What Happened:

Financial Factors in the Great Recession*

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1 Introduction

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 unable to anticipate the crisis nor analyze how the disruption of credit markets turned what initially appeared like a mild downturn into the Great Recession. But since that time there has been an explosion of both theoretical and empirical research aimed at identifying 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.

Much of the work theoretical work builds on the financial accelerator/credit cycle frameworks of Bernanke and Gertler (1989), Kiyotaki and Moore (1997) and Bernanke, Gertler and Gilchrist (1999). This work emphasizes the role of borrower balance sheets in constraining access to credit when capital markets are imperfect. 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. Accordingly many recent papers have introduced balance sheet constraints on households while others have done the same for banks.[1] 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. In addition the new literature also improves upon the way financial crises are modeled, capturing for example the nonlinear dimension of these crises, as we discuss.

At the same time there has been a surge in complementary empirical work. Much of this work makes use of cross-sectional variation to identify the role of financial factors. The pioneers in this area have been Mian and Sufi (2013, 2014). In a series of papers, these authors have used regional variation to identify how the weakening of household balance sheets precipitated by the house price decline contributed to the downturn.[2] Others have focused on banks. For example, Chowdorow-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 (e.g. Giroud and Mueller, 2017), again exploiting cross-sectional variation to attain identification.

[1] Examples of papers focusing on household balance sheets include Eggertsson and Krugman (2012), Justiniano, Primiceri and Tambalotti (2015), and Guerreri and Lorenzoni (2017). Examples focusing on banks include Gertler and Kiyotaki (2011), He and Krishnamurthy (2013), and Brunneremeier and Sannikov (2014).

[2] A few prominent examples of other papers in this vein are Kaplan and Violante (2017a) and Midrigan and Phillippon (2017), and Berger, Guerrieri, Lorenzoni and Vavre, forthcoming.

The rest of this paper is organized into three parts. The first part provides an informal description of the basic theory and concepts, including new developments. The second part then presents a description of the crisis through the lens of the theory. In this regard, the literature has been somewhat balkanized with some work focusing exclusively on the role of 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.

The third part presents 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. As in the literature we find evidence that the household balance sheet channel is important for regional variation in employment. However, while both factors are significant, we also find that the disruption in banking is more important to the overall employment contraction than is the decline in house prices operating through a balance sheet channel.

2 Background theory and basic concepts.

In this section we describe how contemporary macroeconomic models capture the interaction between the financial and real sectors.[3] Though the models differ in detail, they share several key features: The most central is the prediction that aggregate economic activity depends on the condition of borrower balance sheets. 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, in the recent crisis financial distress arose in all three sectors, though it originated in the household and banking sectors as we elaborate later.

We proceed to flesh out the basic theory of financial/real sector interactions and along the way describe a number of key concepts.

[3]For recent surveys, see Gertler and Kiyotaki (2011) and Brunnermeier and Sannikov (2015).

2.1 The external finance premium.

The connection between balance sheet strength and credit access arises when frictions are present that impede borrowing and lending. Absent these frictions the Miller/Modigliani theorem applies: Borrowers' financial positions are irrelevant to their respective real investment decisions. Intuitively, without some type of friction that limits arbitrage, competitive market forces will equalize risk-adjusted borrowing and lending rates. As a result, with perfect markets the cost of raising funds externally equals the opportunity cost of lending out internal funds. It follows that the cost of capital does not depend on whether external or internal funds are used, making the borrower's financial strength irrelevant to the real investment decision.[4]

A common way to endogenize financial market frictions is to introduce an agency problem between borrowers and lenders. There are two basic approaches. The first involves postulating some type of informational asymmetry that leads creditors to be more informed than borrowers. The second involves assuming that it is costly for creditors to enforce certain contractual commitments made by borrowers. In either scenario, a conflict of interest between borrowers and lenders emerges since the former potentially can gain at the expense of the latter by acting dishonestly. Rational lenders recognize the problem. They accordingly impose constraints on the terms of lending to ensure that borrowers act faithfully. The exact nature of these terms (e.g. credit limits, collateral requirements, bankruptcy contingencies, etc.) depends on the details of the agency problem. However, a general implication of this class of models is that the agency problem makes raising funds externally more expensive than using internal funds, what Bernanke and Gertler (1989) referred to as the "external finance" premium.

The exact form of the external finance problem depends on the details of the agency problem. In many instances it emerges 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 the borrowers are likely better informed about their credit-worthiness than are lenders. In cases where there may be 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 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. In this way it distorts real borrowing and spending decisions.

2.2 Balance sheets and the external finance premium.

With agency problems present, the Miller-Modigliani world no longer applies: Borrowers' financial positions affect real activity. The channel operates via the impact on the

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

external finance premium. In particular, an improvement in the borrower's balance sheet reduces the external finance premium. Intuitively, a stronger balance sheet enables the borrower to provide more collateral to guarantee the debt she issues or to self-finance a greater fraction of the investment. In either case, by being able to take a larger stake in the outcome of the investment, the borrower reduces the agency conflict with the lender. The external finance premium declines as a consequence. 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.

2.3 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). Many contemporary models of financial crises have evolved from this approach.[5]

With a sufficient deterioration of balance sheets, a full blown financial crises emerges as external finance premia rise to the point where borrowers are induced to curtail spending sharply. The combination of weak balance sheets and high external finance premia, further, is characteristic of major financial crises. A rough proxy for the external finance premium is the 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 current crisis as we show later. To the extent the widening of spreads reflect an increase in credit costs, one can see directly how the financial crisis spills over to real activity.

Finally, while the formalization of this theory of financial crises occurred in the modern literature, some of the ideas date back to a much earlier time. The most prominent example is Irving Fisher's debt-deflation theory of the Great Depression (Fisher, 1933). According to the theory, the weakening of borrower balance sheets stemming from the sharp price deflation during the early 1930s was a significant factor driving the Depression's depth and duration. The deflation weakened balance sheets because most debts were in nominal terms.

[5]See for example, Gertler and Karadi (2011), Eggertsson and Krugman (2012), Jerman and Quadrini (2012), Brunnermeier and Sannikov (2014), Christiano, Motto and Rostagno (2014), Arellano, Bai and Kehoe (2016), and Guerreri and Iacoviello (2017).

2.4 The role of leverage.

Highly relevant to the exposure of the economy to a financial crisis is the degree to which borrowers rely on debt. The higher the degree of leverage (i.e. 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 price will leave the former with a ten percent reduction in net worth, while the latter will be completely wiped out.

In the context of the recent recession, the high degree of exposure of the economy to the financial crisis was primarily due to the unprecedented rise in leverage in both the household and banking sectors sectors. The dramatic increase in housie prices and associated housing boom led to a huge increase in household leverage in the form mortgage debt. Intermediary leverage grew as both investment banks and commercial banks financed the increase in mortgage holdings with debt (mostly short term). By 2006, the financial positions of both households and banks were highly vulnerable to the decline in house prices that would soon follow. We elaborate below.

