation. Runs on other money market funds were only averted when the Federal Reserve extended deposit insurance to these institutions.

The distress then spread to Lehmann's main source of short-term funding, the repo market in which borrowers obtained overnight loans using securities as collateral. The uncertainty about the value of these securities, particularly if there was a hint of mortgage risk exposure, made creditors less willing to accept them as collateral, leading many to pull out of the repo market (for discussion, see Krishnamurthy, Nagel, and Orlov 2014). What emerged were bank runs in the spirit of Diamond and Dybvig (1983), though in markets for wholesale funding (interbank) as opposed to retail funding. In addition, weakening of their balance sheets exposed these institutions to runs which took the form of a collective failure of creditors to roll over their loans (as in Gertler and Kiyotaki 2015; Gertler, Kiyotaki and Prestipino 2017).

The Federal Reserve was unable to act as a "lender of last resort" to Lehmann, because the bank could not offer sufficient collateral. The lack of short-term credit forced Lehmann into default. Fearing similar vulnerability, the other major investment banks quickly merged with commercial banks in order to get the regulatory protection afforded to the latter. The contraction in investment banking impeded credit flows, placing further downward pressure on economic activity.

The financial crisis spread like a cancer from the shadow banking sector, which funded mainly securitized assets, to the commercial banking sector. When commercial banks merged with investment banks, they also absorbed a share of the assets funded by the investment banks. But commercial banks were limited in the amount they could absorb by their equity capital in conjunction with capital requirements that limited their leverage ratios well below the level at which the investment banks had operated. An additional source of pressure on commercial banks was losses on securitized assets that they had initiated and sold. Even though the banks were no longer directly holding these assets, they had an implicit commitment to absorb the losses. The losses on mortgage-related assets in turn weakened the balance sheets of commercial banks, disrupting the flow of credit through these institutions. Now bank-dependent borrowers, including many non-financial firms and households, also faced increasing credit costs.

The major disruption of financial intermediation following these events in September 2008 led to a sharp across-the-board contraction in economic activity. Figure 4 illustrates. The top panel portrays the behavior of three key credit spreads: the 90-day asset-backed commercial paper spread; the Gilchrist and Zakrajsek (2012) excess bond premium for non-financial companies; and the excess bond premium for financial companies. In each case, the spread measures the difference between the return on the security and the return on a similar maturity government bond.[6] The spread for asset-backed commercial paper increases roughly 150 basis points from early 2007 to the end of that year, reflecting the problems in that market that developed prior to the onset of the recession. After a slight dip, the asset-backed commercial paper spread increased another 100 basis points in response to the turmoil in the commercial paper market following the Lehmann collapse in September 2008. As the turbulence spread to both investment banks and commercial banks, the excess bond premium for financial companies increased to more than 150 basis points in the wake of the Lehmann collapse. Finally, the contraction of the shadow banking sector along with the subsequent disruption of commercial banking steadily pushed up credit costs faced by non-financial borrowers. As an example, the excess bond premium increased from roughly zero in early 2007 to 275 basis points at the time of the Lehmann default.[7]

The bottom panel in Figure 4 shows the accompanying behavior of the real sector, including GDP and four key components: residential investment, consumer durables, producer durables and nondurable consumption. (All variables are in logs.) The growth rate of GDP moves slightly negative in the early stages of the recession starting in late 2007. Contributing to the initial slowdown is a sharp decline in residential investment as pessimism about future housing prices begins to grow. Financial factors also play a role. Problems in the asset-backed commercial paper market led to upward pressure on the cost of mortgage credit. In addition, as Gilchrist, Siemer, and Zakrasjek (2017) emphasize, the disruption of credit markets also increased borrowing costs for construction companies that were building homes on speculation.

Also contributing to the initial slowdown was a drop in consumer durable demand at the beginning of the recession, largely due to a sharp decline in automobile demand. Here, forces working through both household and bank balance sheets were operative.

[6] The excess bond premium is the difference between the yield on an index of non-financial corporate bonds and a similar maturity government bond, where the latter is adjusted to eliminate default risk. The idea is to have a pure measure of the excess return that is not confounded by expectations of default. The excess bond premium in the financial sector is constructed in an analogous manner for publicly-traded companies in the financial sector.

[7] As emphasized by Adrian, Colla and Shin (2012) and Becker and Ivashina (2014) the deterioration in commercial banks' financial health induced many non-financial borrowers to switch from bank to public debt markets to obtain credit, placing upward pressure on the EBP. For an early theoretical description of this bank loan supply effect on corporate bond rates, see Kashyap, Stein and Wilcox (1993).

Using cross-regional evidence, Mian, Rao and Sufi (2013) show that the weakening of household balance sheets due to the decline in house prices induced a significant drop in automobile demand. On the other side of the ledger, as we mentioned earlier, Benmelech, Meisenzahl and Ramacharan (2017) showed that the disruption of the asset-backed commercial paper market had a significant negative effect on the demand for cars.

The recession turns from mild to major following the Lehmann bankruptcy at the end of the third quarter of 2008. GDP begins a sharp contraction that lasts until the spring of 2009. As credit costs rise across the board, demand fell for both consumer and producer durable goods. Consumer durables dropped roughly 15 percent while producer durables dropped a whopping 35 percent.

Financial factors also contributed significantly to the contraction in producer durables. Entering the recession, non-financial firms were not directly financially vulnerable to the fall in home prices in the same way that households and (shadow) banks were. They did not (on average) run up their leverage ratios, nor were they directly exposed to house price risk. On the other hand, as the crisis unfolded, equity values dropped significantly, weakening firm balance sheets. Also, the increased strain on commercial banks made access to credit more difficult for non-financial firms, as just mentioned.

Figure 5 illustrates how financial distress hit the non-financial business sector. The top panel plots the behavior of the debt/equity ratio of the non-financial corporate business sector alongside a measure of the external finance premium, specifically the Gilchrist/Zakrasjek excess bond premium we used in Figure 4. Consistent with the theory we described earlier, a higher credit spread is associated with a high leverage ratio.

The bottom panel of Figure 5 shows how distress in banking may have affected the flow of credit to the nonfinancial business sector. It plots the excess bond premium for financial companies against the results of a survey of senior loan officers about lending terms. The former provides a measure of the distress facing financial institutions, while the latter is an indicator of the tightness of bank credit. As the figure shows, they are closely correlated. Note also that during the Great Recession, the unusually high degree of tightening shown in the survey data is also correlated with the increase in the non-financial excess bond premium plotted in the top panel, suggesting the latter was also likely a contributing factor to the former.

Formal panel data studies also identify a role for financial factors influencing non-financial firm behavior. For example, Giroud and Mueller (2015) show that firms that had built up their leverage prior to the Great Recession accounted mainly for the subsequent contraction in employment across regions. As noted earlier, Chodorow-Reich (2015) and Chodorow-Reich and Falato (2017) document that bank health affected the

flow of credit to non-financial firms. Finally, Gilchrist, Schoenle, Sim and Zakrajsek (2017) show that liquidity constraints induced a fraction of firms to raise their price markups in order to generate increased cash flow over the near term (at the likely cost of reducing future market share).

