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The Real Effects of the Financial Crisis

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The Real Effects of Disrupted Credit

Evidence from the Global Financial Crisis

Ben S. Bernanke[1]

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ABSTRACT   Economists both failed to predict the global financial crisis and underestimated its consequences for the broader economy. Focusing on the second of these failures, this paper makes two contributions. First, I review research since the crisis on the role of credit factors in the decisions of households, firms, and financial intermediaries and in macroeconomic modeling. This research provides broad support for the view that credit-market developments deserve greater attention from macroeconomists, not only for analyzing the economic effects of financial crises but in the study of ordinary business cycles as well. Second, I provide new evidence on the channels by which the recent financial crisis depressed economic activity in the United States. Although the deterioration of household balance sheets and the associated deleveraging likely contributed to the initial economic downturn and the slowness of the recovery, I find that the unusual severity of the Great Recession was due primarily to the panic in funding and securitization markets, which disrupted the supply of credit. This finding helps to justify the government's extraordinary efforts to stem the panic in order to avoid greater damage to the real economy.

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Introduction

The horrific financial crisis of a decade ago, and the deep recession that followed it, exposed two distinct failures of forecasting by economists and economic policymakers. First, although many economists (Greenspan, 2005; Rajan, 2005; Shiller, 2007) worried about low risk premiums, misaligned incentives for risk-taking, high house prices, and other excesses in the run-up to the crisis, the full nature and dimensions of the crisis, including its complex ramifications across markets, institutions, and countries, were not anticipated by the profession. Second, even as the severity of the financial crisis became evident, economists and policymakers significantly underestimated its ultimate impact on the real economy, as measured by indicators like GDP growth, consumption, investment, and employment.

Do these failures imply that we need to remake economics, particularly macroeconomics, from the ground up, as suggested in some quarters? Of course, it is essential that we understand what went wrong. However, I think the failure to anticipate the crisis itself and the underestimation of the crisis's real effects have somewhat different implications for economics as a field. As I argued in a speech some years ago (Bernanke, 2010), the occurrence of a massive, and largely unanticipated, financial crisis might best be understood as a failure of economic engineering and economic management, rather than of economic science. I meant by that that our fundamental understanding of financial panics—which, after all, have occurred periodically around the world for hundreds of years—was not significantly changed by recent events. (Indeed, the policy response to the crisis was importantly informed by the writings of nineteenth-century authors, notably Walter Bagehot.) Rather, we learned from the crisis that our financial regulatory system and private-sector risk-management techniques had not kept up with changes in our complex, opaque, and globally integrated financial markets; and, in particular, that we had not adequately identified or understood the risk that a classic financial panic could arise in a historically novel institutional setting. The unexpected collapse of a bridge should lead us to try to improve bridge design and inspection, rather than to rethink basic physics. By the same token, the response to our failure to predict or prevent the crisis should be to improve regulatory and risk-management systems—the economic engineering—rather than on reconstructing economics at a deep level.

However, the second shortcoming, the failure adequately to anticipate the economic *consequences* of the crisis, seems to me to have somewhat different, and more fundamental, implications for macroeconomics. To be sure, historical and international experience strongly suggested that long and deep recessions often follow severe financial crises (Reinhart and Rogoff, 2008). As a crisis-era policymaker, I was inclined by this evidence—as well as by my own academic research on the Great Depression (Bernanke, 1983) and on the role of credit-market frictions in macroeconomics (Bernanke and Gertler, 1995)—toward the view that the crisis posed serious risks to the broader economy. However, this general concern was not buttressed by much in the way of usable quantitative analyses. For example, as Kohn and Sack (2018) note in their recent study of crisis-era monetary policy, and as I discuss further below, Federal Reserve forecasts significantly under-predicted the rise in unemployment in 2009, even in scenarios designed to reflect extreme financial stress. This is not an indictment of the Fed staff, who well understood that they were in uncharted territory; indeed almost all forecasters at the time made similar errors. Unlike the failure to anticipate the crisis, the underestimation of the impact of the crisis on the broader economy seems to me to implicate basic macroeconomics and requires some significant rethinking of standard models.

Motivated by this observation, the focus of this paper is the relationship between credit-market disruptions and real economic outcomes. I have two somewhat related but ultimately distinct objectives. The first is to provide an overview of post-crisis research on the role of credit factors in economic behavior and economic analysis. There has indeed been an outpouring of such research. Much of the recent work has been at the microeconomic level, documenting the importance of credit and balance sheet factors for the decisions of households, firms, and financial institutions. The experience of the crisis has generated substantial impetus for this line of work, not just as motivation but also by providing what amounts to a natural experiment, allowing researchers to study the effects of a major credit shock on the behavior of economic agents. Moreover, as I discuss, the new empirical research at the microeconomic level has been complemented by innovative macro modeling, which has begun to provide the tools we need to assess the quantitative impact of disruptions to credit markets. Based on this brief review, I argue that the case for including credit factors in mainstream macroeconomic analysis has become quite strong, not only for understanding extreme episodes like the recent global crisis, but possibly for the analysis and for forecasting of more-ordinary fluctuations as well.

The second objective of the paper is to provide new evidence on the specific channels by which the recent crisis depressed economic activity in the United States. Why was the Great Recession so deep? (My focus here is on the severity of the initial downturn rather than the slowness of the recovery, although credit factors probably contributed to the latter as well as the former.) Broadly, various authors have suggested two channels of effect, each of which emphasizes a different aspect of credit-market disruptions. Aikman et al. (2018) describe these two sources of damage from the crisis as (1) fragilities in the financial system, including excessive risk-taking and reliance on "flighty" wholesale funding, which resulted in a financial panic and a credit crunch; and (2) a surge in household borrowing, of which the reversal, in combination with the collapse of housing prices, resulted in sharp deleveraging and depressed household spending.

In the former, "financial fragility" narrative, mortgage-related losses triggered a large-scale panic, including runs by wholesale funders and fire sales of credit-related assets, particularly securitized credit (Brunnermeier, 2009; Bernanke, 2012). The problems were particularly severe at broker-dealers and other nonbank credit providers, which had increased both their market shares and their leverage in the years leading up to the crisis. Like the classic financial panics of the nineteenth and early twentieth centuries, the recent panic—in wholesale funding markets, rather than in retail bank deposits—resulted in a scramble for liquidity and a devastating credit crunch. In this narrative, the dominant problems were on the supply side of the credit market; and the implied policy imperative was to end the panic and stabilize the financial system as quickly as possible, to restore more-normal credit provision.

The alternative, "household leverage" narrative focuses on the buildup of household debt, especially mortgage debt, during the housing boom of the early 2000s. This buildup reflected beliefs (on the part of both borrowers and lenders) that rapid increases in house prices would continue, which in turn promoted a loosening of credit standards, speculative home purchases ("flipping"), and the extraction of home equity through second mortgages. Given the large increase in leverage, the decline in house prices beginning in 2006 sharply reduced household wealth and put many homeowners into financial distress, leading to precipitate declines in consumer spending (Mian and Sufi, 2010). Relative to the financial fragility narrative, this approach emphasizes the decline in the effective demand for credit, rather than the effective supply. From a policy perspective, this narrative does not deny the necessity of restoring calm in financial markets, but it places relatively greater importance on policies aimed at stabilizing housing markets, modifying troubled mortgages, and helping consumers (Mian and Sufi, 2014a). To be sure, the two narratives are complementary, not mutually exclusive. For example, household leverage and mortgage delinquencies affected the financial health of lenders, increasing the risk of panic; while restrictions on the supply of credit lowered house prices and employment and ultimately affected household finances as well. But the two narratives do have somewhat different implications both for policy and for macroeconomic analysis, so assessing their relative importance is worthwhile.

Some recent work has compared the macroeconomic impacts of the two channels in the crisis, finding a significant role for each (Gertler and Gilchrist, 2018; Aikman et al., 2018). In the second part of the paper, I present some new evidence on this issue, comparing the real effects of the financial panic to those arising from deteriorating balance sheets, including household balance sheets. I proceed in two steps. First, I apply factor analysis to daily financial data to identify stages of the financial crisis, beginning with the loss of investor confidence in subprime mortgages, followed by the broad-based run on short-term funding, the panic in securitization markets, and the declining solvency of the banking system. Each of these stages involved disruptions to the operation of credit markets, and so should have had real consequences, as suggested by the research I review in the first portion of the paper. In the second step, I compare the ability of the estimated factors (which are orthogonal by construction) to forecast monthly macroeconomic indicators over the period 2006 through 2012. I find that the factors most strongly associated with the financial panic—the run on short-term funding and the panic in securitization markets—are also by far the best predictors of adverse economic changes in a range of macroeconomic indicators, and that ending the panic is likewise associated with relative economic improvement. The macroeconomic forecasting ability of factors associated with housing and mortgage quality is much more modest. As I discuss, these results do not rule out important effects through each of the identified channels, including channels linked to household balance sheets, but they do highlight the central role of the panic in setting off the Great Recession.

I draw several conclusions. For macroeconomists, recent experience and research highlight the need for greater attention to credit-related factors in modeling and forecasting the economy. Standard models used by central banks and other policymakers include basic financial prices, such as interest rates, stock prices, and exchange rates, but do not easily accommodate financial stresses of the sort seen in 2007-2009, including the evident disruption of credit markets. Plausibly, this omission explains why standard approaches seriously underestimated the economic impact of the crisis. Moreover, if variations in the efficiency of credit markets were important determinants of economic performance during the Great Recession, they may deserve greater attention in the analysis of "garden-variety" business cycles as well.

For policymakers, better understanding why financial stresses are economically costly could help inform efforts to prevent and respond to crises. In particular, the policy response to the financial crisis of 2007-2009 focused heavily on ending the financial panic and protecting the banking system, and it included some highly unpopular measures, including the bailouts of financial institutions with taxpayer funds. The rationale that policymakers gave for their apparent favoritism to the financial industry—despite its culpability in many of the problems that gave rise to the crisis in the first place—was that stabilizing Wall Street was necessary to prevent an even more devastating blow to Main Street. The results of this paper support that rationale. More generally, the results support reforms that improve the resilience of the financial system to future bouts of instability, and that increase the capacity of policymakers to respond effectively to panics, even if such reforms involve some costs in terms of credit extension or growth.

Although some of the empirical studies I discuss bear on the international transmission of the crisis, the focus of this paper is on the experience of the United States. Extending the analysis to other countries and considering aspects of the crisis more prominent outside the U.S., such as sovereign debt problems, are important directions for future research.

I. Credit markets and the external finance premium

The first objective of this paper is to review recent research on the real effects of credit-market disruptions and to discuss some implications for macroeconomics. As background, I begin with some simple theory. The key economic concept to be developed is the existence of an external finance premium, which may vary over time and depends on the financial health of both borrowers and lenders.

The starting point is the familiar observation that the process of credit extension is rife with problems of asymmetric information between borrowers and lenders. Potential lenders are only imperfectly informed about the characteristics of borrowers, including their skills and trustworthiness; nor can they easily observe borrowers' investment opportunities or effort levels. Asymmetric information in the borrower-lender relationship implies that the extension of credit involves costs above those of funding, including the costs of screening and monitoring by the lender and the deadweight losses arising from adverse selection or principal-agent problems. Moreover, even a fully informed lender may face costs of transmitting and verifying its information about borrowers to third parties, forcing the lender to bear liquidity risk and idiosyncratic return risk. These various costs contribute to the existence of a transaction-specific *external finance premium*, or EFP, the difference between the all-in cost of borrowing and the return to safe, liquid assets like Treasury securities.