2.5 Nonlinear effects of financial crises

As many have argued, financial crises are highly nonlinear events (see, e.g., Krishnamurthy, Nagel and Orlov, 2014). They feature sharp increases in credit spreads and sharp contractions in asset prices and output. There is no symmetric movement in these variables during booms. Further, the sharp contraction of the economy during a financial crisis often occurs in the absence of an immediate large non-financial shock to the economy, as was the case recently for the U.S. economy following the Lehmann Brothers bankruptcy.

The earlier generation of financial accelerator models (e.g. 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 ways. For example Mendoza (2010) and He and Krishnamurhy (2015) introduce nonlinearity by allowing balance sheet constraints that bind only occasionally. During booms the constraints are slack. In this instance the economy behaves to a large extent as if the economy 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. A related approach is Brunnermeier and Sannikov (2015) who 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. As an example, 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 prices that strengthened them.

More recently, Gertler, Kiyotaki and Prestipino (GKP, 2017) develop a framework with bank runs as the key source of nonlinearity. As we discuss later, a key element of the crisis was a series of depositor runs that culminated in sudden collapse of the investment banking sector in October 2009. These runs took the form of self-fulfilling failures of lenders to roll over short term loans to investment banks and other financial institutions in the shadow banking sector. Within GKP, in normal times where banks have healthy balance sheets, there is no danger of a roll-over crisis: Lenders are confident that even if other creditors do not rollover, the bank will have sufficient 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.

The nonlinearity then works as follows. In normal times, disturbances (e.g. exogenous shocks to demand) buffet the economy but a financial crisis does not emerge since bank balance sheets are sufficiently healthy. A series of negative shocks, however, can move the economy into a crisis region where bank balance sheets are sufficiently weak to open up the possibility of a roll-over crisis. If the crisis occurs (which depends on the realization of a sunspot), the banking system collapses, sharply curtailing the flow of credit, generating a highly nonlinear rise in credit spreads and contraction in asset prices and output, just as the data suggests.

2.6 Interdependence of household, firm and bank balance sheets

Within any given sector, the balance sheets of borrowers within that sector are critical determinants of credit access. In analyzing the dynamics of a financial crises, however, it is critical to account for the interdependence of balance sheets across sectors.

The issue can be seen as follows. As a number of authors have emphasized, over the post-war period household debt, and mortgage debt in particular, typically surges prior to a financial crisis (e.g. Mian, Sufi and Verner (2017), Shularick, and Taylor, (2012). The origins of the Great Recession similarly involved a surge in mortgage lending. A decline in global long term interest rates beginning in the early 2000s in conjunction with a significant decline in lending standards led to a boom in house prices, housing construction and mortgages. As the house price boom began to reverse itself, household balance sheets weakened and the process accelerated as the pace of the price decline increased. These facts along with the slowdown in consumption growth motivated an important literature initiated by Mian and Sufi (2103, 2015) that investigated the role of the household balance sheets in the Great Recession.

The household sector in isolation however was only part of the story. As we noted above, the housing boom also increased financial vulnerability in the banking sector. Leverage in this sector increased rapidly as banks financed the increase in mortgage lending by issuing short term debt. Just as households became highly vulnerable to a

decline in house prices, so did the banking system, arguably even more so. The latter phenomenon is important because key to any financial crisis is the exposure of the banking system. The recent financial crisis was no exception. Banks (broadly defined) are a critical conduit of credit to all sectors. When banks 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.

Figure 1 illustrates the interconnection between household, firm and bank 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. Loans to households along with loans to firms are bank assets. 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.

The point of the figure is that it is misleading to analyze the balance sheet position of one sector of the economy independently of the others. As we have noted, the crisis was preceded by a rapid buildup of mortgages, which appear as household liabilities. But mortgages also appear on the asset side of bank balance sheets. Further, the lion's share of the growth in mortgages since the late 1990s was absorbed by the thinly capitalized and lighted regulated shadow banking sector. Indeed, securitized mortgage loans, more than any other type of asset, accounted for the huge expansion of shadow banking sector. Accordingly, while the mortgage boom increased the vulnerability of household balance sheets, it also significantly increased the fragility of the banking system. The subsequent collapse of the banking system in turn greatly impeded the flow of credit to both households and firms. Indeed as we discuss later, even though non-financial firms were in reasonably good shape at the start of the recession, the contraction of the banking sector reduced their access to credit as it also did for households.

2.7 Credit aggregates versus credit spreads

A central issue is how to measure the tightness of financial constraints. One approach is to examine the behavior of credit aggregates and then consider the forecasting power of these aggregates for real activity. A difficulty with this approach is that it does not disentangle whether demand or supply is driving the movement in these quantities. Consider the benchmark case of frictionless markets. 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. A corollary is that from the behavior of quantities alone, it is not possible to identify the component due to supply factors. By the latter we refer to the component due to variation in the tightness of financial constraints.

The theory we have presented implies that a natural measure of the tightness of financial constraints is the external finance premium. In periods of tight credit, this premium is large and vice-versa in periods where credit flows smoothly. As we have

discussed, the variation in credit spreads provides a reasonable proxy for the movement in the external finance premium. Indeed, a fairly robust feature of financial crises is highly elevated credit spreads.[6] We show later that this behavior of credit spreads was also a feature of the Great Recession.

We do not mean to suggest the behavior of credit aggregates is uninformative about financial conditions. What they tell us however is the degree of risk exposure of different sectors, as measured by the degree of leverage. What they do not tell us is how tight or loose financial constraints are.

2.8 The relevance of constraints on monetary policy

As a matter of both theory and empirics, 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 offset the effect of the crisis on the cost of credit by reducing interest rates. Conversely, when the hands of monetary policy are tied for one reason or another, the crisis is much more likely to spin out of control. This simple insight is consistent with the evidence. For example, for emerging market economies in the post war, 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 (e.g.,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 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 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 became a constraint on the monetary policies of the other major central banks, including the ECB, the Bank of England and the Bank of Japan. The latter of course had a much longer experience with the limits on monetary policy imposed by zero lower bound.

It is true that central banks led by the Federal Reserve introduced a variety of unconventional monetary policies designed in large part to circumvent the constraints the zero lower bound created. The most visible of these policies was large scale asset purchases (i.e. quantitative easing) which the Fed introduced after the peak of the crisis in early 2009. It is beyond the scope of this paper to go into detail; however, these unconventional monetary policy interventions are widely credited for helping mitigate the severity of the financial crisis.[7]

[6] See, for example,. Gilchrist and Zakrasjek (2012) and Muir and Krishnamurthy (2017).

[7] For a formal analysis of how unconventional monetary policy affects the economy, see Gertler and Karadi (2011) and Curdia and Woodford (2011).

3 The crisis through the lens of the theory

This section provides an overview of how the Great Recession unfolded.[8] We use the theory outlined in the previous section as an organizing framework to identify the role of financial factors. In particular, we identify how and when balance sheet constraints in each of the three sectors (households, banks and firms) become relevant.