The financial and economic contraction following the Lehmann bankruptcy in September 2008 induced a massive policy response, including steps aimed at addressing the problems of financial sector intermediation and bank balance sheets. The Federal Reserve quickly reduced the short-term interest rate to zero, but it also pursued a variety of other interventions. Among the most visible was massive purchases of agency mortgage-backed securities financed mainly by issuing interest bearing reserves. The logic for the policy was to reduce mortgage costs by expanding central bank intermediation to offset the contraction in private intermediation. Upon announcement of the program, interest rates on mortgage-backed securities fell 50 basis points and dropped another 100 as the program was phased in the following spring.

Perhaps the most dramatic intervention was the injection of equity into the commercial banking system under the Troubled Asset Relief Program (TARP), a Treasury action coordinated with the Federal Reserve in October 2008. Under the TARP, the government purchased $250 billion of preferred equity in the nine largest commercial banks. This intervention (along with temporary public guarantees on the debt of these institutions) helped replenish and stabilize the balance sheets of these institutions. In spring 2009, the Federal Reserve conducted a stress test on the commercial banks. It deemed the system as having an adequate level of capital relative to assets, marking the end of the financial crisis. The trough of the recession occurred shortly thereafter, in June 2009.

As is well known, the recovery following the trough was quite slow. Exactly why is still a matter of debate, and we do not dig into the potential reasons in this paper. However, it is worth noting the behavior of nondurable consumption which, unlike other post-World War II recessions, actually declines after the Lehmann collapse. As Figure 4 shows, it then remains stagnant for a long period after the trough. A number of researchers have suggested that the process of household deleveraging can help account for the slow rebound in consumption (for example, Midrigan, Jones and Phillipon 2017).

Digging Deeper: Evidence from State Data

There has been a surge in empirical work on the issues of household balance sheets and financial frictions and the Great Recession, often making use of cross-sectional variation. The pioneers in this area, Mian and Sufi (2014). have used regional variation to

identify how the weakening of household balance sheets precipitated by the house price decline contributed to the downturn.[8] Others have focused on banks. For example, Chodorow-Reich (2014) exploits variation in bank financial health to identify the effects of the disruption in banking on employment. Finally, there is work showing how the deterioration of non-financial firms' balance sheets reduced employment (for example Giroud and Mueller 2017), again exploiting cross-sectional variation to attain identification.

In thinking about the roles of the household balance sheet channel and the disruption of financial intermediation, a natural question is whether one of these played a substantially larger role than the other in the Great Recession. Disentangling the contribution of the household balance sheet channel versus general financial market conditions on employment presents a nontrivial challenge. To date, the two phenomena have been studied separately. As we have noted, the literature on the household balance sheet channel mainly analyzes cross-sectional behavior. Conversely, work that examines the macro effects of disruptions in financial conditions (for example, Gilchrist and Zakrajsek, 2012) mainly employs time series methods.

In this section, we present some evidence on this issue by examining a panel of state level data. Following Mian and Sufi (2015) and others, we exploit the cross-sectional variation in the data to identify the effect of house prices on the regional variation in employment. We then use this information to disentangle the relative contributions of house prices versus a measure of disruption of intermediation to the aggregate decline in employment.

Some Patterns of Cross-Sectional and Time Series Variation

We begin with an illustration of the data before turning to our econometric framework. The panels in Figure 6 portray both the cross-sectional and time series variation of four variables: house prices, the mortgage-to-income ratio, employment and non-construction employment. The data is quarterly and covers the period from 2004 to 2015. For each variable, we group states into three categories based on the severity of the house price contraction from 2006 to 2010. We then construct an aggregate of the variable for each of the three categories (the house price and the mortgage/income ratio are population-weighted, while the employment measures are simple aggregates). The first category experienced the largest house price drop. It includes the four "sand" states—Arizona, California, Florida and Nevada—and accounts for 20 percent of the population. Our middle group contains 30 percent of the population and the bottom group

[8] A few prominent examples of other papers in this vein are Kaplan, Mitman and Violante (2017), Midrigan, Jones and Phillippon (2017), and Berger, Guerrieri, Lorenzoni and Vavra (forthcoming).

the remaining 50 percent. Note that our middle group has the property that it closely mirrors aggregate behavior for each variable, shown by the solid lines.

The cross-sectional patterns in the data are consistent with the evidence of the household balance sheet channel in Mian and Sufi (2014). The states experiencing the largest boom and bust in house prices also had the largest run up in mortgage debt, as the top two panels show. In turn, across the panels there is a strong correlation between the severity of the house price decline and the corresponding employment contraction, as the bottom left panel illustrates.[9]

As will become clear, it is important to take into account that some of the above-average employment contraction in the sand states was the product of a collapse in residential investment as opposed to a household balance sheet channel. Construction employment fell by 40 percent in these regions. Accordingly, in the bottom right panel of Figure 6 we remove construction from the overall employment measure. The general cross-sectional relation between house prices and total employment also holds for non-construction employment, though with two differences. First, the cumulative drop in non-construction employment is roughly 7.5 percentage points, implying that construction accounts for about 2.5 percentage points of the overall employment drop. Second, and more significant for our purposes, from early 2007 through 2008:Q1, the second quarter of the recession, there is little difference in the behavior of non-construction employment across regions despite considerable heterogeneity in house price dynamics. The regional differences emerge later as the recession unfolds.

In addition to a clear cross-sectional pattern, our quarterly data suggests some important temporal co-movements in employment across regions. First, as we just noted, entering the business cycle peak in 2007:Q4 there is a common slowdown in non-construction employment growth across regions that cannot be easily explained by the pattern of house price declines. As Figure 6 makes clear, the prerecession slowdown in total employment in the sand states was largely a product of the construction decline. This slowdown, however, lines up well with the unraveling of the asset-backed commercial paper market described earlier and the behavior of the various measures of financial distress plotted in Figures 4 and 5. Second, and more dramatic, around the time of the Lehmann Brothers collapse, there is a rapid acceleration in the employment decline across regions. The timing of this across the board employment contraction mirrors the indicators of financial distress in Figure 4, which reach a peak at this point. Thus,

[9] As Mian and Sufi (2014) emphasize, the household balance sheet channel should affect directly non-tradable employment, which depends on local demand conditions. Though we do not present the results here, we find that retail employment (their main measure of non-tradable employment) exhibits the same cross-sectional correlation with house prices as total employment. In contrast, although aggregate manufacturing employment (which may be thought of as tradable goods employment) declines by 18 percent from the recession's peak to trough, there is virtually no difference in the decline across the categories of states.

although there are important differences across states that suggest a link between employment and house prices, there is also a considerable aggregate component to employment dynamics that is tied to economy wide indices of financial distress.

Separating the Effects of Household Balance Sheet Stress and Financial Sector Disruption

In this section, we describe a straightforward reduced-form method to separate the effects of household balance sheets stress and financial sector disruption. In effect, we want to combine evidence from both cross-section and time-series data. Here, we summarize the approach and the results. Details on data sources are presented in the appendix.

As our starting point, we use a panel-data vector autoregression to identify "shocks" to state-level house prices and to our indicator of aggregate financial conditions. By shocks, we mean surprise movements or "innovations" in these variables that are orthogonal to movements in employment and to each other.

For our measure of financial stress, we use the financial excess bond premium at any given time. Again, this is the spread between return on an index of financial company corporate bonds and a similar maturity government bond (after controlling for default risk). It is accordingly a measure of the external finance premium faced by financial institutions and thus a reasonable proxy for the degree of disruption of credit intermediation. As we showed in Figure 4, this premium jumps during the asset-backed commercial paper crisis and even more dramatically during the Lehmann fallout.