In much of economics (in corporate finance, for example), the assumption of asymmetric information and theoretical frameworks (principal-agent models, incomplete contracting) based on that assumption are central to the analysis of credit relationships. In macroeconomics, mainstream analyses have paid less attention to these ideas. Certainly, to be relevant to macroeconomics, the external finance premiums associated with diverse transactions must have an aggregate or common component that is quantitatively significant, varies over time, and is linked to broad economic conditions. I will use the term *credit factors* to refer to economic variables that affect the aggregate component of the external finance premium, in contrast to broader financial factors such as the levels of equity prices and interest rates.

What affects the external finance premium? The EFP depends, *inter alia*, on the financial health (broadly defined) of both potential borrowers and financial intermediaries.

Borrowers. On the borrowers' side, the key intuition is that problems of asymmetric information are less severe when potential borrowers have "skin in the game," that is, when they have sufficient net worth, equity, or collateral at risk to align their incentives with the goals of lenders and to reduce lender's exposure to losses. For example, a large down payment by a homebuyer not only protects the lender from price declines, it also reduces the lender's need to investigate the borrower's income prospects in detail and incentivizes the borrower to maintain the home properly. Thus, a borrower who can make a substantial down payment can expect easier access to credit and terms that are more favorable. Likewise, an entrepreneur able to contribute substantial equity to her startup is more likely to obtain outside financing and will face fewer intrusions on her business decision-making by lenders.

In a macroeconomic setting, aggregate descriptors of the average financial health of borrowers (net worth, collateral, leverage) are state variables that, at least in principle, can affect the economy-wide component of the EFP and, consequently, macroeconomic dynamics. In the *financial accelerator* model of Bernanke and Gertler (1989), endogenous deterioration of the net worth of borrowers in an economic downturn, and improvements in an upturn, make the aggregate EFP countercyclical. The endogenous variation in the EFP in turn increases the responsiveness of the economy to exogenous shocks. Kiyotaki and Moore (1997) and Geanakoplos (2010) describe related mechanisms.

Lenders. The EFP can also be affected by the financial health of lenders. Financial intermediaries ("banks") are institutions that specialize in reducing the costs of making loans. Bank employees acquire both general lending skills and specific knowledge about particular industries, firms, communities, or individual borrowers. Complementarities in the provision of financial services—for example, a bank has more information about a potential borrower who also holds checking and savings accounts with the bank—further reduce the costs of lending. Banking organizations, by holding many illiquid loans, may also achieve greater diversification of lending risks.

Although banks serve to reduce the net cost of lending, banks are themselves borrowers as well, in that they must raise funds from the ultimate savers in order to finance their loans. Consequently, the financial health of banks also matters for the external finance premium. For example, if banks suffer loan losses in an economic downturn, the depletion of capital will reduce their ability to attract funding, on the margin. Weakened banks will become choosier in their lending, raising the aggregate EFP and reinforcing the financial accelerator mechanism. (Loss of bank capital won't deter government-insured depositors, but it may lead the deposit insurance agency, acting on behalf of at-risk taxpayers, to insist on tighter lending standards.)

Woodford (2010) discusses, in the context of a simple macro model, how reductions in bank capital and thus the effective supply of intermediary services can depress the economy. Similarly, because liquid assets facilitate lending and risk-taking, increased cost or reduced availability of funding (due to tighter monetary policy, for example) also reduces the supply of bank credit. This is a variant of the so-called bank-lending channel of monetary policy; see Drechsler, Savov, and Schnabl (2018).[2]

Panics. The simple balance-sheet perspective is also useful for understanding the real effects of financial panics, i.e., systemwide runs on banks or other credit intermediaries.

Generally, panics may arise in situations in which longer-term, illiquid assets are financed by very short-term liabilities, e.g., bank loans financed by demand deposits. A large literature has examined why such financing patterns persist and why panics sometimes erupt. In the classic work by Diamond and Dybvig (1983), these arrangements allow society to marshal the necessary resources for long-term investment while simultaneously allowing individual savers to insure against unexpected liquidity needs. The benefits of this setup must be weighed against the possibility of Pareto-inferior, self-fulfilling ("sunspot") panics. In contrast, Calomiris and Kahn (1991) see short-term financing as a mechanism for lenders to discipline borrowers. In their framework, a run or panic is simply investors exercising their prerogative of withdrawing funding from borrowers in whom they have lost confidence.

An approach which seems particularly useful for understanding the recent crisis, and which fits nicely with the idea of a variable external finance premium, comes from Gary Gorton and coauthors (Gorton and Pennachi, 1990; Dang, Gorton, and Holmstrom, 2015). In the Gorton setup, intermediaries meet a substantial part of their financing needs by issuing "information-insensitive" liabilities, that is, liabilities structured in a way that makes their value constant over almost all states of the world. Besides demand deposits, examples of information-insensitive liabilities in modern finance include short-term, over-collateralized loans (e.g., many repo

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[2] Early work on the bank lending channel includes Kashyap, Stein, and Wilcox (1993) and Van den Heuvel (2002). Gertler and Karadi (2011) interpret unconventional monetary policies, like quantitative easing, as a means by which the central bank can partially offset the decline in commercial banks' lending capacity in a downturn.

agreements), asset-backed commercial paper, shares in low-risk money-market mutual funds, and the most senior tranches of securities constructed from diverse underlying credits.

From the perspective of ultimate investors, the advantage of information-insensitive liabilities is that they can be held without incurring the costs of evaluating the individual credits that back those claims—a task at which most investors are at a comparative disadvantage—and without concern about principal-agent problems, adverse selection, and other costs that often arise in lender-borrower relationships. Moreover, information-insensitive liabilities will tend to be liquid, because potential buyers likewise do not have to incur high costs of evaluating them or worry about adverse selection among sellers. Consequently, investors who face unpredictable needs for liquidity (as in Diamond-Dybvig's setup) will benefit from holding such claims. Investor risk and transaction costs are reduced further when the information-insensitive liabilities have short maturities, since rather than selling the assets when liquidity is needed, investors can simply stop rolling over their claims as they mature. From the issuer's point of view, the benefit of information-insensitive liabilities is their lower required yield and their attractiveness to broad classes of investors. Much of the financial innovation of the pre-crisis period reflected issuer efforts to create information-insensitive liabilities from risky underlying assets.[3]

Panics emerge in this setup when, as the result of unexpected events or news, investors begin to worry that the intermediary liabilities are not money-good, that is, their liabilities are no longer information-insensitive. Investors continuing to hold these claims face the unattractive alternatives of either making independent evaluations of the underlying credits—which they are not well equipped to do—or bearing the costs of uncertainty, illiquidity, and adverse selection. If the claims are contractually short-term in nature, many investors will decide not to roll them over, resulting in a panic.

Panics raise the aggregate external finance premium because they can result in a violent disintermediation, which overturns the normally efficient division of labor in credit extension. In

[3] Hanson and Sunderam (2013) provide a model of this process, arguing that, because of informational externalities, information-insensitive securities are over-issued in good times. Caballero, Farhi, and Gourinchas (2017) discuss the global "shortage" of safe assets, which motivates financial engineers to create such assets. Sunderam (2015) discusses the creation of safe assets through shadow banking. Relatedly, Peek and Rosengren (2016) discuss the evolution of financial markets in recent decades, pointing out that many of the changes increased the dependence of the system on "runnable" wholesale funding.

normal times, banks and other intermediaries make loans, manage existing credits, and hold most of the credit risk on their balance sheets. In a panic, intermediaries lose their funding, and as a result (assuming the funding can't be replaced), they must dispose of existing loans and stop making new ones. The resulting "fire sales" of existing loans depress prices to the point that they can be voluntarily held by the subset of savers who are most able to evaluate and manage those assets, or who have the greatest tolerance for illiquidity (Shleifer and Vishny, 2010). Because these asset-holders are not specialists at making and monitoring loans, and because they are satiated with risky credits in the disintermediated equilibrium, the cost of new credit—the external finance premium—spikes during a panic (Gertler and Kiyotaki, 2015). Increases in the EFP can help to explain the adverse macroeconomic effects of financial crises (Bernanke, 1983; Reinhart and Rogoff, 2008).[4]

Panic-type phenomena occurred in a variety of contexts in the recent crisis.[5] The most intense pressures were felt in the so-called shadow banking system, which experienced runs on asset-backed commercial paper (Covitz, Liang, and Suarez, 2009; Kaperczyk and Schnabl (2010); Schroth et al., 2014); structured investment vehicles and other conduits (Gorton, 2008); securities lending (Keane, 2013); and money market funds (McCabe, 2010). Of particular concern were funding pressures in the critical market for repurchase agreements, or repos, used heavily by broker-dealers and others to finance credit holdings. The repo market is dichotomized into two major components: triparty repo, intermediated by two large clearing banks, and the bilateral market, involving direct borrowing and lending among broker-dealers and other participants. The triparty market experienced less overt panic during the crisis, except, crucially, when borrowers like Bear Stearns and Lehman were close to the brink of failure (Copeland, Martin, and Walker, 2010). [6] The bilateral market, in contrast, appears to have suffered runs on multiple dimensions, including not only refusals to roll over loans, but also a

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[4] A secondary effect of the sharp increases in risk-aversion and liquidity preference is that normal relationships among asset prices break down, as arbitrage capital declines (Krishnamurthy, 2010).

[5] Bao, David, and Han (2015) provide comprehensive time series of "runnable" liabilities. They calculate that, during the financial crisis, runnable liabilities fell from about 80 percent of nominal GDP to about 60 percent.

[6] Concerns also arose in the triparty market that the intermediating banks would refuse to accept the credit risk during the daily period in which repo funding is rolled over. The failure of one or both of the banks to accept that exposure would have been equivalent to a massive run on repo borrowers.

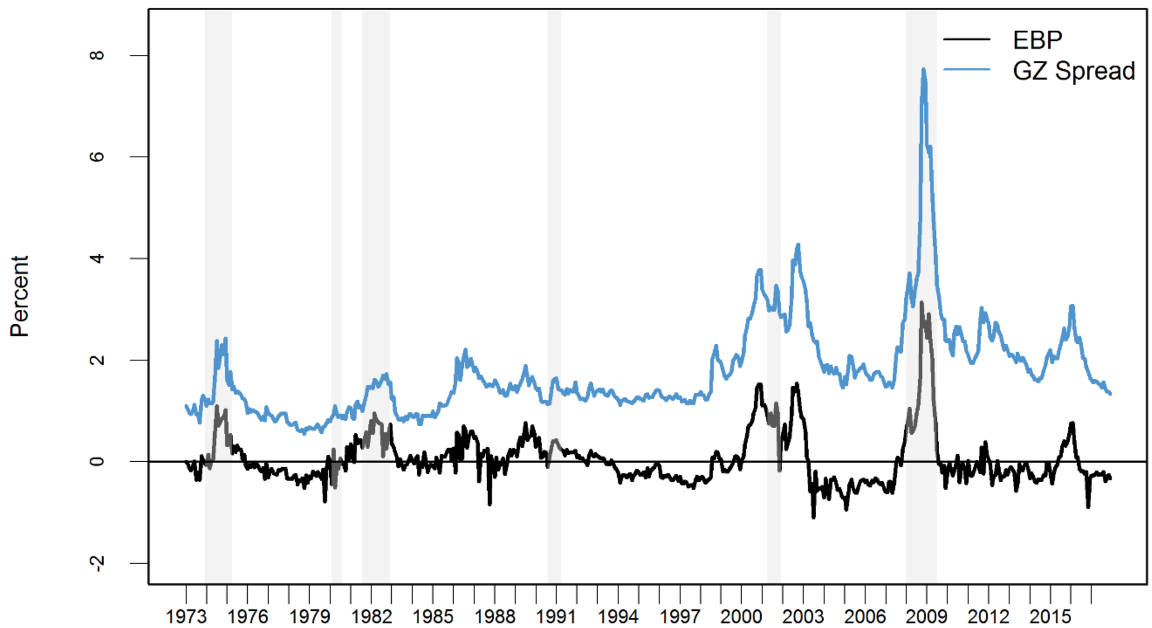
narrowing of the types of collateral accepted, increases in the amount of collateral required ("haircuts"), and reductions in the maturities of loans. Gorton and Metrick (2012b) calculate that, from the second quarter of 2007 to the first quarter of 2009, net repo financing of U.S. intermediaries fell by about $1.3 trillion, more than half its pre-crisis total. Overall, the sharp contraction in funding in the shadow-banking sector forced a painful disintermediation, which in turn depressed prices and raised yields on virtually all forms of private credit, not just troubled mortgages (Longstaff, 2010; Scott, 2016).