3.1 Buildup of vulnerabilities

As we noted earlier, the prelude to the 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 general relaxation of lending standards, and widespread optimism about house prices. Also relevant were developments in mortgage finance. Increased securitization of mortgages permitted greater separation of the origination function of mortgage lending from the funding role. As a result, lightly regulated shadow banks began to displace commercial banks as the primary funders of mortgage related securities. An example is the rise of asset-backed commercial paper (ABCP) conduits which held securitized assets such as mortgages and car loans and funded these assets by issuing short term (e.g. thirty day) commercial paper. The cost of mortgage finance declined since the shadow banks did not face the same kinds of regulatory restrictions as commercial banks (e.g. capital requirements, etc.).

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 red line) and the ratio of household debt to assets (the dashed blue 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 twenty-five 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 stayed roughly constant until the start of the Great Recession.

The high absolute level of debt at the end of 2007 made households vulnerable to the sharp decline in asset values that would follow. Housing prices, which peaked at the end of 2006, declined more than twenty-five percent before hitting a trough. As a result, the aggregate household leverage ratio increased roughly twenty percent

[8]For much of the background material, we rely on the description of the crisis in Bernanke (2010, 2015), Gorton (2010), Adrian and Shin (2010) and Gertler, Kiyotaki and Prestipino (2016).

from early 2007 to the business cycle trough.[9] Underlying this aggregate behavior was considerable regional heterogeneity with states like California and Florida experiencing much sharper declines in house prices and increases in household leverage than the national average.

The deterioration of balance sheets provided a channel through which declining house prices affected household spending and in turn economic activity. Under perfect financial markets a drop in house prices does not induce a wealth effect on household spending: the decline in house prices is offset by the decline in the cost of housing.[10] With imperfect financial markets, the weakening of the household balance sheet due to the price decline reduces access to credit (e.g. home equity loans) along the lines of the theory described in the previous section. A vast literature initiated by the seminal work of Mian and Sufi (2013,2015) 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 later.

At the same time vulnerabilities in household balance sheets were materializing, strains on the financial system were emerging, leading to corresponding vulnerabilities in bank balance sheets. Particularly relevant was the exposure of the shadow banking sector, which ultimately was the main component of the financial system to unravel. As we noted earlier, the shadow banking sector accounted for most of the growth in mortgage funding in the pre-Great Recession period. Shadow banks grew from intermediating less than fifteen percent of credit in the early 1980s to roughly forty percent on the eve of the Great Recession, an amount on par with commercial banks (See, e.g., Gertler, Prestipino and Kiyotaki, 2015). Because these institutions, unlike commercial banks, were not subject to regulatory capital requirements, they funded the sharp increase in mortgage related securities mainly using short term debt. The net effect was a significant increase in the leverage of the banking sector.

Figure 3 provides information about the balance sheet behavior of publicly traded investment banks, a major component of the shadow banking sector. As the dotted blue line shows, from 2004 to the start of the Great Recession these institutions increased their real debt levels by more than fifty percent. This surge in indebtedness was, as we just noted, the consequence of financing the rapid expansion in securitized assets by borrowing in short term credit markets. Since they did not face regulatory capital requirements and since they generally received high marks from the ratings agencies on the mortgage related securities that they held, the investment banks tended to operate with much higher leverage ratios than did the commercial banks. As the red line in the figure shows, prior to the Lehmann Brothers collapse, investment banks operated

[9]The decline in stock prices also contributed to the rise in the household leverage ratio, though this occurred later in the recession, after the collapse of Lehmann.

[10]The argument assumes that the household continues to reside in the same neighborhood where house prices have declined.

at ratios of debt to book equity of between twenty and twenty-five percent, 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.

Along with an increase in the quantity of mortgage debt was 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. During this time the share of newly issued mortgages that could be classified a priori as risky rose to roughly forty percent, up from ten percent in 2002. The risky mortgages 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 both cases a general relaxation of lending standards help fuel the increase. Also complicating matters is that roughly thirty percent of newly issued mortgages were variable rate at a time when the Federal Reserve was in the midst of a tightening cycle, enhancing their overall risk.

3.2 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. Initially it was mortgage origination companies that experienced losses. But in July 2007, the investment bank Bear Stearns defaulted on two of its mutual funds that were exposed to mortgage risk. Then, in the event largely considered to mark the beginning of the crisis, the investment bank BNP suspended withdrawals from funds that also had mortgage exposure risk.

Concern then spread quickly about other financial institutions that might be funding securities with mortgage risk exposure, particularly those relying heavily on short term funding. An initial way this distress was transmitted to the real sector was via the disruption of the asset-backed commercial paper market.[11] As we noted earlier, 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 (e.g. money market funds) to either tighten the terms of credit or withdraw from the market completely. The net effect was a sharp contraction in the amount of credit-intermediated in this market: The value of asset-backed commercial paper outstanding fell from a peak of 1.2 trillion dollars in June 2007 to 800 billion by the following December.

[11] For descriptions of how turbulence in the commercial paper market emerged and how the disruption of this market may have influenced the real economy, see Kacperczyk and Schnabl (2010) and Covitz, Liang and Suarez (2013).

The contraction of asset-backed commercial paper market and how the effects of this contraction 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 ABCP issuers weakened their balance sheets and raised the cost of access to the commercial paper market. Rates on ABCP paper increased relative to similar maturity Treasury Bill rates and other terms of lending, such as collateral requirements, tightened as well. The increase in funding costs faced by ABCP issuers in turn raised the cost of credit for mortgages, auto loans and other types of borrowing that made use of securitized lending.

Overall, the collapse of the ABCP 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 ABCP funding. Benmelech, Meisenzahl and Ramacharan (2014), for example, present evidence that tightening of credit conditions in this market accounted for roughly a 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 along the lines of the theory sketched in the previous section. In addition, the end of the housing boom meant a sharp drop in residential investment. These factors along with the disruption of the ABCP market and other short term credit markets were sufficient to move the economy into recession at the end of 2007.

The Federal Reserve responded aggressively to the onset of the recession. It reduced interest rates, which as we noted earlier can help moderate a financial crisis. It also undertook a variety of new measures designed to improve the availability of short term credit which, as we just noted, was being curtailed due to mortgage related risks. 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 go to the window. 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. Finally, 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.

3.3 Collapse of the financial and real sectors

Through the summer of 2008 the economy continued to slow. But the 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 banks and not shadow banks and centered on commercial real estate and

not residential. In September of 2008, however, the second and most significant wave of financial distress hit.

Lehman 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 its was obtaining virtually all its funding. The Reserve Primary Fund, a large money market mutual fund which held commercial paper issued by Lehman, 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. But the distress spread to Lehman's main source of short term funding, the repo market where 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.[12] 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, as in Gertler and Kiyotaki (2015) and GKP (2017), 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.

Loans from the Federal Reserve were also a non-starter as Lehman could not offer sufficient collateral to justify a "lender-of-last resort" intervention by the central bank. The drying up of short term credit forced Lehman into default. Fearing similar vulnerability to short term credit conditions, the other major investment banks quickly merged with commercial banks in order to get the regulatory protection afforded to the latter.

Just as with the ABCP market, the contraction in investment banking impeded credit flows, placing further downward pressure on economic activity. Commercial banks absorbed a share of the assets funded by the investment banks. But they 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. Thus, much like a cancer, the financial crisis spread from the shadow banking sector which funded mainly securitized assets to the commercial banking sector, the most central conduit for credit in the economy. Now bank dependent borrowers, including many non-financial firms and households were facing increasing credit costs.