To identify shocks to the spread, we use conventional time series methods: We regress the financial excess bond premium s_t during each time period on four lags of itself, along with current and four lags of quarterly aggregate house price growth $\Delta \log P_t$ and quarterly aggregate employment growth $\Delta \log E_t$:

$$s_t = \sum_{i=1}^{4} \alpha_i^s s_{t-i} + \sum_{i=0}^{4} \gamma_i^s \Delta log P_{t-i} + \sum_{i=0}^{4} \omega_i^s \Delta \, log E_{t-i} + \varepsilon_t$$

The residual in this regression ε_t provides our measure of the shock to the financial excess bond premium that cannot be explained by housing prices or employment. An example might be the jump in the spread due to the financial panic that led to the Lehmann bankruptcy.

When we carry out this regression, we find that we cannot reject the hypothesis that the residuals are serially uncorrelated implying that the estimated shocks are true surprises. This approach also makes use of timing restrictions to identify the exogenous shock ε_t in the excess bond premium equation. In this case, given that financial markets react quickly to news, we assume that the financial excess bond premium responds immediately to current house prices and current employment growth: hence the presence of current values for those variables in the regression. However, we assume that movements in the spread affect employment and house prices only with a lag of at least one quarter, given sluggishness in response of real sector variables to shocks. This kind of timing restriction is standard in the literature on identified vector autoregressions, but our results are robust to alternative timing assumptions.

Similarly, to obtain the shock in state-level house prices we regress the quarterly change in house prices for each state on four lags of itself, four lags of the financial bond premium and the current and four lagged values of that state's growth in employment. Let $\Delta \log P_{j,t}$ and $\Delta \log E_{j,t}$ denote house price and employment growth in state j. We estimate

$$\Delta \log P_{j,t} = \sum_{i=1}^{4} \alpha_i^p s_{t-i} + \sum_{i=1}^{4} \gamma_i^p \Delta log P_{j,t-i} + \sum_{i=0}^{4} \omega_i^p \Delta \, log E_{j,t-i} + \mu_{j,t}$$

The residual in this equation $\mu_{j,t}$ provides our measure of shocks to house prices in a given state. An example of what could underlie this kind of shock is a spontaneous burst of optimism or pessimism about future house price appreciation (as in Kaplan, Mitman and Violante, 2017). This specification imposes common coefficients across states and over time, but our aggregate decomposition is insensitive to this assumption. The additional timing assumption we make in this instance is that current employment can influence housing prices, but the latter can affect the former only with a lag.

With these measures of the shocks to housing prices and financial stress in hand, our next step is to estimate the effects of these shocks on the dynamic behavior of both state-level and aggregate employment. In doing so, we interact our measures of state level house price shocks with a state-level measure of household indebtedness. We do so in a way that permits isolating the household balance sheet channel from other ways that house prices could affect employment (for example, via the impact on residential construction). To measure the balance sheet channel, we look at the mortgage-to-income ratio in each state.

We are interested in estimating the effect of shocks to housing prices and financial intermediation over different time horizons that then allow us to provide a historical decomposition over the crisis period. Thus, we estimate a series of regressions with

different time horizons, using state level employment growth from one quarter up to 10 quarters ahead as the dependent variable.

We include three explanatory variables. The first variable is the shock to housing prices at the state level, taken from the earlier calculation. The second variable starts with the mortgage-to-income ratio in a given state at the end of the house price boom, 2006:Q4, which gives a sense of the vulnerability of households in that state to a decline in housing prices, and combine this with an indicator variable that takes on a value of 1 over the crisis period where house prices were declining, 2007:Q1-2009:Q4, and zero otherwise. This term is then multiplied by the housing price shock at the state level. Interacting the housing price shock with the mortgage-to-income ratio provides a way to identify the balance sheet channel (analogous to Mian and Sufi 2014). Restricting the interactive effect to be operative only during the crisis captures the idea that balance sheet constraints were likely most relevant during this period.[10] The third explanatory variable is the shock to financial stress, taken from the earlier calculation. For the h quarter ahead growth in employment growth rate of employment the regression also includes a horizon-specific state fixed effect $\epsilon_{j,h}$ and an error term $\epsilon_{j,t,h}$ is specified as

$$logE_{j,t+h} - \log E_{j,t} = \beta_{p,h}\mu_{j,t} + \beta_{b,h}[Crisis = 1]\frac{M_j}{Y_j}\mu_{j,t} + \beta_{s,h}\varepsilon_t + \epsilon_{j,h} + \epsilon_{j,h,t.}$$

Because our identified shocks to housing prices and financial conditions were obtained by conditioning on current and lagged values of state level employment and other variables they are orthogonal to other information that may predict future employment growth. Consequently, ordinary least squares gives consistent estimates of the coefficients. Following Jorda (2005), we can then use estimates of our equation over different horizons to construct measures of the response of employment to our identified shocks.

Table 1 reports estimates of the effects of the identified shocks on employment growth across horizons that span 1 to 10 quarters. The estimation period is 1992:Q2 to 2015. The first column of Table 1 reports for each horizon h the linear response coefficient $\beta_{p,h}$ to a house price shock $\mu_{j,t}$ that does not operate through a balance sheet channel. These coefficients imply a statistically significant effect at all horizons. It is though economically modest compared to the effect of a leverage adjusted house price shock. Interpreted causally, these estimates imply that a one percent surprise decrease in house prices leads to a 0.3 percent decrease in aggregate employment at the two-year horizon.

[10]As Berger, Guerrieri, Lorenzoni and Vavra (forthcoming) argue, consumption was likely not that sensitive to house price movements during the boom phase as leverage constraints were likely not close to binding.

The second row of Table 1 reports the estimated employment effect of the leverage adjusted house price shock during the crisis period, which we have argued captures the balance sheet channel. The leverage measure M_j / Y_j is normalized by the median value across states. It then ranges from 0.5 on the low end to 2.0 on the upper end of the distribution. For the median state this balance sheet effect implies a 0.72 percent drop in employment at the two-year horizon in response to a 1 percent drop in house prices. This household balance sheet effect is more than twice as large as the estimated effect of house price shocks on employment during normal times. In addition, consistent with Mian and Sufi (2014), these coefficients imply substantially variation across states in the employment response to house price shocks. For states in the upper quartile of the mortgage to income distribution, this balance sheet response is four times larger than the implied response for states in the lower quartile of the mortgage to income distribution. Interestingly, the balance sheet effect does not become economically significant until five quarters after a shock and then builds from there. This is consistent with the observation that differences in non-construction employment across states occur with a significant delay following the decline in house prices.

The last row of Table 1 reports the estimated response to a shock to the financial excess bond premium. These are statistically significant and economically large. A one percent surprise increase in the excess financial bond premium implies a 3.6 percent drop in aggregate employment at the two-year horizon. These estimates are comparable to those obtained by Gilchrist and Zakrajsek (2012) using a standard VAR methodology to compute impulse responses.