Although the most severe disintermediation occurred at broker-dealers and other shadow banks, commercial banks also faced pressures, including from uninsured depositors (Rose, 2015), in wholesale funding and interbank loan markets (Afonso, Kovner, and Schoar, 2011), and from borrowers taking down precommitted credit lines in order to hoard liquidity (Ivashina and Scharfstein, 2010). Banks were also (explicit or implicit) backstop liquidity providers for SIVs, ABCP programs, and other conduits, and were consequently forced to replace much of their funding as it ran (Arteta et al., 2013). Acharya and Mora (2016) find that liquidity was a significant issue for banks from the beginning of the crisis until after the collapse of Lehman, when government capital became available. However, commercial banks generally had more stable funding sources than broker-dealers—including insured deposits, advances from Federal Home Loan Banks (Gissler and Narajabad, 2017, part 1), and access to the Fed's discount window. Consequently, as the crisis wore on, banks were able to take advantage of fire sale prices to increase holdings of some forms of credit (He, Khang, and Krishnamurthy, 2010).

Measures of the external finance premium. The simple analysis thus far makes two basic predictions about the aggregate external finance premium: that it should be countercyclical, rising in downturns when the balances sheets of lenders and borrowers deteriorate; and that it should rise sharply during periods of financial instability. To evaluate these predictions, we need measures of the EFP. Of course, although in macro modeling we may speak of "the" EFP (as we often speak of "the" interest rate), in principle the EFP is heterogeneous, depending not only on the balance sheets of individual prospective borrowers and lenders but also on borrower type (household versus firm) and other characteristics that bear on the costs of lending, like firm size.

With those caveats in mind, Figure 1 shows two related measures of borrowing costs for nonfinancial corporations developed by Gilchrist and Zakrajšek (2012a), following earlier work by Levin, Natalucci, and Zakrajšek (2004). The series in Figure 1 labeled *GZ spread* is essentially the difference between the yield on nonfinancial corporate bonds and comparable-maturity Treasury obligations, constructed from data on individual issues to match durations and to adjust for call options and other features. The second series, labeled *EBP* for excess bond premium, subtracts from the GZ credit spread a measure of issue-specific default probabilities, based on the “distance to default” methodology of Merton (1974). Gilchrist and Zakrajšek (2012a) interpret the EBP as a measure of investor appetite for corporate debt, holding constant estimated default risk. They find that both measures are highly predictive of real economic activity but that, interestingly, the bulk of the predictive power lies in the excess bond premium rather than in the default probability. We will use the EBP in later analysis. For now, I note that both indicators are generally countercyclical (shaded bars in the figure show NBER recessions), and both spike during the 2008 crisis, consistent with the theory. The cyclicality of these measures also appears to have increased over time, consistent with the general perceptions that financial factors have played a larger role in business cycles since the 1980s.

Figure 1. Two Measures of the External Finance Premium for Nonfinancial Corporations, 1973-2017[7]



The Gilchrist-Zakrajšek measures, derived from observed yields, reflect the "price" of credit to certain classes of borrowers. Students of credit markets have long noted that, consistent with the complex agency and monitoring problems that affect lender-borrower relationships, loans often involve many nonprice elements, including limits on loan size, covenants, call provisions, and so on. In principle, the shadow value of nonprice terms should be included in the external finance premium. Studies suggest that these nonprice terms move in the same way as more directly observable spreads, and, moreover, that nonprice terms have predictive power for economic activity. For example, using bank-level responses to the Federal Reserve's Loan Officer Opinion Survey, Bassett et al. (2014) constructed an indicator of changes in lending standards, adjusted for factors affecting loan demand, and found that their indicator forecasts lending and output. Altavilla et al. (2015) found similar results for the euro area.

[7]Source: Gilchrist and Zakrajšek (2012a); updated data from Favara et al. (2016). Shaded bars indicate NBER recession dates.

Credit factors in pre-crisis mainstream macroeconomics. Prior to the crisis, mainstream macro models (including models used by central banks for forecasting and policy analysis) did not include much role for credit factors, of the type described in the previous section. Notably, the FRB/US model of the U.S. economy, the Fed's workhorse model, provided little guidance to the staff on how to think about the likely economic effects of the crisis, despite having (relative to the models most used in academic work) an extensive financial sector. The staff supplemented FRB/US with various ad hoc adjustments, based on historical case studies, anecdotes, and judgment. However, the staff and the Federal Open Market Committee still systematically under-predicted the economic impact of the crisis, as mentioned earlier.

For example, as noted by Kohn and Sack (2018), in August 2008, a year into the crisis, the Fed staff predicted (in the FOMC briefing document known as the Greenbook) that unemployment would peak at under 6 percent. In reality, the unemployment rate would rise to nearly 10 percent. This under-prediction partly reflected excessive optimism about the evolution of financial conditions. However, an alternative Greenbook forecast scenario that hypothesized "severe financial stress," and which assumed in particular that house prices would fall further than they ultimately did, saw unemployment remaining below 7 percent. Moreover, even in October 2008, well after the collapse of Lehman and the rescue of AIG, the staff saw unemployment peaking at around 7-1/4 percent.[8]

What accounts for this important blind spot—which, I emphasize again, was shared by all major forecasters? Although the basic theoretical framework outlined above existed before the crisis, in the view of many economists the benefits of incorporating credit factors into macro models did not exceed the costs. Most macroeconomic modeling focused on explaining the behavior of the postwar U.S. economy, a period that until 2007 had been without a major financial crisis. From a modeling perspective, adding credit factors required allowing heterogeneity among agents (including savers, borrowers, and intermediaries), which added

[8] Kohn and Sack also report an exercise, conducted by Bob Tetlow of the Federal Reserve Board, which calculates what the forecast of the FRBUS model would have been if the staff had had perfect foresight about the financial variables included in the model. Even with this information, according to this exercise, FRB/US would have significantly under-predicted the magnitude and speed of the rise in the unemployment rate.

technical complexity. Arguments from parsimony and computational simplicity thus worked against the addition of credit factors to the standard model.

Deficiencies in the received credit literature also played a role. The financial accelerator literature, which incorporated credit factors into otherwise standard macro models, showed that such factors could improve the fit of models to data (Bernanke, Gertler, and Gilchrist, 1999). However, this literature, like other new Keynesian modeling of the time, focused on the dynamics of normal business cycles rather than on financial crises and their effects.

Another barrier to the incorporation of credit factors was that the use of microeconomic data to measure credit effects, an essential element in building quantitative macro models, was bedeviled by identification problems. Credit-focused theories posit relationships between measures of financial health—like net worth, leverage, or collateral values—and aspects of economic behavior, such as borrowing, consuming, or investing. However, measures of financial health are generally themselves endogenous, complicating identification. For example, the theory suggests that, all else equal, a firm with more internal funds available should face a lower external finance premium and thus be willing to invest more. In practice, though, a finding that internal cash flow and investment are correlated across firms (Fazzari, Hubbard, and Petersen, 1988) is subject to the potential critique that causality may flow in both directions. In particular, although higher cash flows may promote investment, it is likely also true that firms endowed with better investment opportunities will tend to enjoy higher profits and stronger cash flows, even if no credit-market frictions are present.

However, the recent crisis has significantly changed economists' views on the importance of credit factors. The Great Recession was the worst downturn since the Great Depression of the 1930s, and its severity seems impossible to explain except as the result of credit-market dysfunction, broadly construed (Stock and Watson, 2012). Explanation of recent events thus requires incorporation of credit factors into otherwise standard models, and there has been much activity in this area. Studies at the microeconomic level have also proliferated, as economists have tried to better understand the links between credit factors and aspects of household, firm, and bank behavior. An interesting side effect of the crisis is that it helped solve the perennial identification problem, by creating what is in effect a natural experiment. Since the crisis was plausibly an exogenous event for most economic units, differences in behavior that correlate with initial financial health provide better-identified estimates of the effects of credit-market shocks.

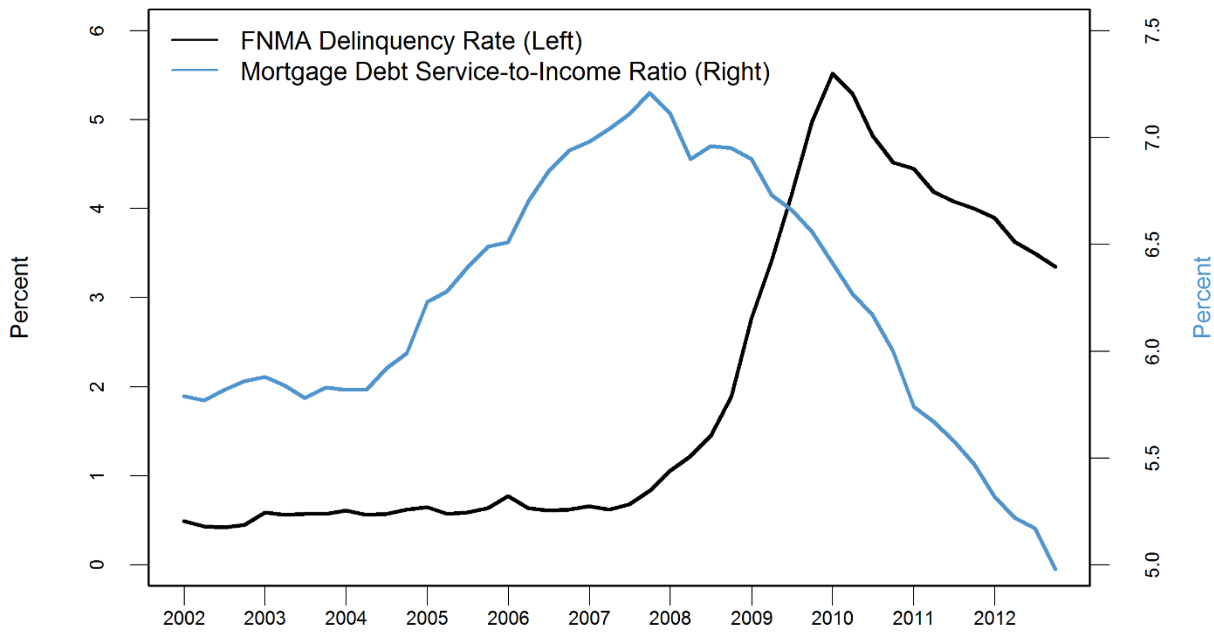
In the next section I briefly review this post-crisis literature. Collectively, the research provides substantial support to the view that factors affecting the costs of credit extension have an important independent influence on credit flows and, crucially, on the economic choices of households and businesses as well.

II. Recent research on credit factors and real economic activity

This section first reviews new microeconomic evidence on the role of credit factors, then turns to post-crisis research in macroeconomic modeling that includes such factors.

Microeconomic evidence: households. The run-up to the crisis showed a significant expansion in household debt, especially mortgage debt. As aspiring homeowners pressed to get into the hot housing market, weakening lending standards gave more households access to mortgages, and existing homeowners borrowed against built-up home equity. Figure 2 shows the mortgage debt-service-to-income ratio and the Fannie Mae single-family mortgage delinquency rate for the period 2002-2012. Evident in the figure is both the buildup in debt-service burdens before the crisis and the financial stress placed on households by the reversal of the housing boom in 2006 and thereafter.