[12]See, for example, Krishnamurthy, Nagel and Orlov (2014).

The major disruption of financial intermediation following the Lehman bankruptcy 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 thirty day ABCP spread; the Gilchrist and Zakrajsek (GZ, 2012) excess bond premium for non-financial companies and the GZ excess bond premium for financial companies (EBPF).[13] The behavior of the spreads is consistent with the two waves of financial distress that we described. The ABCP spread increases roughly one hundred fifty 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 ABCP spread increased another one hundred basis points in response to the turmoil in the commercial paper market induced by the Lehman collapse. As the turbulence spread to both investment banks and commercial banks, the EBPF spread increased to more than one hundred fifty basis points in the wake of the Lehman collapse. Finally, as we discussed earlier, 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 EBP increased from roughly zero in early 2007 to two hundred seventy-five basis points at the time of the Lehman default.

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, before the Lehmann bankruptcy. Contributing to the initial slowdown is a sharp decline in residential investment as pessimism about future housing demand begins to grow. Financial factors also play a role. As we noted earlier, problems in the ABCP 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. Using cross-regional evidence, Mian 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 discussed earlier, Benmelech, Meisenzahl and Ramacharan (2017) showed that the disruption of the ABCP market also had a significant negative effect on the demand for cars.

[13]In each case the spread measures the difference between the return on the security and the return on a similar maturity government bond. The EBP 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 EBPF is constructed in an analogous manner for publicly-traded companies in the financial sector.

The economy turns from a mild to a major recession following the Lehman bankruptcy at the end of the third quarter of 2008. GDP begins a sharp contraction that lasts until the spring of 2009. As we discussed, the turmoil in shadow banking spread to commercial banking, leading to a large across the board increase in credit costs. The contraction featured a large decline in both consumer and producer durable goods demand. Consumer durables dropped roughly fifteen percent while producer durables dropped a whopping thirty five percent.

We have described how financial factors influenced the behavior of consumer durables. There is also evidence to suggest that they contributed significantly to the contraction in producer durables. It is true that entering the recession, non-financial firms were not directly financially vulnerable 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, two forces contributed to driving up the credit costs they faced. First, as the crisis unfolded, equity values dropped significantly, weakening firm balance sheets. Second, the increased strain on commercial banks made access to credit more difficult for non-financial firms, as we just discussed.

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, the credit spread varies positively with the leverage ratio, with the former at a peak at the time of the Lehman collapse and the latter at a trough.

The bottom panel, in turn, 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 senior loan officer survey of 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. The two series move closely together over the crisis, again consistent with the theory we presented earlier. As the financial excess bond premium increases, the fraction of banks reporting a tightening of credit terms also increases, with both series reaching a peak at the time of the Lehmann bankruptcy. Note also that during the Great Recession the survey shows an unusually high degree of tightening. The increase in the non-financial excess bond premium plotted in the top panel also mirrors the degree of tightening, 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 we noted earlier, Chowdorow-Reich (2015) and Chowdorow-Reich and Falato (2017) document that bank health affected the flow of credit to non-financial firms. Finally, Gilchrist et. al. (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 Lehman induced a massive policy response, including both monetary and fiscal policy. The Federal Reserve quickly reduce the short term interest rate to zero. It also pursued a variety of lender-of-last resort 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 rates on mortgage-backed securities fell fifty-basis points and dropped another hundred 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 two hundred and fifty 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 the spring of 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 of 2009.

As is well known, the recovery following the trough was quite slow. Exactly why is still a matter of debate and it is beyond the scope of this paper to investigate. It is worth noting the behavior of nondurable consumption which, unlike other post-war 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 (e.g. Midrigan and Phillipon, 2017) have suggested that the process of household deleveraging can help account for the slow rebound in consumption.

4 Digging deeper: evidence from state data

From our earlier discussion, a central issue is the relative contribution of the decline in house prices (operating through a household balance sheet channel) versus the disruption of financial intermediation to the overall contraction in economic activity. 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 effectively use this information to disentangle the relative contributions of house prices versus a measure of disruption of intermediation to the aggregate decline in employment. Our measure of intermediation disruption is the financial excess bond

premium described in the previous section.

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 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.[14] The first category experienced the largest house price drop. It includes the four "sand" states, Arizona, California, Florida and Nevada and accounts for 20% of the population. Our middle group contains 30% of the population and the bottom group the remaining 50%. Note that our middle group has the property that it closely mirrors aggregate behavior for each variable, where the latter is given by the solid line.

The cross-sectional patterns in the data are consistent with the evidence of the household balance sheet channel in Mian and Sufi (2015). The states experiencing the largest boom and bust in house prices are those that also had the largest run up in mortgage debt as the top two panels show. In turn, across categories there is a strong correlation between the severity of the house price decline and the corresponding employment contraction, as the bottom left panel illustrates.[15]

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 forty 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 seven and a half percentage points, implying that construction accounts for about two and a half 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 nonconstruction employment across regions despite considerable heterogeneity in house price dynamics. The regional differences emerge later as the recession unfolds. We elaborate on this point next.

[14]House price and the mortgage/income ratio are population-weighted. The employment measures are simple aggregates.

[15]As Mian and Sufi 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 (which is 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 catagories of states.

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.[16] This slowdown, however, lines up well with the unraveling of the ABCP market describe in section 3 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 Lehman 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 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 much more closely tied to economy wide indices of financial distress.

Disentangling the contribution of the household balance sheet channel versus general financial market conditions on employment presents a nontrivial challenge. To date, the two phenomenon 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 (e.g., Gilchrist and Zakrajsek, 2012) mainly employs time series methods. We propose a new methodology that combines these two approaches within a panel-data framework.

First, we use a panel-data vector autogression to identify "shocks" to state-level house prices and to our indicator of aggregate financial conditions. By shocks, we mean innovations (i.e. surprise movements) in these variables that are orthogonal to movements in employment and to each other. We then 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 to identify the balance sheet channel. Armed with the estimates of the effects of the various shocks, we then provide a historical decomposition that measures the relative contribution of the household balance sheet channel and the deterioration in overall financial conditions to the decline in aggregate employment that occurred over the 2007-2010 period.

Let s_t denote the financial excess bond premium at time t. As we noted in the previous section, s_t 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 disruption of credit intermediation. As we showed in Figure 4, s_t jumps during the ABCP paper crisis and even more dramatically during the Lehman fallout.

[16] As Figure 6 makes clear, the prerecession slowdown in total employment in the sand states was largely a product of the construction decline.