Given the estimates from Table 1 we can now provide a measure of the relative contributions of each of the shocks to the behavior of aggregate employment over the Great Recession. We first construct measures of the aggregate house price shock μ_t as a population-weighted average of the individual state price shocks $\mu_{j,t}$. We then construct a measure of the aggregate leverage adjusted house price shock, $\mu_{b,t}$ as a population weighted average of the state level leverage adjusted shocks $(M_j / Y_j)\mu_{j,t}$. We can then decompose the movements in aggregate employment over the crisis period into the distinct contributions of the three aggregate shocks, μ_t, μ_{bt} and the financial shock ε_t.

To do the decomposition, we exploit the fact that house price shocks and financial shocks are serially uncorrelated. Let $\log\hat{E}_{p,t}$ be the component of employment due to house price shocks independent of balance sheet effects; $\log\hat{E}_{b,t}$ the part due to house price shocks operating through balance sheets; and $\log\hat{E}_{s,t}$ the part due to shocks to financial conditions. To obtain these components we construct the cumulative response to previous house price and financial shocks, as follows:

$$\log\hat{E}_{p,t} = \sum_h \beta_{p,h}\mu_{t-h}\,; \quad \hat{E}_{b,t} = \sum_h \beta_{b,h}\mu_{b,t-h}\,; \quad \log\hat{E}_{s,t} = \sum_h \beta_{s,h}\varepsilon_{t-h}$$

Figure 7 displays the cumulative contribution of each of these shocks to aggregate employment over the period 2007:Q1 to 2010:Q1 along with the realized path of aggregate employment (measured as a deviation from a linear trend). Aggregate employment fell by 9 percentage points relative to trend over this time period. The linear effect of house price shocks on aggregate employment is modest and implies a 1.7 percent decline in employment over this time period. In contrast, the household balance sheet effect estimated during the crisis is sizeable and implies a 4.1 percent decline in aggregate employment. The shock to the financial bond premium provides the largest effect however and explains a 5.7 percent decline in employment during this period. Notably, the shock to the financial bond premium that occurred during the 2008:Q3 Lehman collapse accounts for 3.5 percent of the overall employment contraction. In contrast, the Lehman collapse explains none of the decline in employment associated with house prices or household balance sheets. Thus although the direct effect of house prices on household balance sheets is an important component of the decline in aggregate output, our estimates imply that the recession would have been far milder in the absence of the financial turmoil that ensued.[11]

We conclude with two qualifications for this exercise. First, it is important to emphasize the reduced form nature of our exercise. It is easy to suggest other propagation mechanisms for a financial crisis. For example, the weakening of the economy in response to either a household balance sheet or financial market shock can give rise to tightening of financial constraints on non-financial firms. Indeed, in the previous section we presented some descriptive evidence suggesting that non-financial firms faced financial distress as the crisis wore on. The response of monetary policy will matter to the cumulative effect, and so on. What all this suggests is that a full accounting of how the financial crisis played out will require structural modeling.

Second, we identify orthogonal shocks to house prices and credit spreads by using a linear vector autoregression in conjunction with restrictions on their contemporaneous interaction. However, the financial excess bond premium plotted in Figures 4 and 5 shows large jumps, which likely reflect complex interactions with housing prices and their impact on the mortgage market. These may not be well-captured in a linear regression. We believe that the approach described here is a reasonable starting point,

[11] We note that our estimate of the effect of the financial shock on employment is conservative in the sense that we do not allow the shock to the financial excess bond premium to affect current house prices but do let the former affect the latter. Under the alternative extreme, where the bond premium shock affects current house prices but not the reverse, the financial shock explains a 6.4 percent employment decline while the leveraged adjusted house price shock accounts for 3.7 percent.

and that the household balance sheet shocks capture the main source of nonlinearity so that our identified credit spread shock reasonably identifies the effects of financial conditions on employment. Nonetheless incorporating nonlinearities explicitly in the estimation would be desirable. Again, this would likely involve a more structural approach.

Conclusion

Gaining a deeper understanding of the Great Recession is important, because the lessons that arise from that event will shape our perceptions of how the macroeconomy works, and sometimes doesn't work, for years to come. We have argued on theoretical and empirical grounds that financial distress in each of the three main sectors – households, financial intermediaries and non-financial firms – played a meaningful role in the evolution of the Great Recession. Our empirical exercise suggests that while the household balance sheet channel and the disruption of financial intermediation contributed significantly to the overall employment contraction, the recent recession would have been relatively mild without the disruption of financial intermediation.

Of course, understanding the Great Recession ultimately requires more than looking at the downturn. We also need a better understanding of the run up to the crisis and the slow recovery afterward. For example, purely fundamentals-based models have difficulty accounting for the boom and then subsequent bust in house prices. This opens up the possibility for a behavioral approach to explain how a wave of optimism turned to pessimism in housing markets, though a widely accepted approach along these lines has yet to materialize. For the slow recovery, we know from Reinhart and Rogoff (2009) that recoveries from financial crises are often much longer than normal. Although broad measures of financial stress suggest that financial markets normalized to a considerable extent by in 2009, there is some evidence that tightness in credit markets persisted for both households (Midrigan, Jones and Phillipon 2017) and small businesses (Chen, Hanson and Stein 2017). Accounting for the slow recovery, including the role of financial factors, is an important topic for future research.

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Table 1: Impulse Response from Local Projection

	Horizon									
	1	2	3	4	5	6	7	8	9	10
μ_{jt}	0.07 (0.04)	0.11 (0.05)	0.15 (0.06)	0.17 (0.07)	0.21 (0.08)	0.23 (0.09)	0.27 (0.10)	0.30 (0.12)	0.33 (0.13)	0.39 (0.15)
$\frac{M_j}{Y_j}\mu_{jt}$	-0.10 (0.09)	-0.08 (0.14)	0.03 (0.18)	0.18 (0.21)	0.38 (0.24)	0.55 (0.25)	0.68 (0.27)	0.72 (0.29)	0.72 (0.29)	0.70 (0.31)
ε_{jt}	-0.54 (0.07)	-1.14 (0.01)	-1.86 (0.12)	-2.46 (0.14)	-2.98 (0.15)	-3.48 (0.17)	-3.48 (0.18)	-3.61 (0.19)	-3.57 (0.19)	-3.62 (0.19)
Rsq	0.02	0.04	0.06	0.08	0.10	0.12	0.11	0.10	0.09	0.09

Note: Table 1 reports estimates of the effect of the three explanatory variables on employment growth that span 1 to 10 quarters. The estimation period is 1992Q2 to 2015Q4. The first row reports the estimated effect of a house price shock over the normal course of the business cycle. The second row reports the estimated effect of a house price shock interacted with the mortgage-to-income ratio during the crisis period. The third row reports the estimated effect of a shock to financial intermediation. (See text for details.) For all three explanatory variables, we also report the standard deviation of these estimates (in parentheses), along with the explanatory power of the regression, as measure by the R-squared at each horizon.