Figure 2. Household Debt Service and Delinquencies, 2002-2012[9]



In a frictionless world, with no credit constraints, declining house prices would have only small effects on consumer spending, as households would be able to borrow and save as needed to smooth over time the effects of wealth changes. Moreover, the negative impact of a house price decline on wealth should, in principle, be largely offset by a corresponding decline in the user cost associated with living in the house. In short, with no credit constraints, the marginal propensity to consume (MPC) out of housing wealth should be small.

However, when households face an external finance premium that in turn depends on the states of their balance sheets, declines in housing wealth can have much larger effects on spending, for two related reasons. First, declining housing wealth depletes the pool of net worth that the household could draw upon to smooth spending if needed; and, second, declines in net worth and the collateral value of the home raise the effective cost of credit (the EFP) to the homeowner. Note that the effects of rising and falling house prices on consumption may be

[9] Mortgage debt service is measured relative to disposable personal income. The delinquency rate refers to the share of conventional single-family home mortgages that are 90+ days past due or in foreclosure. Sources: Haver Analytics, Fannie Mae, Federal Reserve Board Z.1 Financial Accounts of the United States.

asymmetric. Starting from a level of home equity at which credit constraints do not bind very tightly, the MPC out of additional housing wealth is likely to be small, while declines in housing wealth that cause the constraints to bind can reduce consumption significantly. This asymmetry helps explain why the positive effects of the housing boom on consumption appear to have been outweighed by the negative effects of the housing bust (Guerrieri and Iacoviello, 2014).

The period since the crisis has seen a great deal of new research on the links between household balance sheets and household spending. Atif Mian and Amir Sufi, with coauthors, have been especially prolific on this topic. For example, using county-level and zip-code-level data, Mian, Rao, and Sufi (2013) confirmed the basic predictions of the theory that MPCs out of housing wealth are much higher than can be explained in standard life-cycle frameworks, and that these MPCs are relatively higher for poorer, more-levered households. Consistent with a link between home equity and credit access, they also found that areas with larger declines in house prices saw, on average, relatively larger deteriorations in credit scores and credit limits, as well as greater declines in the likelihoods of mortgage refinancing.

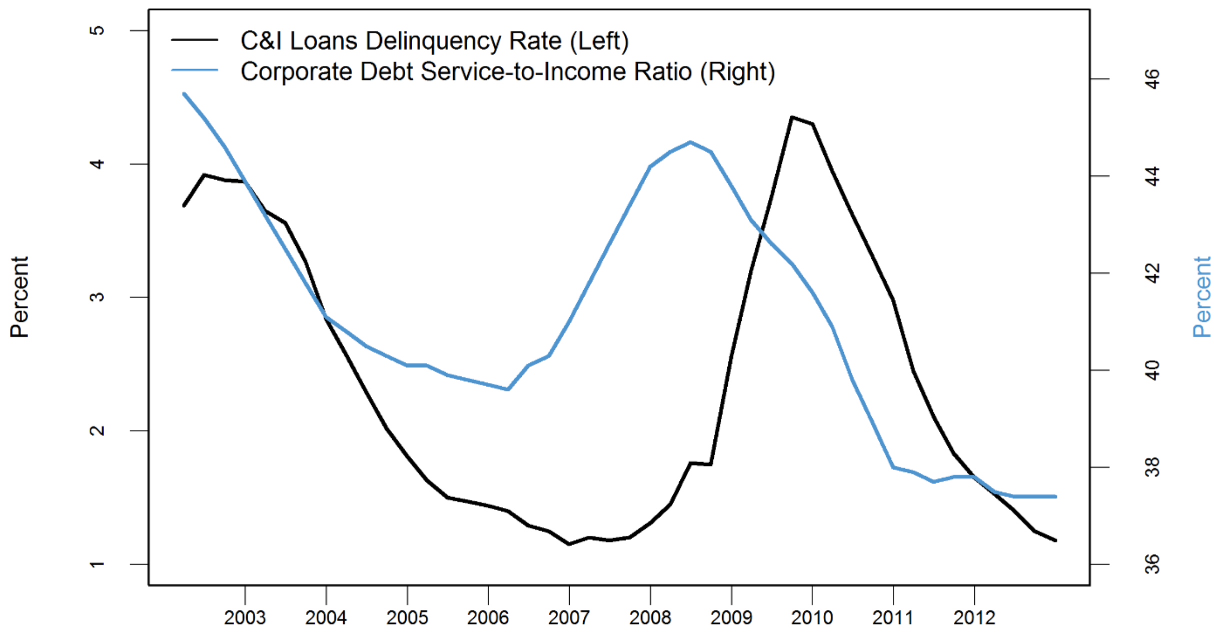
Mian and Sufi have particularly emphasized the role of weakening household balance sheets in triggering the Great Recession. For example, they showed that, in counties in which housing booms were accompanied by large increases in household leverage from 2002 to 2006, durables consumption declined relatively more sharply beginning in the second half of 2006 (Mian and Sufi, 2010). Similarly, Mian and Sufi (2014b) found that, in a cross-section of U.S. counties, deterioration in household balance sheets was an important correlate of declining employment in the recession period 2007-2009. Much of this work treats the housing boom and bust as given, focusing on the economic consequences. However, in their most recent research, Mian and Sufi (2018b) also explore the credit-market sources of the boom, finding that zip codes that were most exposed to the 2003 acceleration of private-label mortgage securitization market saw a sudden subsequent increase in mortgage originations and house prices, followed by sharp housing price collapses.

Other researchers have also explored the links between households' balance sheets and their spending decisions. Notably, while Mian and Sufi have mostly used data aggregated over geographic units, a study by Baker (2018) employed data on millions of individual households, matched with employers. He considered household income changes associated with shocks to their employers, and which are therefore arguably exogenous to the households. He found that the consumption of highly indebted households is meaningfully more sensitive to income, and that these differences are almost entirely driven by borrowing and liquidity constraints. Baker estimated that consumption in the 2007-2009 recession dropped by 20 percent more than it would have if household balance sheets positions had been comparable to those in the 1980s. Also consistent with the Mian-Sufi findings, Aladangady (2014) reported that homeowners with high debt-service ratios have significantly higher MPCs out of housing wealth. Kaplan, Mitman, and Violante (2016) also found a high MPC out of housing wealth, although—in contrast to Mian and Sufi and other authors—they did not find an independent role for leverage. Sahm, Shapiro, and Slemrod (2015) found that the condition of a household's balance sheet was a key determinant of its spending and saving behavior in response to a change in fiscal policy.

As has been known for some time, household balance sheets influence entrepreneurial activity, as many small-business startups are financed from personal resources, including borrowing against home equity. Consistent with this "collateral channel," Adelino, Schoar, and Severino (2015) found that, in the period leading up to the crisis, small business starts and small-firm employment growth were highest in areas with rising house prices and leverage. They did not find the same relative increase in employment in large firms, which presumably do not rely on household collateral for financing.

Microeconomic evidence: nonfinancial firms. The balance sheets of nonfinancial firms did not deteriorate as dramatically as those of households in the periods before and during the recession, but nonfinancial firms certainly did experience increased stress. Figure 3 shows that corporate debt service and delinquencies during the period around the crisis. Corporate balance sheets improved in the period after the 2001 recession. However, starting in about 2006, nonfinancial corporate debt service began to rise, to be followed by a spike in delinquencies in commercial-industrial loans after the recession began.

Figure 3. Corporate Debt Service and Delinquency, 2002-2012[10]



Similar to studies of households, cross-sectional studies of nonfinancial firms during the crisis era have provided an opportunity to observe how differing balance-sheet conditions affected the responses of those firms to the downturn. Analogous to the responses of households to changes in wealth or income, firms with initially weaker balance sheets (higher leverage, less internal cash, less usable collateral) would be expected to react more sensitively—for example, in terms of hiring and investment—to changes in revenue or demand. Likewise, smaller or younger firms, which typically require more lender screening and monitoring per dollar of lending, should be more sensitive to deteriorating financial conditions.

Post-crisis research has generally confirmed these predictions. For example, Giroud and Mueller (2017) found that, during the Great Recession, highly levered firms cut employment significantly more than other firms did, in response to a given decline in local consumer demand. They concluded that firms' balance sheets were an essential part of the link between final

[10] The debt service of nonfinancial corporations is measured relative to pre-tax profits. The delinquency rate is the share of C&I loans at commercial banks that are 30+ days past due. Sources: Haver Analytics, Call Report, BIS.

demand and employment. Similarly, Duchin, Ozbas, and Sensoy (2010) found that the crisis affected investment the most in companies with low cash reserves or high net short-term debt. In a novel application of the theory, Gilchrist et al. (2017) considered the effects of firms' balance sheets on their pricing behavior, finding that firms with limited internal liquidity and high operating leverage raised rather than lowered their prices in the face of the 2008 contraction. Interpreting price cuts as investments in maintaining customer relationships, the paper found that financially stressed firms were relatively less able to make such investments.

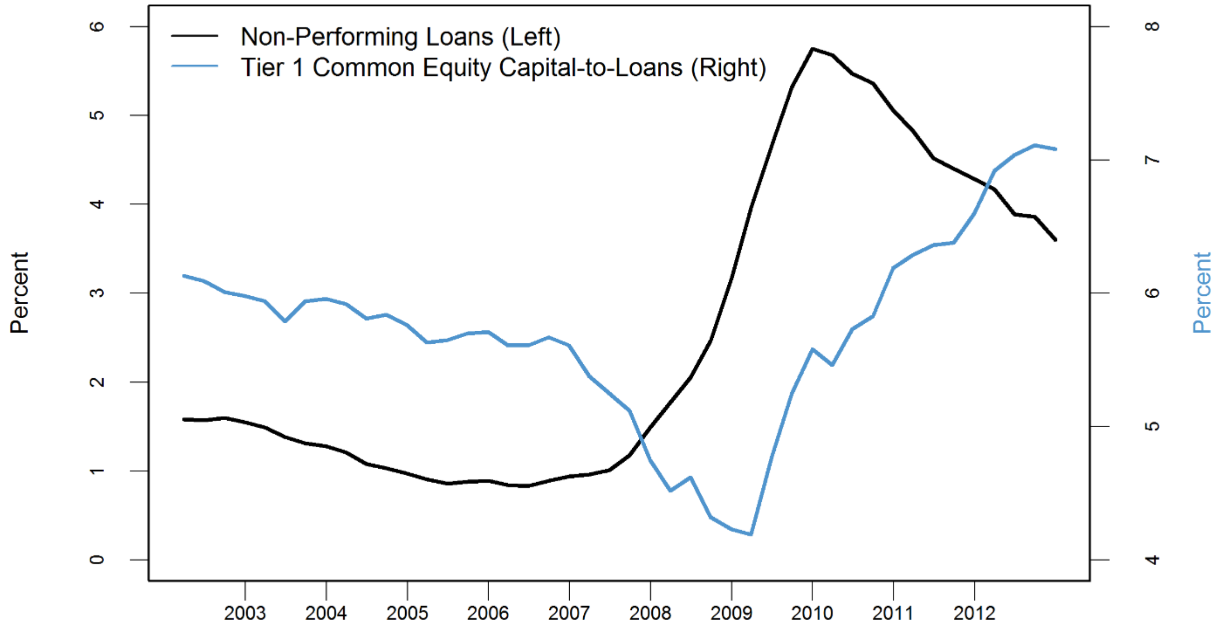
An interesting aspect of the recent literature on nonfinancial firms is the variety of identification strategies that researchers have applied. For example, following pre-crisis work by Dell'Ariccia, Detragiache, and Rajan (2005), quite a few studies have compared firms in industries that are normally more dependent on external finance to firms in industries that are normally more self-sufficient for credit. Studies using this approach (among others), and finding that firms in industries more dependent on external finance also reacted more sharply to the crisis include the aforementioned Duchin, Ozbas, and Sensoy (2010); Laeven and Valencia (2013); and Haltenhof, Lee, and Stebunovs (2014), among others. In another approach to identification, Chaney, Sraer, and Thesmar (2012) used local variations in real estate prices as a proxy for the change in the value of collateral of firms owning real estate, finding a strong association of new capital investment at the firm level with changes in collateral values. Following yet another identification strategy, in a sample of firms with long-term debt, Almeida et al (2009) found that firms with large portions of long-term debt maturing right at the time of the crisis reduced investment by considerably more than otherwise similar firms whose debt was not scheduled to mature. However, in a contrarian study, Kahle and Stulze (2013) found that firms relatively more dependent on bank-provided credit did not decrease capital expenditures more than otherwise similar firms in the early stages of the crisis.