To identify shocks to the spread, we use conventional time series methods: We regress the financial bond premium s_t on four lags of itself and current and four lags of quarterly aggregate house price growth $\Delta logP_{t-i}$ and quarterly aggregate employment growth $\Delta logE_{t-i}$:

$$s_t = \sum_{i=1}^{4} \alpha_i^s s_{t-i} + \sum_{i=0}^{4} \gamma_i^s \Delta logP_{t-i} + \sum_{i=0}^{4} \omega_i^s \Delta logE_{t-i} + \varepsilon_t$$

The residual ε_t in this regression reflects movements in s_t that are orthogonal to lagged values of itself and also to current and lagged movements in $\Delta logP_t$ and $\Delta logE_t$. Further, one cannot reject that ε_t is serially uncorrelated.[17] Accordingly, ε_t provides our measure of the shock to s_t, i.e., the innovation to s_t 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 Lehman bankruptcy[18]. Note that to identify ε_t we impose the following timing restrictions: Given that financial markets react quickly to news, we assume that the financial excess bond premium responds immediately to current house price and current employment growth: hence the presence of $\Delta logP_t$ and $\Delta logE_t$ 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.[19]

Similarly, to obtain the shock in state-level house prices we regress the quarterly change in house prices $\Delta logP_{j,t}$ for each state j on four lags of itself, four lags of the financial bond premium and the current and four lagged values of state j's employment growth $\Delta logE_{j,t-i}$:

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

The residual in this equation $\mu_{j,t}$ provides our measure of shocks to house prices in state j.[20] An example of what could underlie this kind of shock is a spontaneous bursts of optimism or pessimism about future house price appreciation (e.g. Kaplan, Mitman and Violante, 2017b). As with ε_t, one cannot reject that $\mu_{j,t}$ is serially uncorrelated.

[17] The lagged variables in the regression capture the dynamic movement in s_t

[18] Our regression controls for linear effects of house prices on the spread. But it may be argued that the Lehman collapse and hence the jump in the credit spread was a highly nonlinear response to the decline in housing prices. However, as we discuss later, within our framework it is reasonable to treat the nonlinear component of the response of the spread as reflecting exogenous variation from the standpoint of identifying effects of the spread on employment.

[19] This kind of timing restriction is standard in the literature on identified vector autoregressions. We note though that our results are robust to alternative timing assumptions.

[20] This specification imposes common coefficients across states and over time. 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.

We next turn to estimating the effect of the orthogonalized shocks to house prices and the financial conditions indicator on state level employment growth. We do so in a way that permits isolating the household balance sheet channel from other ways that house prices could affect employment (e.g. via the impact on residential construction.) Let M_j/Y_j be the mortgage to income ratio in state j at the end of the house price boom, 2006:Q4, and let $Crisis = 1$ be an indicator variable that takes on a value of unity over the crisis period where house prices were declining, 2007:Q1-2009:Q4, and zero otherwise. Then we estimate the following relation for the h quarter ahead growth in employment in state $j, logE_{j,t+h} - logE_{j,t}$:

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

where $\epsilon_{j,h}$ is a state-specific fixed effect for horizon h and $\epsilon_{j,t,h}$ is the error term. Note that since the our identified shocks $\mu_{j,t}$ and ε_t are orthogonal to the error term, ordinary least squares gives consistent estimates of the coefficients.

We allow $logE_{j,t+h} - logE_{j,t}$ to depend on the shock to state-specific house prices and the aggregate shock to the financial excess bond premium, ε_t. In addition. over the crisis period we allow the effect of house price shocks to interact with the pre-crisis measure of mortgage indebtedness, M_j/Y_j. We refer to $(M_j/Y_j)\mu_{j,t}$ as the leverage adjusted house price shock. Analogous to Mian and Sufi (2009), the interactive term provides a way to identify the balance sheet channel. 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.[21]

Following Jorda (2005), we can use estimates of our equation over different horizons to construct measures of the response of employment to our identified shocks. Because in each case the shock in the equation is serially uncorrelated, we can use the coefficient estimate on the shock to measure the h horizon change in employment in response to the shock. As we show next, our estimates show non-trivial employment effects of both the leverage adjusted house price shock and the financial shock.

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.[22] 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 operated 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, they imply that a one percent surprise decrease in

[21] As Berger et. al. (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.

[22] The appendix provides further details on the exact sample and estimation method.

house prices leads to a 0.3 percent decrease in aggregate employment at the two-year horizon.

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 (2015), 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, μ_{bt} 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.[23] 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.[24]

We conclude with two qualifications of our analysis. First, it is important to emphasize the reduced form nature of our exercise. It is reasonable to argue that leverage adjusted house price shocks affect employment via a balance sheet channel and also that shocks to the financial excess bond premium capture the effect of disruption in intermediation. However, the cumulative effect on employment that each shock has depends on all the propagation mechanisms that are operative. For example, the weakening of the economy in response to either shock can give rise to tightening of financial constraints on non-financial firms. Indeed, in the previous section we presented some descriptive evidence suggestion that non-financial firms faced financial distress as the crisis wore on. Also relevant to the cumulative effect is the response of monetary policy, 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 the their contemporaneous interaction. In the case of the credit spread, some of the orthogonal variation we identify likely reflects a complex nonlinear response to the house price decline. As we discussed earlier, the 2007 decline in house prices contributed to an uptick in mortgage defaults which in turn unsettled the market for mortgage related securities, eventually leading to the collapse of the shadow banking system. The large jumps in the financial excess bond premium plotted in Figures 4 and 5 thus had their origins in the initial house price decline, but not in a way that could be captured in a linear regression. However, we can treat our identified shock to the spread as reflecting exogenous variation

[23] In addition to the fact that these estimates exclude a direct shock to employment, the non-linearity associated with the balance-sheet effect implies that the sum of these effects does not necessarily equal the realized aggregate decline in employment.

[24] 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 innovation in 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.

from the standpoint of identifying the effects of the spread on employment, so long as we have controlled for other channels through which house prices could have a nonlinear impact on employment. The literature has suggested the balance sheet channel is the main nonlinear alternative to financial market disruption. Our regression controls for this channel via the presence of the leverage adjusted house price shock. Accordingly, our identified credit spread shock reasonably identifies the effects of financial conditions on employment. Nonetheless incorporating nonlinearities explicitly in the estimation would be desirable. This would likely involve a more structural approach and is a task left for future research.

5 Conclusion

We have characterized how the recent financial crisis unfolded using recent developments in both theoretical and empirical research as a guide. A theme of our analysis is that financial distress in each of the three main sectors – households, financial intermediaries and non-financial firms – played a nontrivial role. We then presented some new evidence from a panel of quarterly state level data suggesting that while both the household balance sheet channel and the disruption of financial intermediation contributed significantly to the overall employment contraction, the latter was the dominant factor. Indeed, absent the disruption of intermediation, the recent recession would have been relatively mild. Of course our empirical analysis and well as much of the empirical analysis in the literature is reduced form. A more complete accounting of how the crisis played out will require structural modeling.

Finally, we need to better understand the run up to the crisis and also the slow recovery afterward. For example, as we discussed, the boom and then subsequent bust in house prices was pivotal in triggering the financial distress. Purely fundamentals-based models have difficulty accounting for these price dynamics. This opens up the possibility for a behavioral approach to explain the wave of optimism turned to pessimism in housing markets, though such a widely accepted approach has yet to materialize. Conversely, as we know from Reinhart and Rogoff (2009), recoveries from financial crises are often much longer than normal. As we discussed, after the TARP and stress tests in 2009, there was a considerable normalization of financial markets, if not quite a return to pre-crisis conditions. However, there is some evidence that tightness in credit markets persisted for both households and small businesses.[25] Accounting for the slow recovery, including the role of financial factors, is an important topic for future research.