Figure 1: Sectoral Balance Sheets

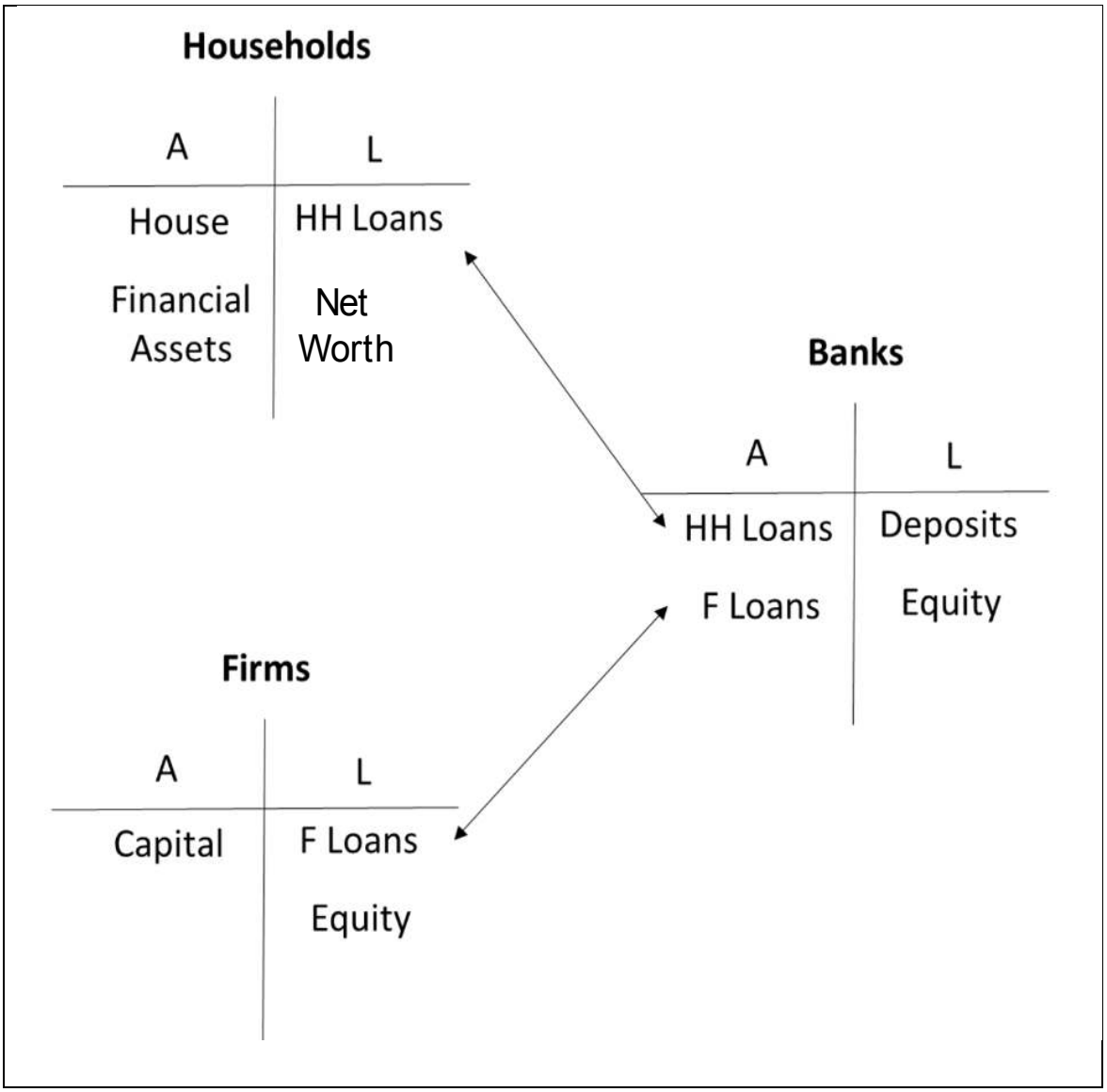
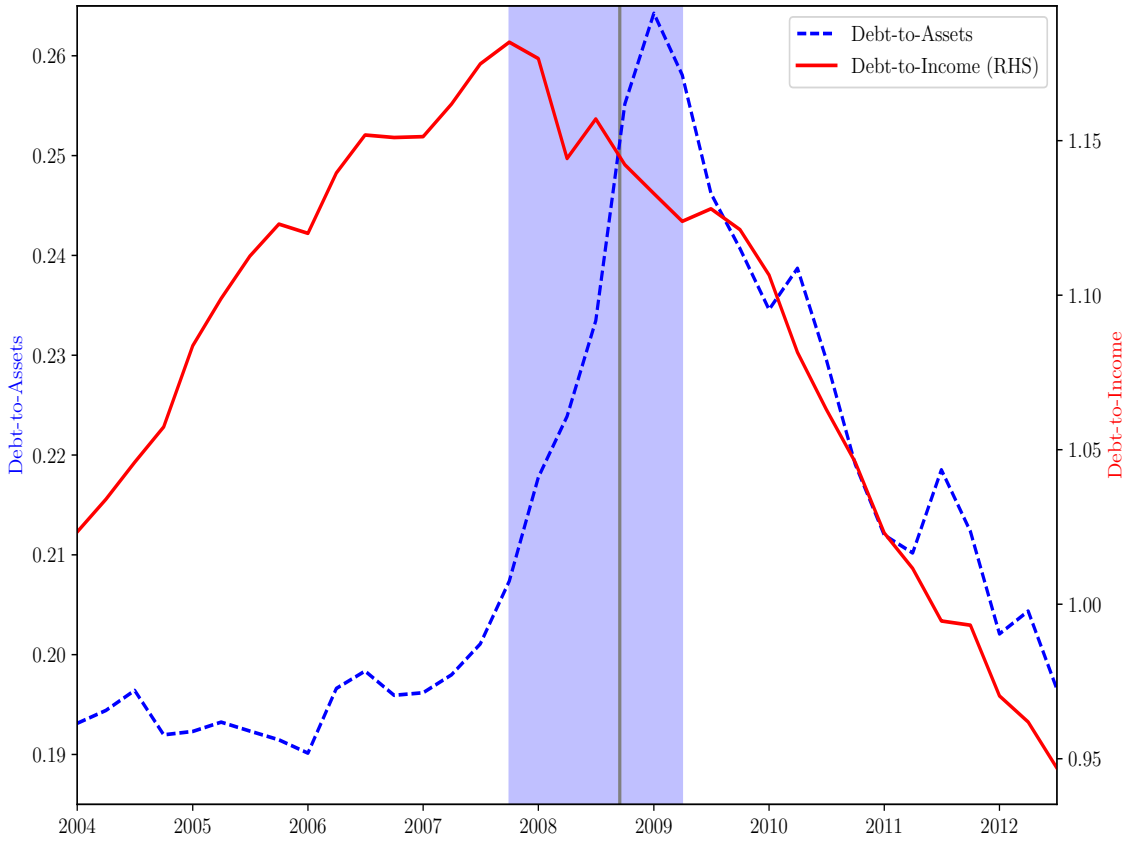
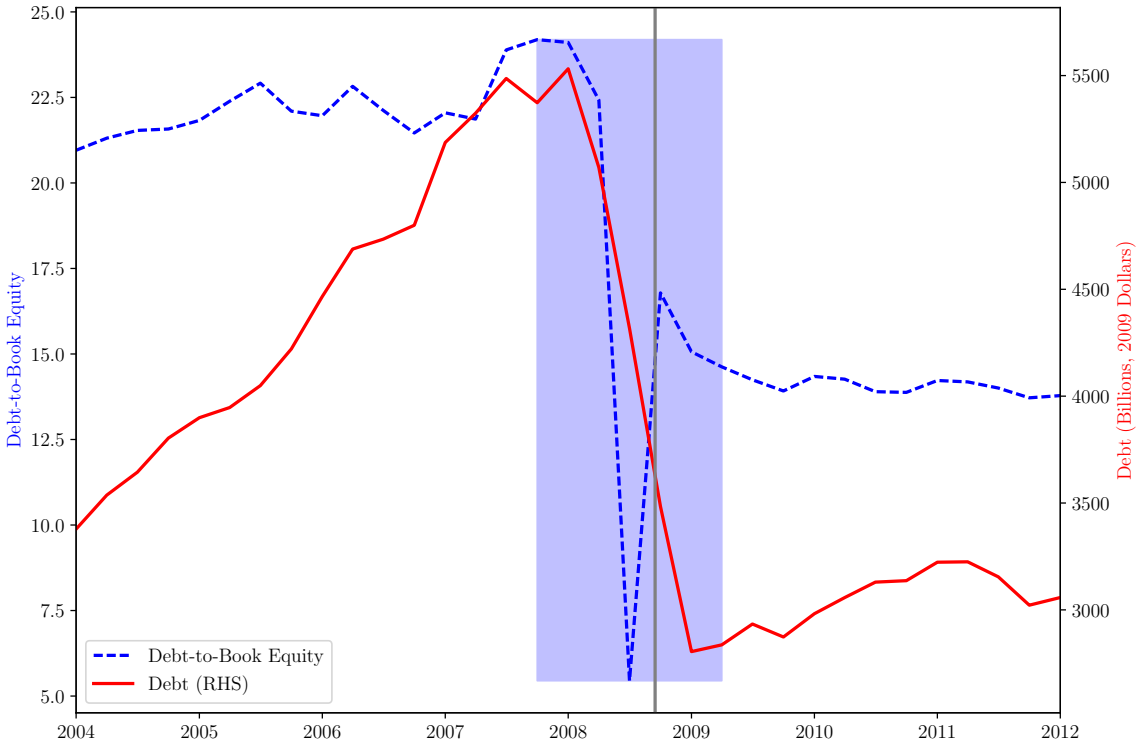