Researchers studying firm behavior have also made use of survey data. For example, based on a survey of 1,050 chief financial officers around the world, Campello, Graham, and Harvey (2010) reported that firms describing themselves as credit-constrained during the crisis planned relatively deeper cuts in employment and capital spending, including bypassing otherwise attractive opportunities and cancelling or postponing planned investments.

Small firms are likely to be more sensitive to reductions in credit supply, and the research confirms that this sector was hit hard during the crisis. For example, using firm-level data, Siemer (2014) found that, during the 2007-09 recession, financial constraints substantially reduced employment in small relative to large firms, controlling for aggregate demand and other factors. Other studies documenting the impact of restricted credit on the entry, growth, and survival of smaller firms include Mach and Wolken (2012), Kennickell, Kwast, and Pogach (2015), and Duygan-Bump, Lekov, and Montoriol-Garriga (2015). Chen, Hanson, and Stein found that the largest U.S. banks pulled back sharply and differentially from small business lending in 2008-2010, as they grappled with the stresses of the crisis.

Microeconomic evidence: banks and nonbank lenders. As discussed earlier, the theory suggests that the balance sheets of financial intermediaries should also affect the external finance premium and the flow of credit. The post-crisis research generally confirms this prediction, finding in particular that cross-sectional differences among lenders in initial capital, funding sources, and exposure to mortgage-related losses affected their willingness or ability to make non-mortgage loans. Although some borrowers were able to shift to other sources of credit, including trade credit, the available evidence suggests that many could not, or had to pay much higher rates. Consequently, shocks to the financial health of lenders had consequences for the real economy, including for consumption, investment, and employment. Figure 4 shows capital and non-performing loans at U.S. commercial banks in the period around the crisis. Despite capital raises, the ratio of bank Tier 1 common equity capital to loans dropped precipitously in 2007 and 2008 as delinquencies rose. Gertler and Gilchrist (2018, Figure 3) document the rapid deleveraging of investment banks during the crisis.

Figure 4. Capital and Non-performing Loans at Commercial Banks, 2002-2012[11]



Once again, for many studies, the shock of the crisis provided a natural experiment that helped to sharpen identification. For example, for a variety of reasons, banks differed in their exposures to mortgage losses arising from the housing and subprime busts. Absent balance sheet effects, there is no evident reason that those differential exposures should have affected the willingness of individual banks to make *non-mortgage* loans. However, many studies have found that there was a linkage between mortgage exposures and non-mortgage lending, presumably because mortgage-related losses depleted bank capital. For example, controlling for firm-specific factors, Santos (2011) found that firms borrowing from banks that suffered larger subprime losses paid higher spreads and received smaller loans than those borrowing from other banks. Zhang, Uluc, and Bezemer (2017) obtained similar results for the United Kingdom, finding that British banks that were more exposed to residential mortgages before the crisis reduced their non-mortgage lending by relatively more during and after the crisis. Berrospide,

[11] Non-performing loans are defined as the share of loans with payments that are 90+ days past due. Sources: Haver Analytics, Federal Reserve Bank of New York.

Black, and Keaton (2016) found that, all else equal, banks serving a number of metropolitan areas reduced their local mortgage lending in response to mortgage losses in other markets.

Earlier, I cited evidence that the effects of balance sheet conditions on household spending are not symmetric, with balance-sheet deterioration having a larger effect than improvements. Analogous effects appear to occur for banks. For example, Carlson, Shan, and Warusawitharana (2013), using matched samples of banks and, controlling for a variety of factors, found that the effect of changes in bank capital on lending is nonlinear—modest when capital is at high levels, but large when capital is low, as predicted by the theory.

Researchers have linked banks' willingness to lend to their sources of liquidity, as well as to their levels of capital. Notably, quite a few studies report that banks able to fund through retail deposits, rather than wholesale funding, cut their lending by relatively less (Ivashina and Scharfstein, 2010; Cornett et al, 2011; Dagher and Kazimov, 2015; Irani and Meisenzahl, 2014).

Changes in loan supply by individual banks would not matter much if borrowers could easily compensate, e.g., by switching to other lenders or other sources of credit, such as trade credit. As noted, however, this does not seem to have been the case in most instances. In a nice study, Chodorow-Reich (2014) used the dispersion in lender health following the Lehman crisis as a source of exogenous variation in credit availability to borrowers. Using data on 2,000 nonfinancial firms with pre-crisis banking relationships, he found that firms with weaker lenders borrowed less, paid higher rates when they borrowed, and reduced employment more than other firms. The strongest employment effects were at small and medium-sized firms. Other studies making the explicit linkages among bank health, credit extension, and real economic activity include Goetz and Gozzi (2010); Falato and Liang (2016); Kandrac (2014); and Alfaro, Garcia-Santana, and Moral-Benito (2018). Adrian, Colla, and Shin (2012) found that some large nonfinancial firms were able to make up part of the reduction in bank lending through bond issuance, but only by paying high rates. Those authors argue that the impact of the credit crisis on real activity came through the associated spike in risk premiums rather than a contraction in the total quantity of credit. However, that finding is consistent with an approach centered on the external finance premium, which, as Figure 1 suggests, rose sharply during the crisis.

In the United States, nonbank lenders are important credit providers, and many nonbanks were severely affected by the crisis. A number of interesting studies have identified links between nonbank lending and economic activity. For example, using a data set linking every U.S. car sale to an associated supplier of auto credit, Benmelech, Meisenzahl, and Ramcharan (2017) drew an empirical connection between the collapse of the asset-backed commercial paper market and auto sales. The collapse of the ABCP market hit the financing capacity of nonbank auto lenders, like captive leasing companies, particularly hard. These authors found that counties in which nonbank lenders had traditionally been dominant suffered deeper declines in car sales than other counties. In another interesting analysis, Ramcharan, van den Heuvel, and Verani (2016) used the unique tiered structure of national credit unions to identify credit supply effects. Losses in the asset-backed securities market at top-tier institutions imposed costs on local credit unions, in ways plausibly uncorrelated with local market conditions. However, these authors found that credit unions suffering such losses contracted their extensions of consumer credit to local customers by more than credit unions without such losses.

Microeconomic evidence: cross-border banking. Cross-border effects, in which financial stresses in one country affect credit supply and economic activity in another, are a potentially important channel of international transmission of crises. Documenting such effects also provides another tool for identifying the links between bank balance sheets, lending, and economic outcomes.

Peek and Rosengren (2000), in a classic paper, were among the first to use cross-border linkages to identify balance-sheet effects. They used the facts that (1) Japanese banks were active lenders in the United States during the 1990s and that (2) the Japanese banking crisis of that decade could reasonably be viewed as exogenous to economic developments in the U.S. to construct a natural experiment. Using the variation in the lending shares of Japanese banks across various U.S. commercial real estate markets, they showed that loan supply shocks emanating from Japan had real effects on economic activity in the United States.

In a similar vein, for the recent crisis, the evidence suggests that banks experiencing losses abroad, or which were dependent on foreign sources of funding that came under pressure, reduced their domestic lending by more than other banks. For example, Puri et al. (2011) examined the domestic retail lending of German savings banks during 2006-2008, comparing savings banks with substantial indirect exposures to U.S. subprime mortgages with savings banks without such exposures. They found that the exposed banks rejected substantially more loan applications than banks not so affected. Also for Germany, Huber (2018) studied the effects of domestic lending cuts by Commerzbank, a large bank that suffered significant losses in its international trading book. He found that cuts to Commerzbank's lending in Germany were not offset by other sources of credit. Rather, they resulted in persistent adverse effects on output, employment, and productivity in firms and regions in which the bank had a relatively larger market share before the crisis.

Studies with analogous findings exist for many other countries, including the United Kingdom (Aiyar, 2011 and 2012); Italy (Albertazzi and Merchetti, 2010); Portugal (Iyer et al., 2014); and Denmark (Jensen and Johannesen, 2017). In a multi-country study, De Haas and van Horen (2012) analyzed cross-border syndicated lending by 75 banks to 59 countries after the collapse of Lehman, finding that banks that had to write down subprime assets or refinance large amounts of long-term debt reacted by curtailing their lending abroad. Not all cross-border studies look at the effects of events in the United States on foreign economies: For example, Correa, Sapriza, and Zlate (2013) found that the European sovereign debt crisis affected the United States, as U.S. branches of euro-area banks, hit by liquidity strains, reduced lending to U.S. firms by more than did the U.S. branches of foreign banks headquartered outside Europe. Shin (2011) emphasizes the role of global banks in transmitting changes in financial conditions internationally.

The Great Depression. Interestingly, the recent crisis appears also to have inspired new research on another worldwide financial and banking crisis, the Great Depression of the 1930s. My research on the Depression discussed the real effects of the deterioration of both bank and borrower balance sheets (Bernanke, 1983). I also drew on international comparisons for evidence (Bernanke and James, 1991; Bernanke, 1994). However, my empirical work on the period relied heavily on aggregate time series, making it subject to the usual concerns about endogeneity and identification. Remarkably, recent research has developed new microeconomic, cross-sectional databases for the 1930s, allowing for something closer to the natural experiment approach.

For example, using newly collected data on large industrial firms, Benmelech, Frydman, and Papanikolaou (2017) exploited pre-existing variation in the need to raise external funds at a time when bond markets were frozen and banks were failing. They found a large, negative effect of financing frictions on employment at large firms. Building on earlier work by Calomiris and Mason (2003), who found that bank distress in the 1930s reduced loan supply and economic activity in the regions where the banks operated, Mitchener and Richardson (2016) examined the effects of correspondent relationships that played an important role in interwar banking. They found that a bank's financial distress reduced credit available not only to the bank's own customers, but also to the customers of their (regionally dispersed) correspondents, who had to accommodate sharp increases in the demand for liquidity. Other, related papers using cross-sectional data to study the effects of bank distress during the Depression include Carlson and Rose (2015), Ramcharan and Rajan (2014), and Cohen, Hachem, and Richardson (2018). In general, this literature supports the view that disruptions in banking and credit markets help to explain the depth, duration, and international incidence of the Depression.

Credit factors in quantitative macroeconomic models. Microeconomic studies provide evidence that household, firm, and bank behavior are affected by balance-sheet conditions and asymmetric information about creditworthiness. However, such studies are inherently partial equilibrium in nature. It is possible that balance-sheet effects, though important in the cross section, "wash out" in aggregate time series (Jones, Midrigan, and Philippon, 2018). For example, it could be that, for the economy as a whole, reduced investment or hiring by financially constrained firms is offset by greater activity at less-constrained firms. Assessing the importance of credit factors for macroeconomic outcomes inevitably requires the incorporation of such factors into quantitative, general equilibrium models of the economy.