[25]See Midrigan and Phillipon (2017) for evidence that household leverage may have contributed to the slow recovery in nondurable consumption and Chen, Hanson and Stein (2017) for evidence of persistent tightness in credit available to small businesses.

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Appendix

In this appendix we summarize data sources and details of the estimation.

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% (largest depreciations, 20-50% (moderate depreciations), and 50-100% (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.

Table 1: Impulse Response from Local Projection

Horizon	$p_{j,t}$	$\frac{M_j}{Y_j} p_{j,t}$	s_t	R^2
1	0.074	-0.099	-0.540	0.017
	(0.035)	(0.091)	(0.067)	
2	0.114	-0.077	-1.137	0.035
	(0.050)	(0.140)	(0.096)	
3	0.145	0.033	-1.861	0.061
	(0.060)	(0.181)	(0.115)	
4	0.171	0.183	-2.458	0.08
	(0.071)	(0.212)	(0.138)	
5	0.208	0.384	-2.984	0.102
	(0.080)	(0.239)	(0.153)	
6	0.232	0.548	-3.475	0.117
	(0.091)	(0.252)	(0.166)	
7	0.265	0.675	-3.482	0.110
	(0.102)	(0.272)	(0.182)	
8	0.295	0.721	-3.614	0.104
	(0.118)	(0.289)	(0.185)	
9	0.333	0.720	-3.566	0.092
	(0.129)	(0.291)	(0.186)	
10	0.387	0.700	-3.621	0.085
	(0.152)	(0.309)	(0.186)	