Figure 2: Debt/Income and Debt/Assets: Households.



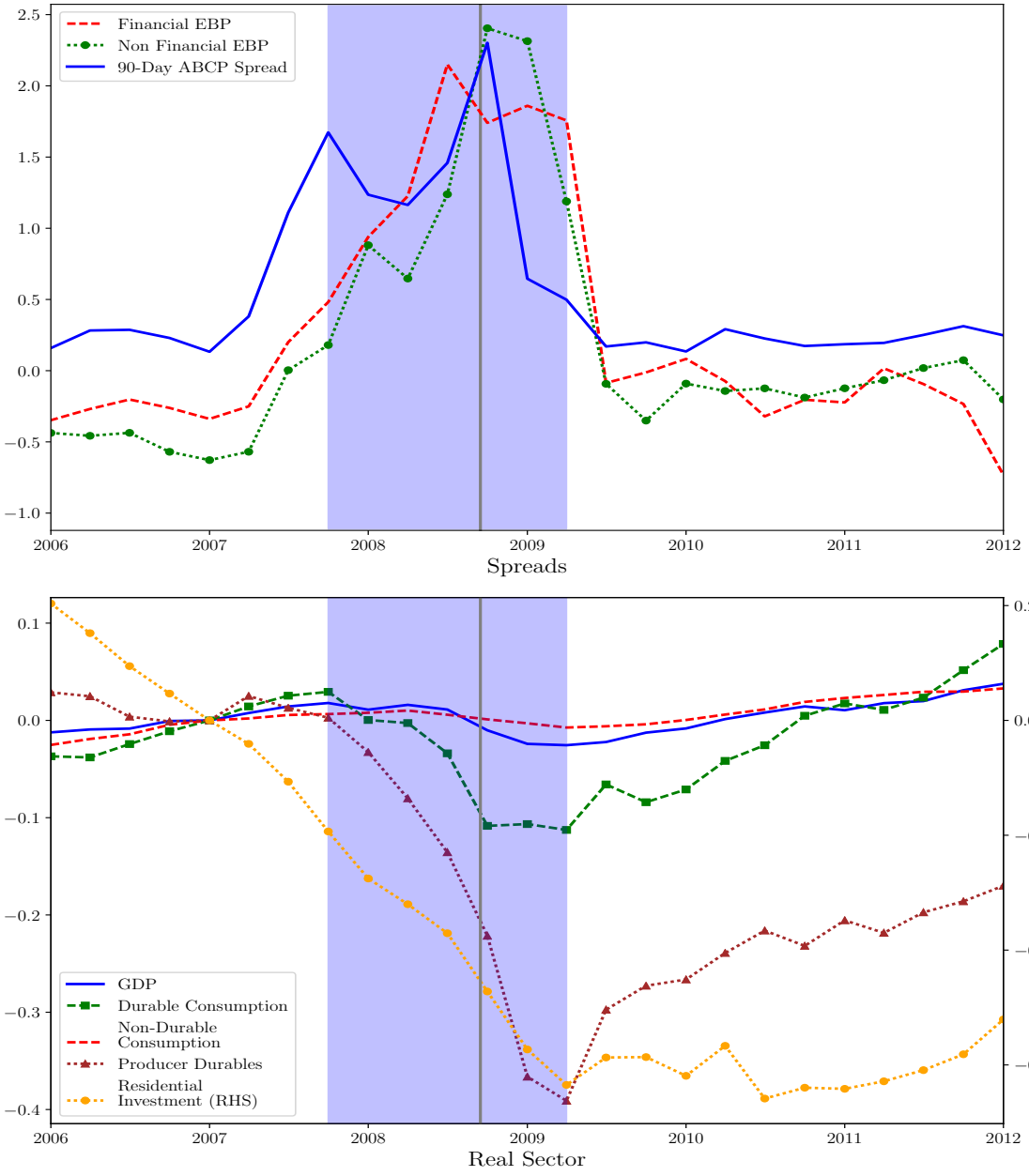
Note: Figure 2 portrays two measures of household leverage: the ratio of household debt-to-inocme (the solid line) and the ratio of household debt-to-assets (the dashed line) where the latter includes the market values of housing and financial wealth. The shaded area is the time from peak to trough of the Great Recession and the vertical line marks the Lehmann Brothers bankruptcy.

Figure 3: Debt/Income and Debt/Equity: Investment Banks.