As noted earlier, prior to the crisis, a modest literature incorporated credit factors into otherwise standard models, generally finding that doing so could improve the fit of the models to the data (Bernanke, Gertler, and Gilchrist, 1999; Carlstrom and Fuerst, 1997). However, these papers did not argue that credit factors were a dominant source of variation in output and employment. More important, the earlier models did not capture the phenomenon of the occasional large, discontinuous crisis, or other nonlinear effects.

Work since the crisis has made substantial progress in accommodating credit factors in dynamic macro models. This research supports two separate, though related, substantive conclusions. The first of these is that credit factors are essential for understanding the Great Recession specifically. In the words of Christiano, Eichenbaum, and Trabandt (2014), “the vast bulk of movements in aggregate real economic activity during the Great Recession were due to [in their terminology] financial frictions interacting with the zero lower bound [on short-term interest rates].” Many other papers have reported similar conclusions. The finding that the Great Recession was in large part the result of financial and credit-market dysfunction is of course not really a surprise at this point, but it is nevertheless important to confirm that quantitatively realistic economic effects of credit shocks can be rationalized in what are otherwise largely standard models

That observation, together with the conclusion of Stock and Watson (2012) that the Great Recession differed from other postwar business cycles in magnitude but not in kind, leads to the second conclusion: that credit factors may play an important role than previously thought even in “garden-variety” business cycles. Complementary, model-based analyses finding central roles for credit shocks in both the Great Recession and in business cycles generally include (in a very partial listing) Nolan and Thoenissen (2009); Hall (2010, 2011); Jermann and Quadrini (2012); Gilchrist and Zakrajšek (2012b); Iacoviello (2014); and Del Negro et al. (2017). In related research, Mian and Sufi (2018a, 2017) have recently argued that periodic, excessive expansions in the supply of credit to households are a major source of business cycles globally, not just the U.S. Great Recession. Arellano, Bai, and Kehoe (2018) show that credit-market frictions can help models match cross-sectional aspects of the macro data (such as the dispersion of investment and hiring across firms) as well as time-series aspects. In a stylized macro model, Eggertsson and Krugman (2012) discuss the interaction of household leverage and the zero lower bound on interest rates. Bacchetta and van Wincoop (2016) use a two-country model to study the transmission of the panic between economies.

Bernanke, Gertler, and Gilchrist (1999) and other papers of that genre studied log-linear approximations around steady states, which facilitated the analysis of credit factors in normal cyclical dynamics but ruled out large, discontinuous shifts in economic activity. As discussed earlier, financial panics are inherently discontinuous (e.g., the economy shifts from one equilibrium to a quite different one), and the empirical work to be presented later in this paper will rely on those discontinuities for identification. Recent modeling has shown how to reproduce this important feature of the data. Notably, Gertler and Kiyotaki (2015) and Gertler, Kiyotaki, and Prestipino (2017) incorporate banking panics in quantitative macro models, finding that panics can produce severe, highly nonlinear contractions in economic activity. The mechanism of this effect, as discussed earlier, is the sharp disintermediation and rise in the external finance premium associated with a panic. Brunnermeier and Sannikov (2014) analyze a theoretical model in which financial frictions create highly nonlinear contractions in economic activity and lead to occasional crisis episodes. Nonlinear outcomes also emerge from the models of He and Krishnamurthy (2013) and Boissay, Collard, and Smets (2016). Recent work has also made progress in modeling housing booms and busts in a general equilibrium context; see, for example, Favilukis, Ludvigson, and Van Nieuwerburgh (2010).

In sum, there has been substantial recent progress in the development of quantitative macro models incorporating credit factors, including the potentially large and nonlinear effects of financial crises. This literature represents an important step forward in remedying the weaknesses of empirical modeling and forecasting that became evident during the crisis.

III. The Effects of the Financial Crisis on the Real Economy: Some New Evidence

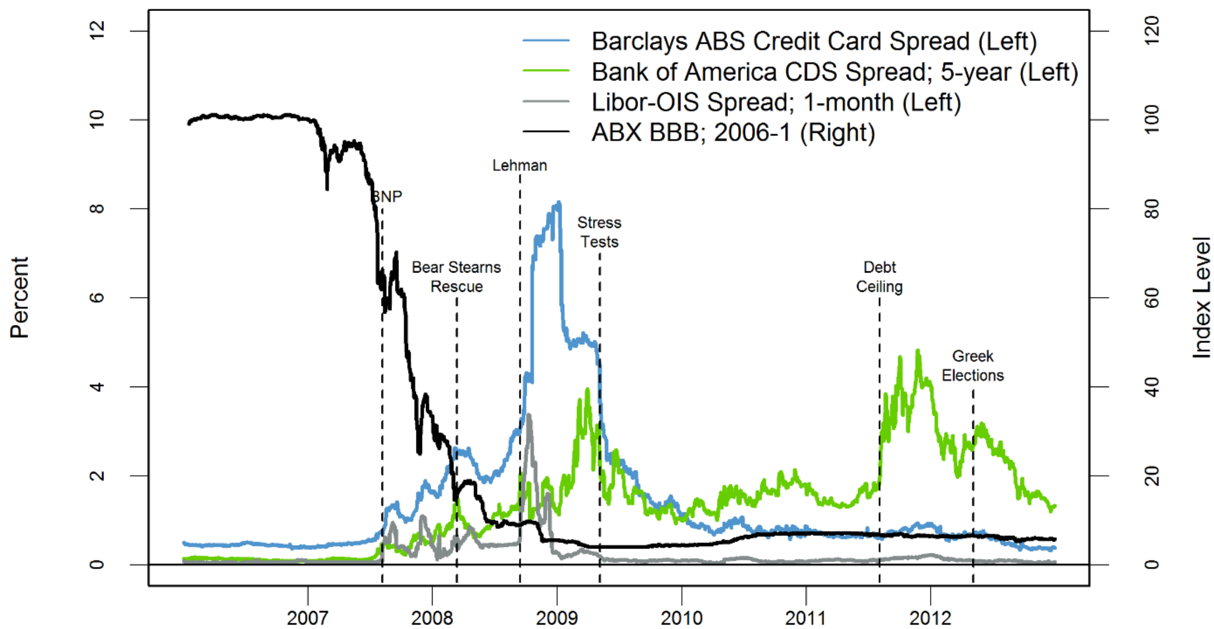
Research since the financial crisis suggests that credit factors matter. However, credit was disrupted in a number of ways during the crisis, including through the two broad mechanisms described in the introduction: (1) the loss of investor confidence in financial institutions and securitized credit, which triggered a financial panic that choked off credit supply; and (2) the weakening of household balance sheets, which resulted in deleveraging and the constriction of household spending. This section provides some new evidence on the links between the financial crisis and the Great Recession and, in particular, on the relative importance of these two channels. The empirical strategy is to use financial data to identify points of discontinuity in the evolution of the crisis, and then to evaluate the extent to which those shifts predict movements in a standard set of macroeconomic variables.

The analysis to come is loosely motivated by figures presented in Gorton and Metrick (2012a); see especially their Figures 8 and 9. Similar to their figures, the two panels in this paper's Figure 5 use four representative (daily) financial data series to illustrate informally the principal stages of the crisis. The four series shown in Figure 5 are:

- ABX BBB (2006-1) is a market-traded index of the value of BBB-rated, 2006-vintage subprime mortgage-backed securities. It is a proxy for investor views of housing and mortgage markets.
- LIBOR-OIS is the interest rate on one-month interbank loans (LIBOR) less an indicator of expected safe rates (OIS). This variable is an indicator of stress in the interbank lending market and, more generally, in wholesale funding.
- The spread on ABS (asset-backed securities) backed by credit card receivables (Barclay's index) shows the yield (relative to Treasuries) on securities backed by an important class of non-mortgage credit. This spread measures investor willingness to hold non-mortgage credit, especially in the form of securitizations.
- The CDS (credit default swap) spread of a large bank reflects the perceived risk of default on that bank's bonds, and is thus a measure of banking system solvency.

By means of these four representative financial variables, Figure 5 illustrates the stages of the financial crisis. Stage 1, captured here by the ABX index of subprime mortgage values, is the deflation of the housing bubble and the growing concerns about the mortgage market. That variable takes an index value near 100 through 2006, showing that through that year investors remained sanguine about the prospects for subprime mortgages. As reflected in the ABX indicator, that confidence began to wane in early 2007 and ratcheted downward thereafter. Worsening conditions in mortgage markets corresponded to deterioration of household balance sheets and, ultimately, in the balance sheets of mortgage lenders as well.

Figure 5. Stages of the Financial Crisis, 2006-2012[12]



Stage 2 of the crisis, indicated by the LIBOR-OIS spread in Figure 5, was the inception of liquidity pressures on financial institutions that began in the summer of 2007. As Gorton-Metrick point out, the initial loss of investor confidence in the mortgage market (ABX) was not mirrored by any investor concerns about lenders or securitization markets. However, after BNP Paribas announced in August 2007 that it was no longer able to value the subprime mortgages in its sponsored funds, wholesale funding markets came under pressure, beginning with asset-backed commercial paper conduits and other off-balance sheet vehicles. Funding pressures, as proxied by LIBOR-OIS, continued to build through the second half of 2007 and in 2008, spiking after Lehman's failure and AIG's rescue in September 2008. Funding pressures eased by the end of 2008, presumably reflecting the strong policy response, and declined further after the bank stress test results were announced in the spring of 2009.

Stage 3 of the crisis, according to this taxonomy, corresponds to the sharp rise in the ABS spreads on non-mortgage credit (specifically, in Figure 5, on credit-card receivables) that

[12] Sources: Bloomberg, Haver Analytics.

occurred after the sale of Bear Stearns in March 2008 and, especially, after the collapse of Lehman and the rescue of AIG. Gorton and Metrick (2012a) describe this episode as the "run on repo," in which repo lenders (particularly in the bilateral repo market) stopped lending against private-credit securitizations, except at very short term and with very high haircuts. The pullback from securitized credit was, I think, somewhat broader than Gorton-Metrick suggest, in that it reflected runs by almost all forms of wholesale funding, not just repo, as well as dumping of credit-backed securities by some investors as well as by dealers and other intermediaries. A spike in risk aversion also contributed to the pullback. In any case, a particularly critical aspect of Stage 3, indicative of panic and contagion, was that investors had begun to flee from non-mortgage-related assets as well as mortgage-related ones, despite the fact that non-mortgage credit quality never deteriorated to the extent that most lower-rated mortgages did. As discussed earlier, the panic led to disintermediation and fire sales, driving up yields on existing credits, as evident from the behavior of the ABS spread in Figure 5. These stresses also moderated around the end of 2008 but continued well into the next year.

The combination of mortgage losses, funding problems, and markdowns of non-mortgage credit took its toll on the banking system, although government interventions ranging from capital injections to debt guarantees shored up banks as well. Stage 4 of the crisis, capital losses at banks and other lenders, are represented in Figure 5 by the CDS spread for Bank of America. As that variable shows, bank health worsened steadily through early 2009 (higher values imply a higher risk of default), improved following the stress tests of that spring, then worsened again at about the time of the credit downgrade of the U.S. government in 2011 and with continuing pressures in Europe.