Figure 1: Sectoral Balance Sheets

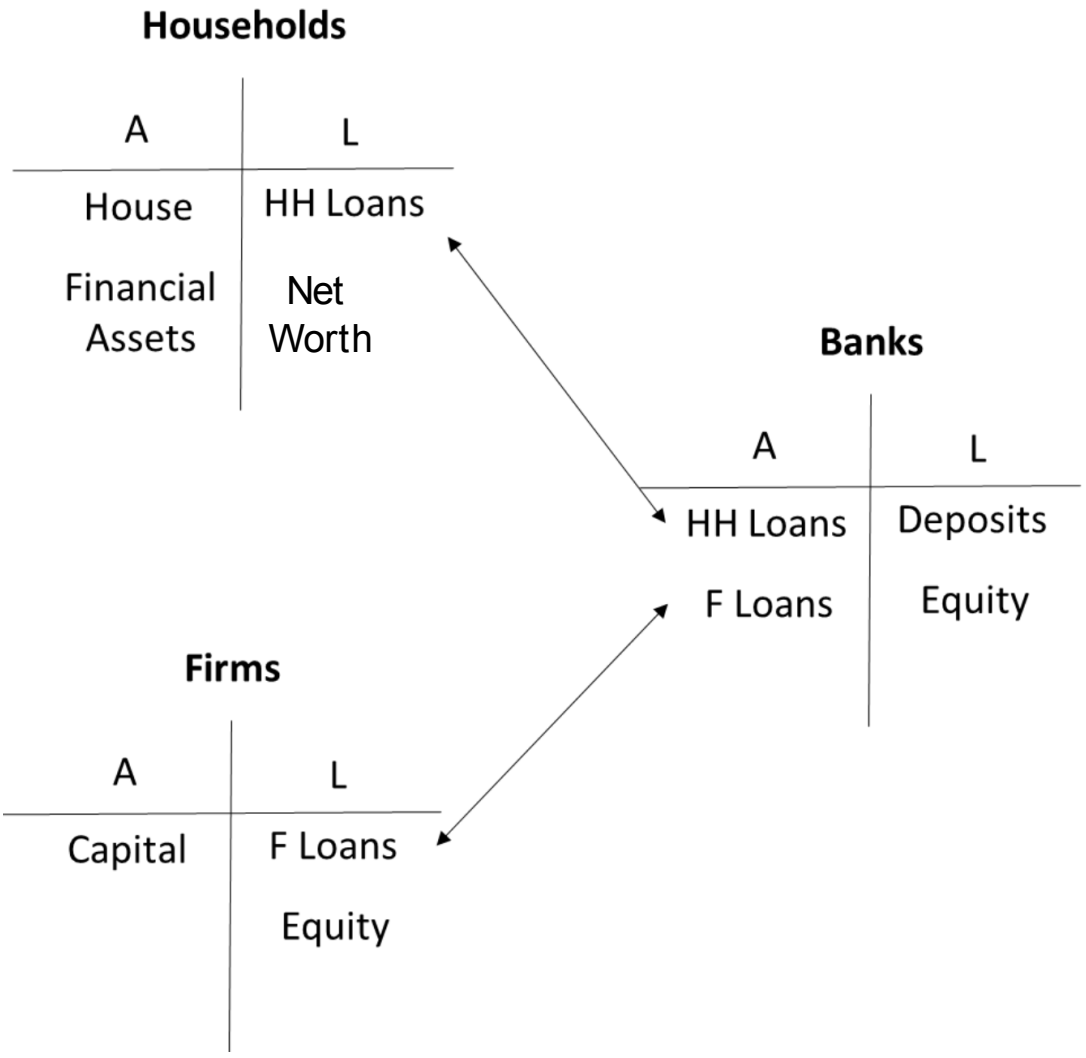


Figure 2: Debt/Income and Debt/Assets: Households

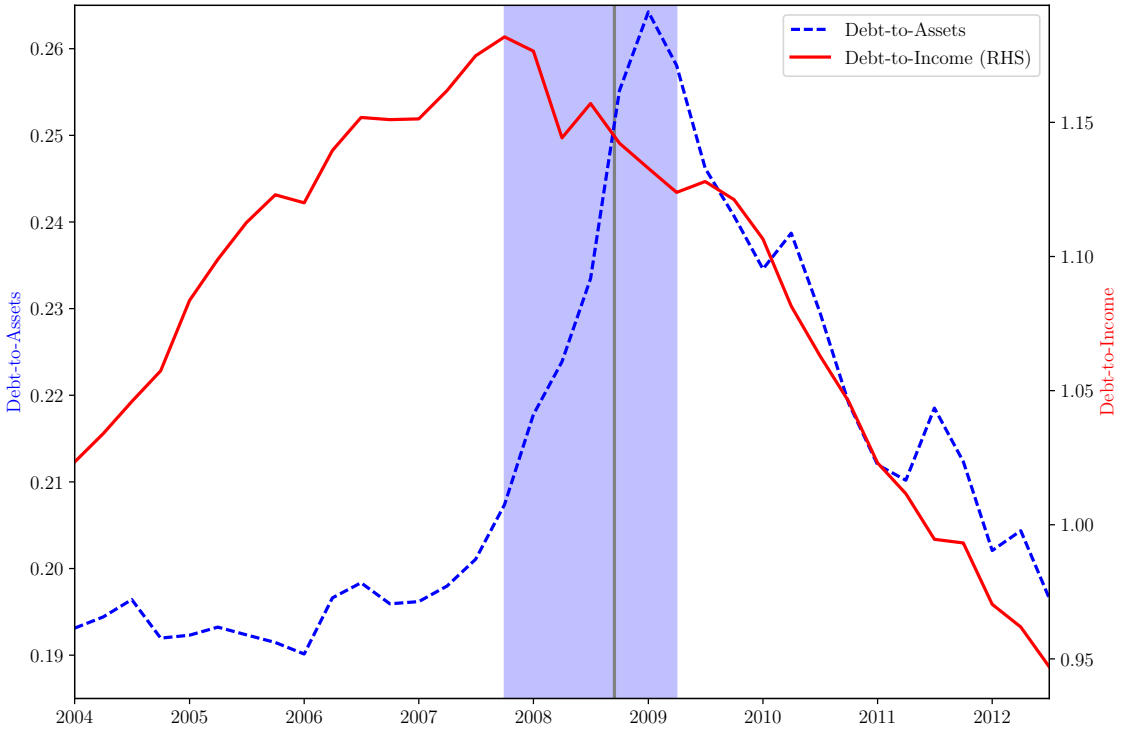


Figure 3: Debt and Debt/Equity: Investment Banks

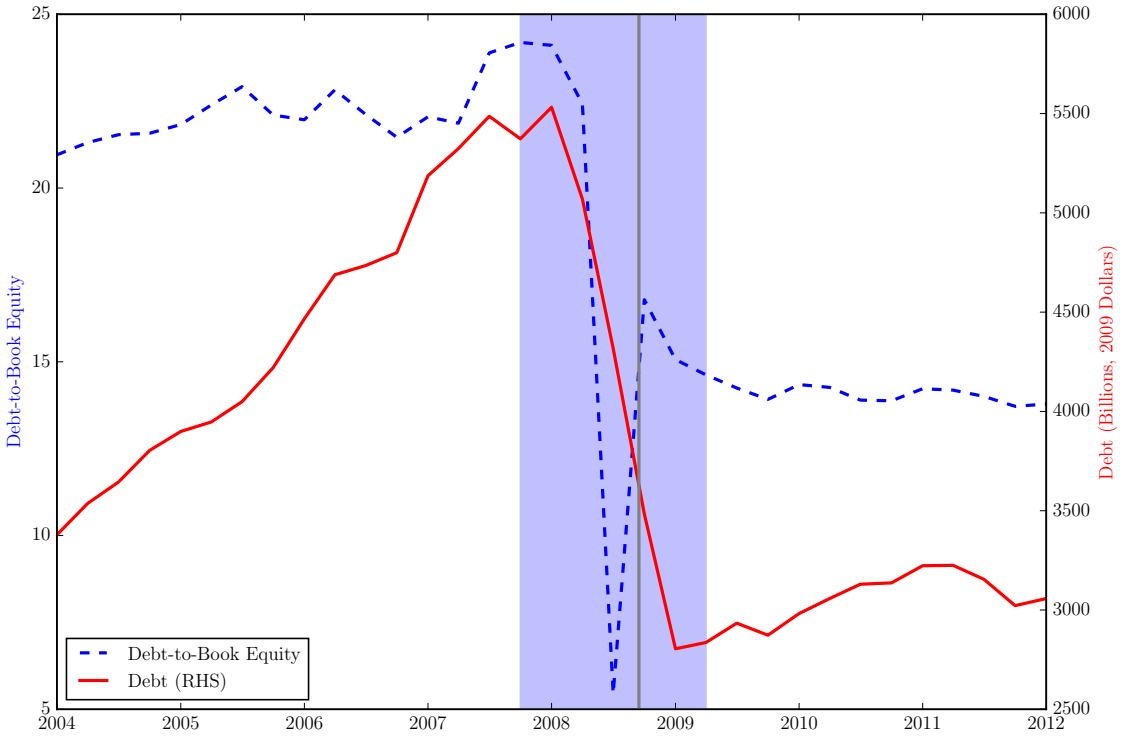


Figure 4: Credit Spreads and Economic Activity

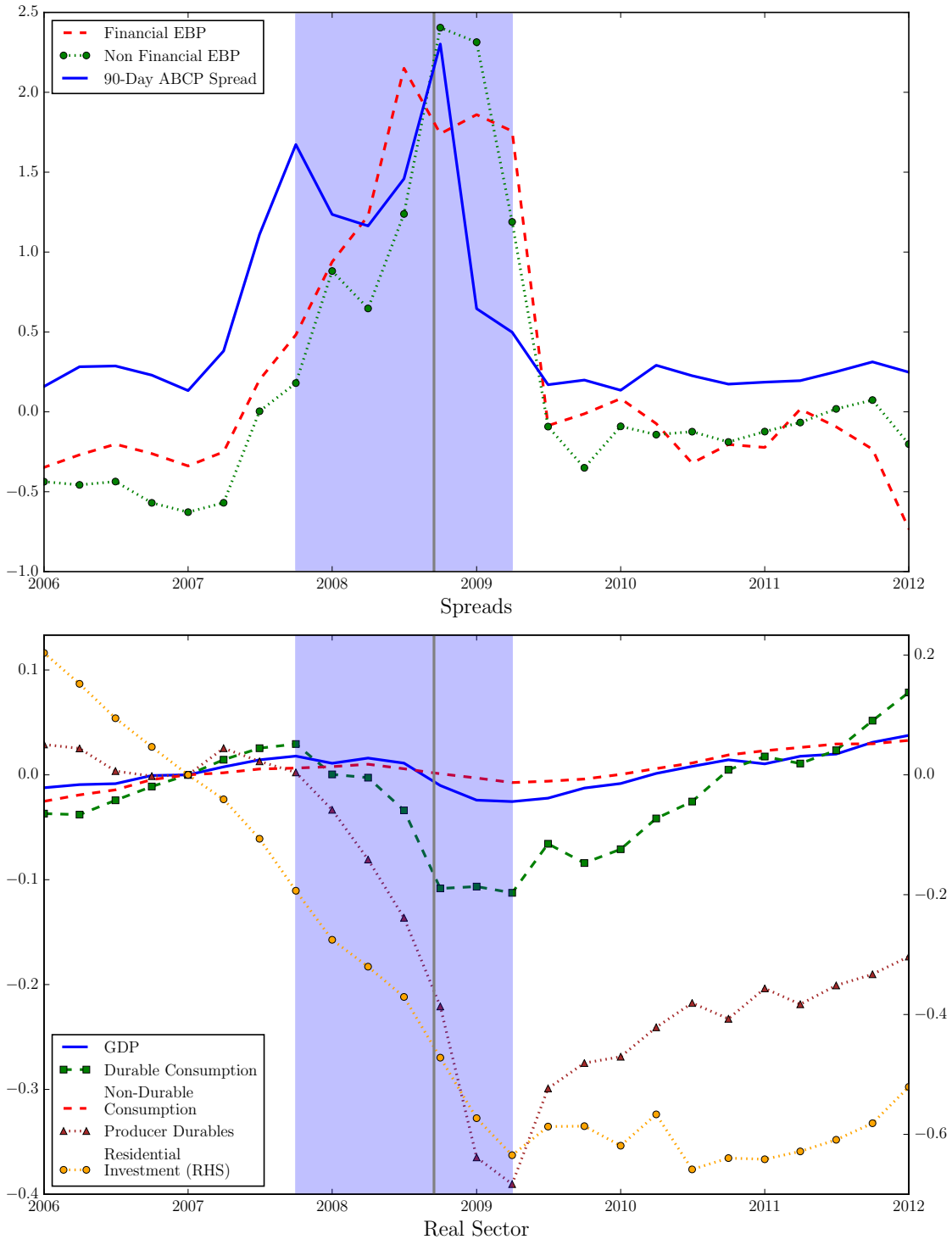