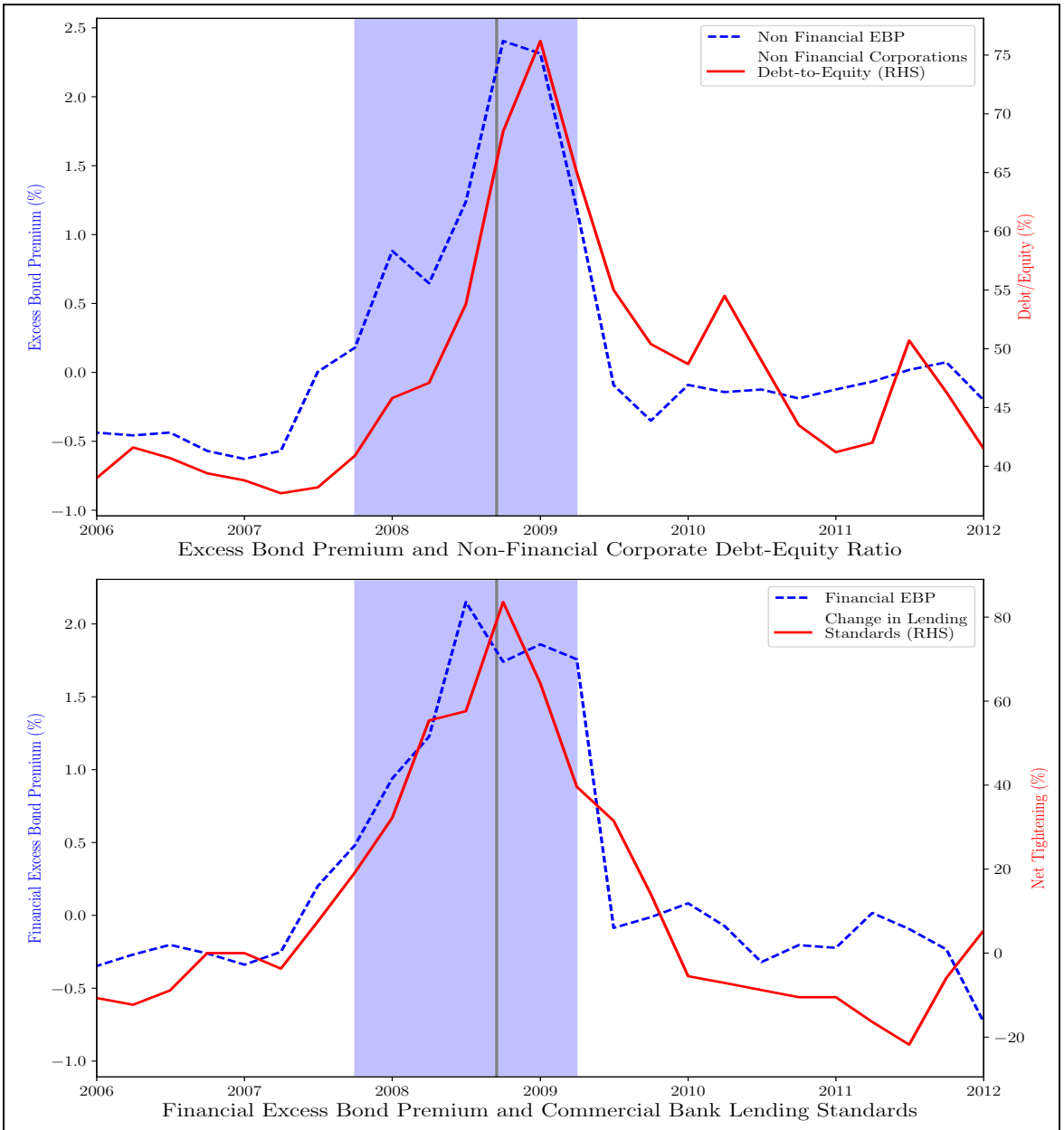
Note: Figure 3 displays the real value of debt outstanding (the solid line) and the ratio of debt to the book value of equity for publicly traded investment banks. The shaded area is the time from peak to trough of the Great Recession and the vertical line marks the Lehmann Brothers bankruptcy.

Figure 4: Credit Spreads and Economic Activity.



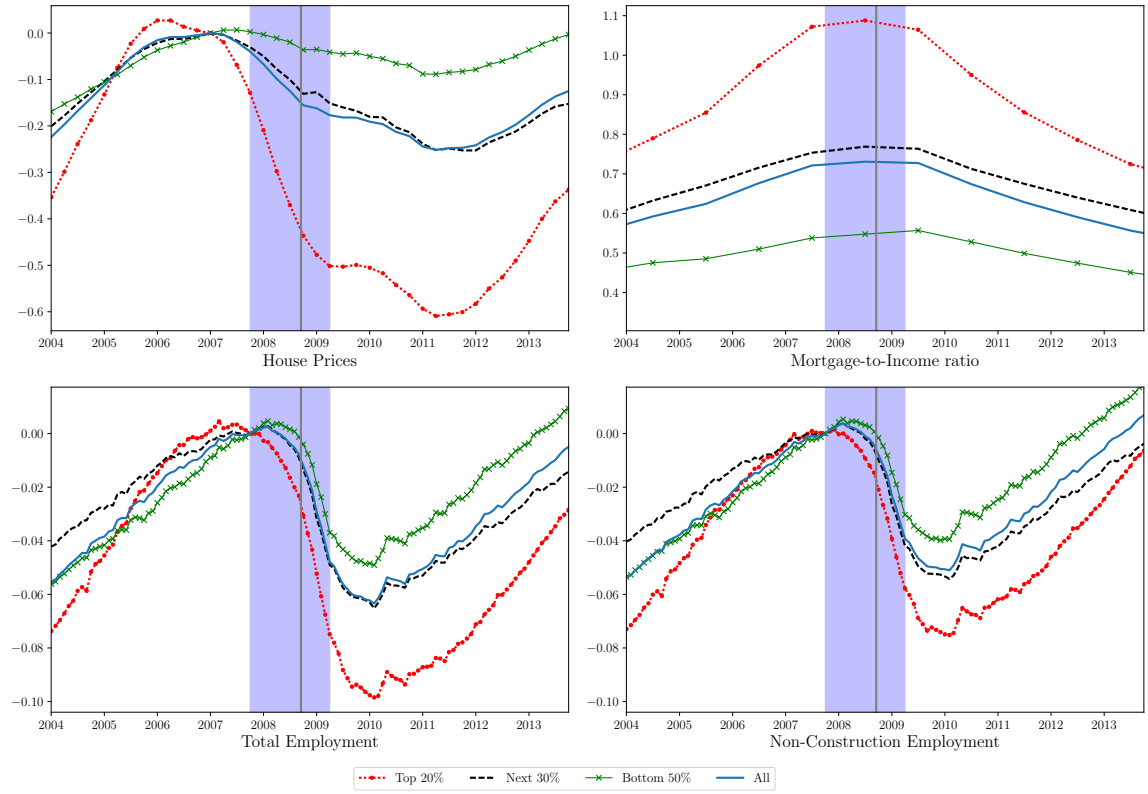
Note: The top panel of Figure 4 portrays the behavior of three credit spreads: the 90-day asset-backed commercial paper (ABCP) spread,; the Gilchrist and Zakrajsek (2012) excess bond premium (EBP) for non-financial companies; and the excess bond premium (EBP) for financial companies. In each case, the spread measures the annualized difference between the return on the security and the return on a government bond of similar maturity. The lower panel shows the accompanying behavior of the real sector, including GDP and four key components: residential investment, consumer durables, producer durables and nondurable consumption. (All variables in the lower panel are in logs and indexed to zero in 2007). The shaded area is the time from peak to trough of the Great Recession and the vertical line marks the Lehmann Brothers bankruptcy.

Figure 5: Financial Sector Distress and Non-Financial Firm Leverage.