As suggested by the simple theory given earlier, each stage of the crisis potentially affected real economic activity. In Stage 1, falling house prices and rising mortgage payments relative to income pressured household balance sheets and consumer spending, as documented by Mian and Sufi and others. Stage 2 showed the first signs of the panic, as wholesale funders pulled back from lenders, including off-balance-sheet vehicles and conduits. Tighter funding conditions would have been reflected in restrictions on credit supply. Stage 3 was the most violent stage of the panic, as investors refused to fund even non-mortgage securitizations, driving up the yield on non-mortgage credit. As noted, the expansion of the panic to include non-mortgage credit as well as mortgages was arguably a turning point of the crisis, with broad ramifications for both firm and household borrowers. Finally, in Stage 4, the commercial banking system weakened further, perhaps adding to the constraints on the supply of credit. Powerful feedback effects operated throughout, for example, among the solvency of mortgage lenders, the supply of mortgage credit, household balance sheets, and house prices, with each affecting the others. There were also strong feedbacks between financial and economic developments, as financial disruptions slowed the economy, which in turn worsened financial and credit conditions.

Figure 5 is just illustrative, of course—a vehicle for laying out a narrative of the crisis. (As I've noted, I am focusing here on the United States; additional stages of the crisis could be identified as problems continued and spread in Europe and emerging-market economies.) I have two reasons for presenting this figure in detail.

First, as we will see, the four variables shown in Figure 5 are not idiosyncratic but instead are stand-ins for larger groupings of financial variables. That is, the narrative I have summarized shows up in a much larger set of financial indicators than the four seemingly arbitrary choices shown above.

Second, Figure 5 shows clearly the sharp discontinuities and nonlinearities that characterized the crisis. Those discontinuities are the basis of the identification strategy of this section. While there is little doubt, for example, that mortgage problems (Stage 1) were an important ultimate source of the subsequent stages of the crisis, the precise size and timing of the subsequent stages depended on many contingencies, ranging from the capital and mortgage exposures of particular firms to the psychology of market participants. In the spirit of regression discontinuity design, those discontinuities should allow us to identify the effects of the various stages of the crisis on the real economy.[13] Put another way, we can ask what would have

[13] Formally, regression discontinuity design takes advantage of situations in which the outcome of an experiment is discontinuous with respect to inputs. For example, suppose that students are assigned to a special course only if they score above a fixed grade on an admissions test. A researcher could study the effects of the course on student learning by comparing outcomes of students scoring just above and just below the cutoff. Likewise, if panics occur when economic conditions pass an unobserved threshold, economic changes associated with periods before and after the eruption of the panic provide some insight into the effects of the panic, relative to a situation in which the threshold was not reached. Similar arguments apply to identifying the severity of the panic, which is largely unpredictable and depends on many unobserved factors.

happened in the real economy if the housing/mortgage crisis had occurred, say, but for some reason the panic in non-mortgage securitization markets had been avoided. This identification should shed light on the mechanisms by which the crisis affected the economy and help evaluate policy responses.

Identifying stages of the crisis: Methodology and data.

The methodology employed in the rest of this paper is factor analysis, a data reduction technique that can be used to represent *n* time series variables as linear combinations of *k* underlying, orthogonal factors plus idiosyncratic noise, with *k* much smaller than *n*. Motivated by Figure 5, I applied factor analysis to a set of financial variables, observed daily over 2006-2012. Since the period of financial distress is relatively short, the hope is that daily data will allow greater insight into the sources of covariation among the indicators and to identify the stages of the crisis with greater precision. Financial variables are used because they are available at high frequency and because they are likely to quickly embody new information about the outlook for financial markets and the economy. I consider 75 series, grouped in four broad categories of roughly equal size. The categories and groupings reflect the narrative of the stages of the crisis given above. Qualitative descriptions of the included variables are below; for a more detailed listing of data and sources, see the data appendix.

- *Housing and mortgages* (17 series): Indexes of securitized mortgage values (ABX); ABS spreads for securities backed by home equity loans; homebuilder stock prices; REIT stock prices; subprime lender stock prices (all stock prices are relative to the S&P 500 index)
- *Short-term funding* (15 series): LIBOR - OIS spreads of various maturities; TED spreads; ABCP spreads; financial CP spreads; repo spreads (yields on GCF MBS and agency over Treasury repo)
- *Non-mortgage credit* (22 series): ABS spreads (credit cards, auto loans, student loans); ABS indices (consumer loans); corporate bond spread indexes; A2P2 (lower-rated) commercial paper rates, relative to OIS
- *Bank solvency* (21 series): For the largest US commercial and investment banks, CDS spreads and stock prices (relative to the S&P 500)

To interpret these data, I performed two exercises.

First, I applied factor analysis to the full sample of 75 variables, an exercise I will refer to as *full-sample factor analysis*. This analysis, which makes no prior distinctions among the four groups of financial variables, shows that at least three orthogonal factors are required to adequately describe the data, with a borderline case for including a fourth factor (see below for further discussion).

Second, I applied factor analysis to each of the four groups of variables separately, extracting a single factor from each group. I will call this procedure *sub-sample factor analysis*. I found that one estimated factor per group seemed adequate, with a single factor typically explaining about 70 percent of the sum of squared residuals in each sub-sample. Unlike the full-sample factors, the sub-sample factors reflect my prior groupings of the 75 variables into descriptive categories.

As a general matter, for the purposes of summarizing and, potentially, interpreting these data, both the full-sample and sub-sample factor analyses have advantages. The full-sample analysis uses and describes all the data simultaneously, without imposing prior categories; and, because the estimated full-sample factors are orthogonal by construction, decomposing economic forecasts into components attributable to each factor is straightforward. On the other hand, without further assumptions, the economic interpretations of the full-sample factors may not be clear. In contrast, the factors estimated in individual sub-samples have more-obvious economic interpretations, by construction. The factor extracted from the group of mortgage and housing variables, for example, is naturally viewed as a summary measure of housing developments, as reflected in financial markets. However, the sub-sample analyses would generally be expected to have their own shortcomings. In particular, the factors estimated separately in the sub-samples are not guaranteed to be mutually orthogonal, making more difficult the attribution of forecasting power or causality to one factor versus another.

Importantly, however, for reasons that will be discussed presently, the sets of factors extracted by the two methods turn out to be quite similar. Figure 6 compares graphically the four factors estimated jointly from the full sample with those estimated separately in the sub-samples. In the figure, Factor 1 is the estimated factor explaining the greatest share of the variance of the 75 variables; Factor 2 explains the greatest share of the remaining variance after controlling for

Factor 1; Factor 3 explains the most variance after controlling for Factors 1 and 2; and so on.[14] The factors estimated independently from the four sub-samples are designated in the figure as the "housing," "non-mortgage credit", "funding", and "bank solvency" factors.

The comparison in Figure 6 between the estimated full-sample and sub-sample factors is striking. The first factor estimated from the full sample (Factor 1) lines up nearly perfectly with the factor estimated from the housing subgroup (Figure 6, upper left-hand panel). Likewise, the second estimated factor from the full sample (Factor 2) looks very similar to the factor estimated from only the financial variables related to non-mortgage credit, and the third full-sample factor (Factor 3) lies nearly on top of the factor estimated from short-term funding variables only. The fourth full-sample factor, which as noted earlier explains a relatively small amount of the variance of the full set of data, is evidently correlated with the factor estimated from the bank solvency variables (as can be seen in the lower right panel of Figure 6), but the overall relationship is weaker.

The correlations of the full-sample and sub-sample factors, shown in Table 1, confirm the visual impressions of Figure 6. The correlations of Factors 1, 2, and 3 with the housing, credit, and funding factors are 0.97, 0.95, and 0.93 respectively, despite the noisiness of the daily data. The correlation of Factor 4 with the bank solvency factor is only 0.36, however. Interestingly, however, the bank solvency factor has a correlation with Factor 1 of -0.89. Economically, interpreting Factor 1 as the housing factor, that suggests that deterioration in the housing and mortgage markets is an important driver of investor assessments of bank solvency over this period.

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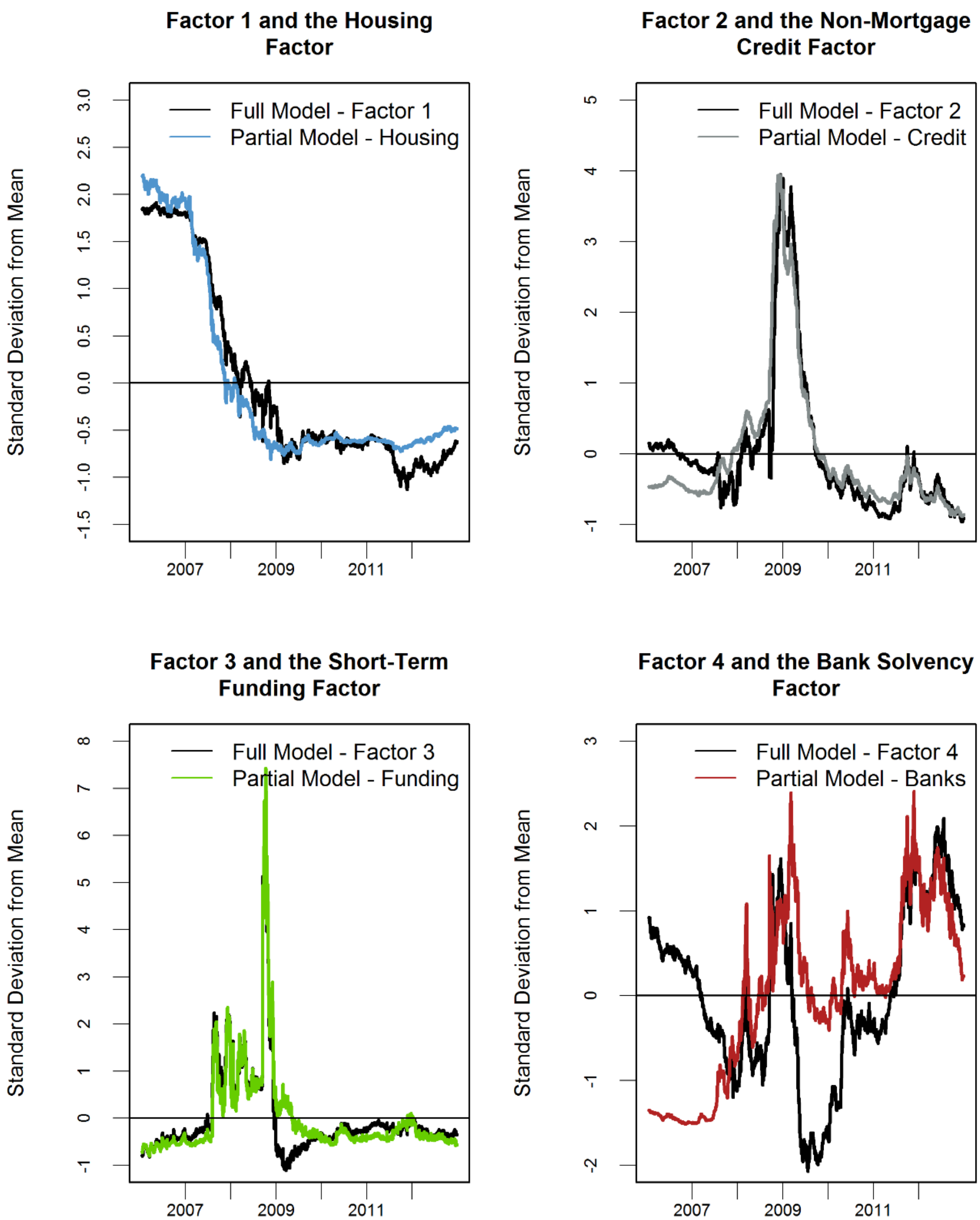
[14] The shares of variance explained by Factors 1-4 are 0.34, 0.24, 0.19, and 0.08, respectively.

Figure 6. Estimated Factors: Full Sample versus Sub-samples, 2006-2012[15]



[15] The panels compare estimated factors from the full sample and from the sub-samples.