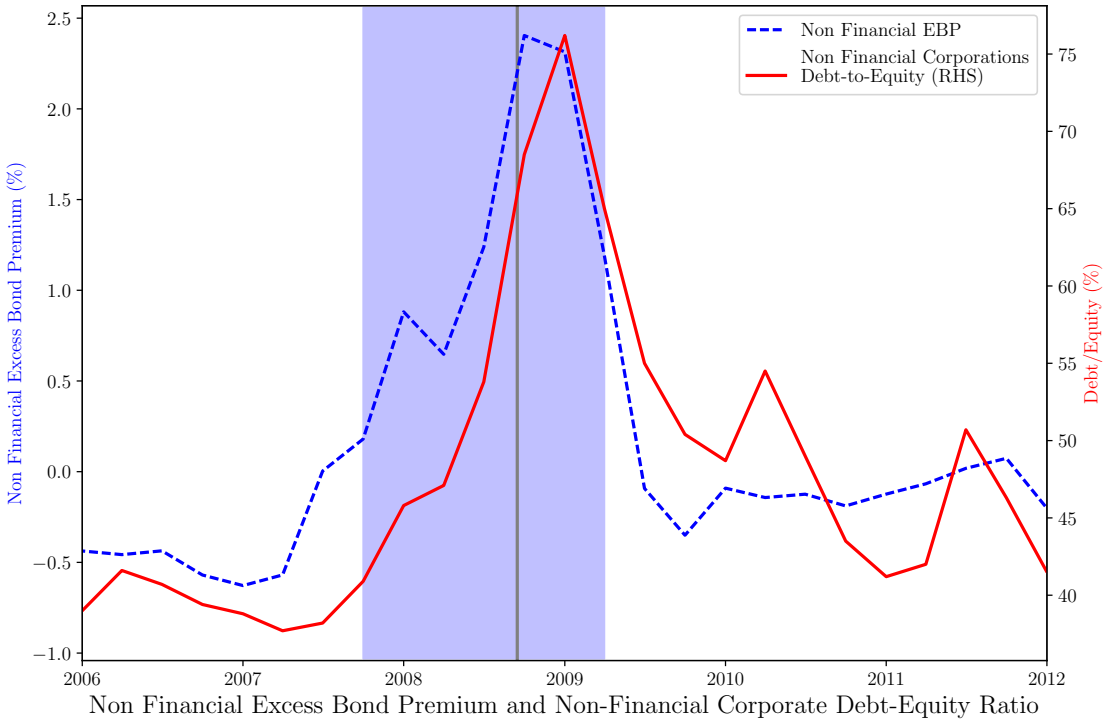


Figure 5: Credit Conditions Facing Non-Financial Firms



Non Financial Excess Bond Premium and Non-Financial Corporate Debt-Equity Ratio

Excess Bond Premium and Commercial Bank Lending Standards

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

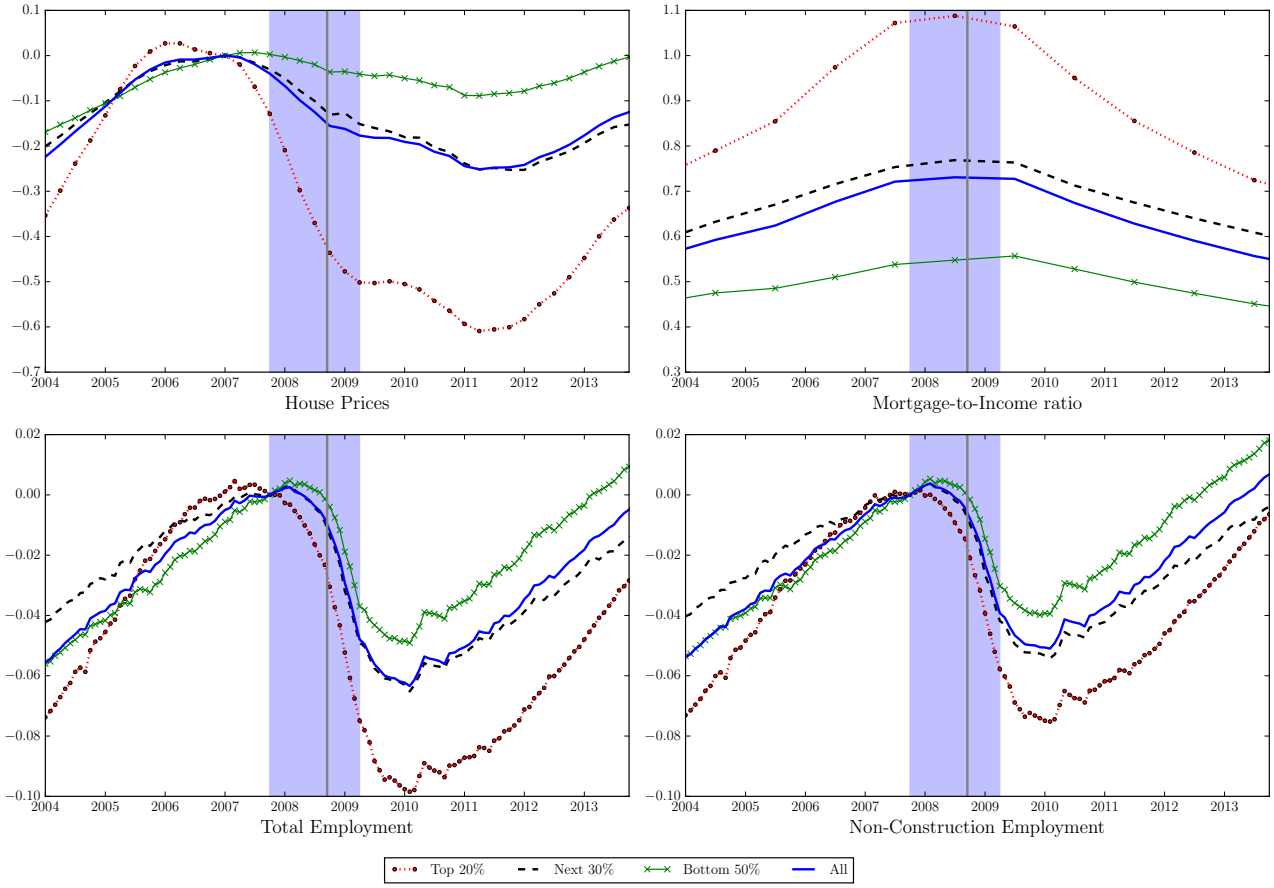


Figure 7: Employment Decomposition