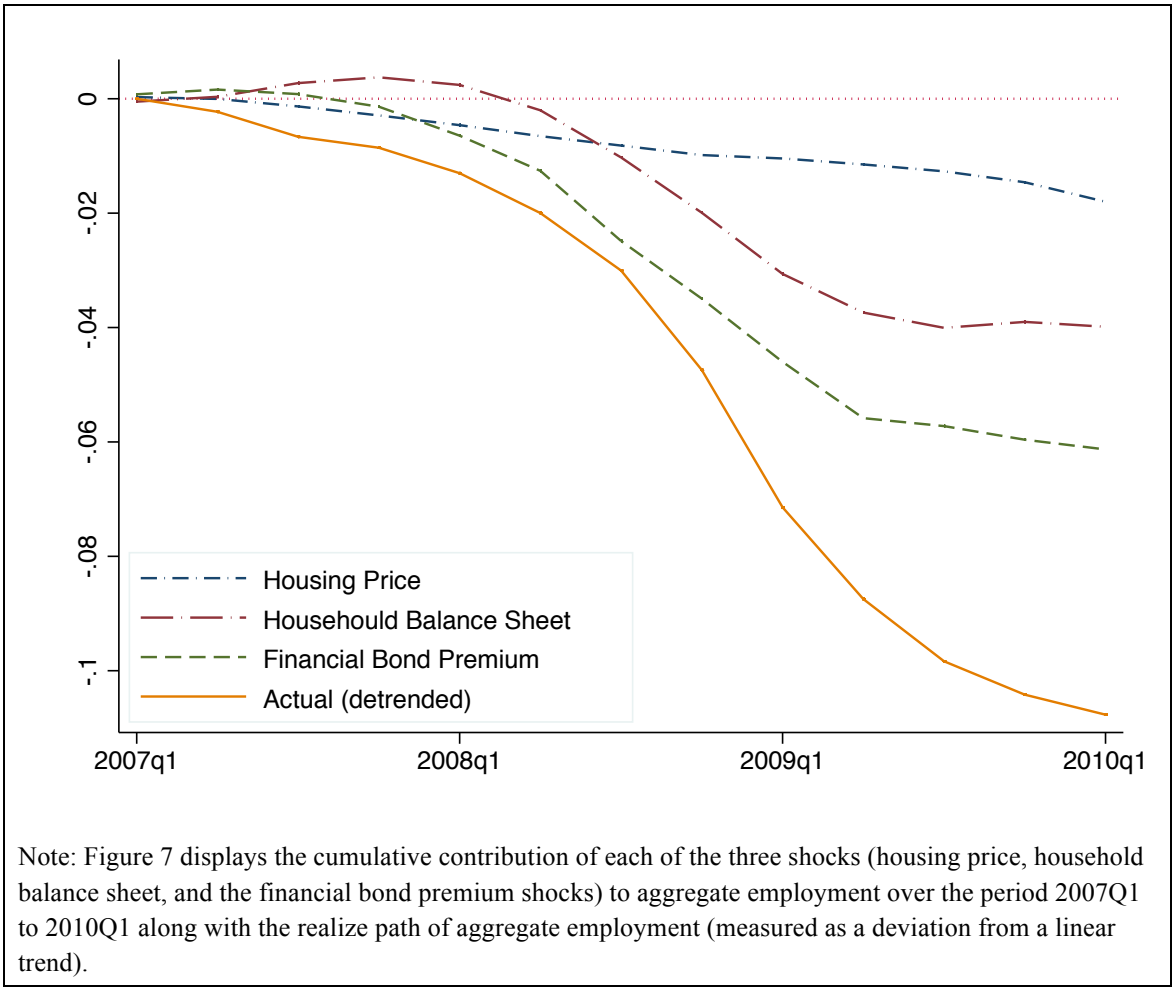
Note: The top panel of Figure 5 plots the debt/equity ratio of the nonfinancial corporate business sector alongside the Gilchrist/Zakrajsek excess bond premium for non-financial companies. The lower panel plots the excess bond premium for financial companies against the tightness of bank credit measured by the change in bank lending standards from the Senior Loan Officer Opinion Survey of Bank Lending Practices. The shaded area is the time from peak to trough of the Great Recession and the vertical line marks the Lehmann Brothers bankruptcy.

Figure 6: State-Level House Prices, Mortgage Debt, and Employment.



Note: Figure 6 portrays cross-sectional and time series variation of four variables: house prices, the mortgage-to-income ratio, employment and nonconstruction employment. The data is quarterly and covers the period from 2004-2014. House prices and the employment variables are plotted as percentage deviations from the peak. For each variable, we group states into three categories based on the severity of the house price contraction from 2006-2010. The first category experienced the largest house price drop and accounts for 20 percent of the population, the middle group accounts for 30 percent of the population, and the bottom group the remaining 50 percent. The solid line shows the aggregate behavior of each variable. The shaded area is the time from peak to trough of the Great Recession and the vertical line marks the Lehmann Brothers bankruptcy.

Figure 7: Employment Decomposition by Type of Shock.



Note: Figure 7 displays the cumulative contribution of each of the three shocks (housing price, household balance sheet, and the financial bond premium shocks) to aggregate employment over the period 2007Q1 to 2010Q1 along with the realize path of aggregate employment (measured as a deviation from a linear trend).

Appendix

We summarize data sources and details of the estimation behind Table 1 and Figure 7 in the text.

Debt-to-book equity and the level of debt for the investment banking sector are collected from Compustat. These are taken from all firms in the sub-industries that comprise the broad NAICS code 523, "Securities, Commodity Contracts, and Other Financial Investments and Related Activities". Total liabilities (Compustat code: LTQ), and total assets (Compustat code: ATQ) are summed across firms in the industry at each point in time. Aggregate book equity is then computed as assets less liabilities.

In terms of state-level data, house price data are a Purchase Only Index from the Federal Housing Authority. Mortgage data are from the New York Federal Reserve Bank/Equifax Consumer Credit Panel (note, this excludes HELOCs). Personal income data are from the Bureau of Economic Analysis Regional Accounts. Employment and population data are from the Bureau of Labor Statistics Employment and Unemployment reports. Employment data for the construction, retail, and manufacturing industries are obtained from FRED.

To construct cross-state averages displayed in Figure 6 we compute the house price depreciation for each state between 2006:Q3 and 2009:Q3. Quantiles of the price depreciation distribution are computed using population weights from 2009:Q3. For any given state-level variable, we then compute the cross-state average for states between the house price depreciation quantiles: 0-20 percent (largest depreciations, 20-50 percent (moderate depreciations), and 50-100 percent (smallest depreciations).

With the exception of state-level house prices and the excess financial bond premium all data relevant for the empirical analysis is available over the period 1990-2016. Data on state-level house prices begins in 1991:Q1. The excess financial bond premium is available up until 2012:Q3. Allowing for four lags in quarterly data, we therefore estimate the house price and financial excess bond premium equations using ordinary least squares over the period 1992:Q2-2012:Q3. The state house price regression is estimated as a pooled panel with state-level fixed effects. Observations are weighted using the state-level mean population over this period as weights. We construct shocks to house prices and the financial bond premium over these 82 time periods. At each horizon, we then estimate the local projection with a shifting sample of 82 time periods such that we may include all available shocks as right hand side variables. Thus for $h = 1$ the estimation period for the local projection is 1992:Q3-2012:Q4 whereas for $h = 8$ the estimation period is 1994:Q3-2014:Q4. These state-level equations are also estimated as a pooled least squares regression using the same population weights and allowing for state-level fixed effects. For $h > 1$ our local projection uses overlapping data which induces

serial correlation. Reported standard errors in Table 1 are computed by clustering at the state level and therefore are robust to arbitrary serial correlation over time. Finally, the employment data plotted in Figure 7 are detrended over the period 1990:Q2-2014:Q4.