Table 1. Correlations of Full-sample Factors and Sub-sample Factors

	Factor 1	Factor 2	Factor 3	Factor 4
Housing	0.97	-0.07	-0.14	0.13
Funding	-0.08	0.29	0.95	-0.02
Credit	-0.15	0.93	0.33	-0.07
Banks	-0.89	0.20	0.03	0.36

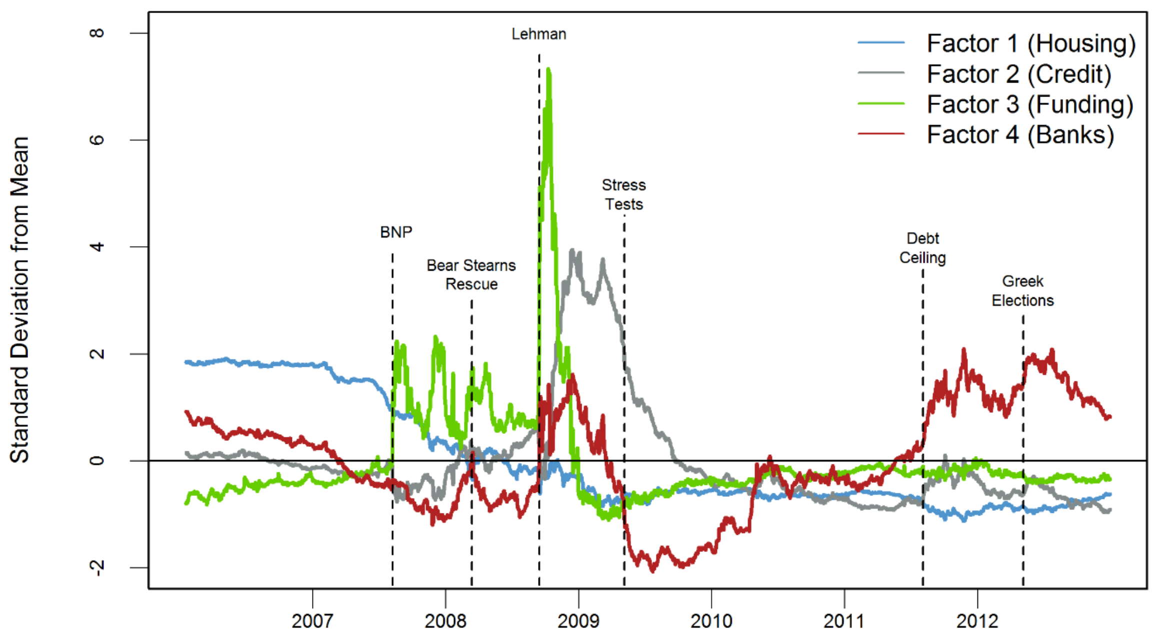
What accounts for the close correlation of the full-sample factors, estimated in an unconstrained way from all 75 variables, and the sub-sample factors, each estimated from about one-fourth of the variables? To answer this question, first note that, in general, estimated factors are identified only up to an orthogonal rotation, as any linear combinations of the estimated factors that preserve their orthogonality will explain precisely the same fraction of the variability of the data. To pick a normalization, in our full-sample estimation I applied a standard procedure called a varimax rotation. By design, this procedure tends to favor normalizations in which some variables have very high loadings on a given factor and near-zero loadings on the other factors.[16] In effect, the varimax procedure tends to associate estimated factors with groups of observed variables that are highly correlated within the group but have relatively low correlations with variables outside the group.

I suggested earlier that the four variables shown in Figure 5 were representative of a broader set of data. The factor analysis confirms that claim. The full-sample factor analysis sorts the larger data set into three, or possibly four, groups of variables, with relatively high intra-group correlations and lower inter-group correlations. Comparing the full-sample and sub-sample factors in turn suggests that these groups are economically interpretable and correspond to our description of the stages of the financial crisis. In particular, Figure 7, which shows the

[16] More specifically, this procedure chooses the particular orthogonal combination of factors that maximizes the sum of the variances of the squared correlations between the explained variables and the estimated factors.

estimated full-sample factors, looks qualitatively very similar to Figure 5, which described the stages of the crisis in terms of a few, apparently arbitrarily chosen variables. In short, the story told using a few chosen variables in Figure 5 can also be told by considering the common factors in larger groups of financial variables.

Figure 7. Estimated Factors from the Full Sample, 2006-2012[17]

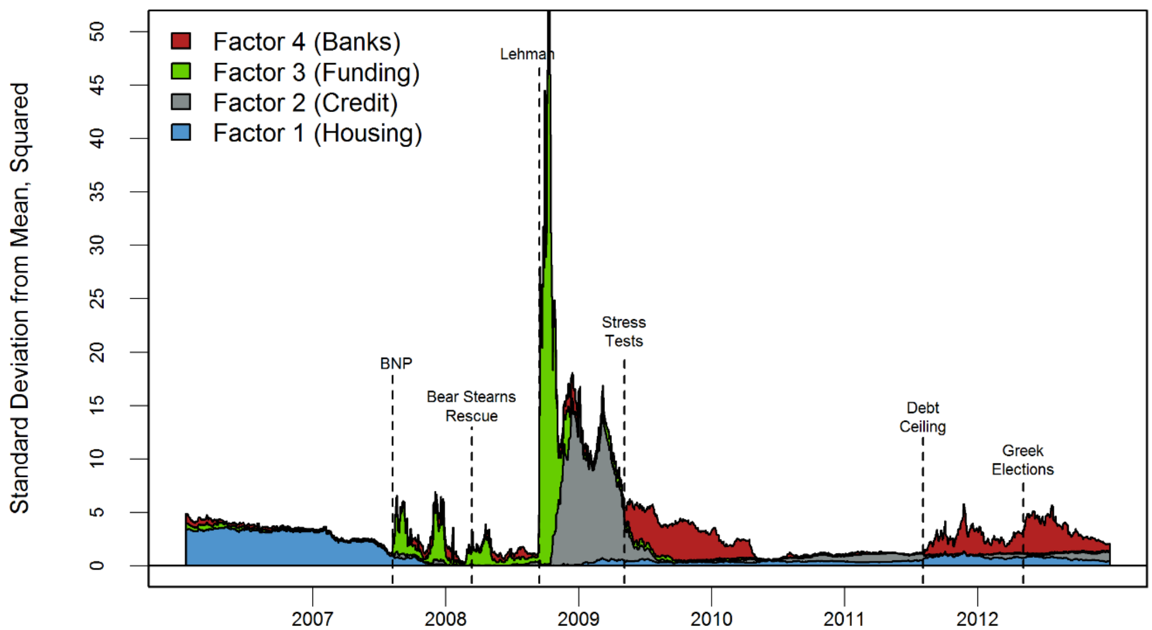


Further motivation for equating the estimated factors with stages of the financial crisis is given by Figure 8, which shows the squared factor scores for the full-sample factors. Loosely, the figure shows the average variability of the financial data and the share of that variability accounted for by each factor over the 2006-2012 period. The periods during which each factor is dominant correspond closely to the stages of the crisis, discussed earlier. For example, Factor 1, which from now on we will identify with housing and mortgages, is the dominant source of variability from the beginning of the sample through mid-2007, while Factor 3, which corresponds to short-term funding stresses, becomes important after the BNP Paribas announcement, spiking after the Lehman failure and the AIG rescue. Factor 2 (non-mortgage

[17] Data show full-sample estimated factors computed from 75 standardized variables over the period of 2006 to 2012.

credit) is the dominant factor beginning shortly after Lehman/AIG into early 2009, and Factor 4 (bank solvency) lags the other stages. Based on our economic interpretations of the estimated factors, we will use them in the next stage of the analysis, where we examine how well they forecasts aspects of real activity.

Figure 8. Squared Factor Scores, 2006-2012[18]



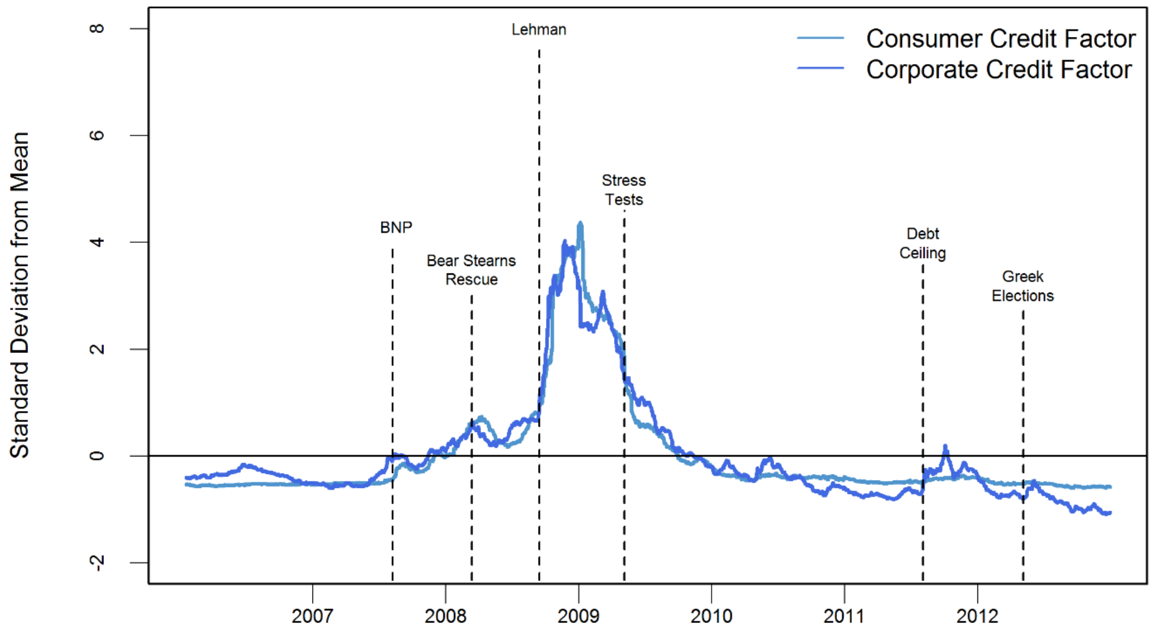
Before turning to those results, there is one further issue of interpretation to discuss. Factor 2, the second most important estimated factor in the full data set, is associated with the deterioration of non-mortgage credit, as reflected for example in wider spreads for securities backed by non-mortgage assets. However, even within a framework that emphasizes credit frictions and asymmetric information, there are at least two alternative economic interpretations of this factor. First, the weakening of the economy, and the associated deterioration of household and nonfinancial firm balance sheets, clearly worsened the creditworthiness of consumers and firms; in principle, this deterioration in borrowers' financial health could account for the blowout in non-mortgage spreads. A second possibility is that the rise in non-mortgage

[18] See note from Figure 7.

spreads reflected primarily a change in investor behavior, as investors lost confidence in all forms of private (and especially securitized) credit. In this interpretation, the panicky pullback from mortgage-related and securitized credit (including the Gorton-Metrick "run on repo") and the subsequent fire sales led to sharply depressed prices and higher spreads on non-mortgage credit as well. In short, in principle, the movements in Factor 2 could reflect developments on either the demand side of credit markets (borrower financial health) or the supply side (lender health and investor confidence).

Although these two interpretations of Factor 2 are not mutually exclusive, the evidence favors the second, investor-led explanation. First, aggregate balance sheets evolve relatively slowly, which seems inconsistent with the sharp deterioration in the non-mortgage credit factor after Lehman, and (given the slow pace of deleveraging and financial recovery) looks especially inconsistent with the sharp improvement in this factor that began just a few months later. Additional evidence on this point is given by Figure 9, which shows factors estimated separately for the household and nonfinancial corporate components of the non-mortgage credit sub-sample. As the figure shows, the two estimated factors lie almost on top of each other, indicating the virtually identical behavior of spreads on these two categories of credit. The correlation of the two series in daily data is 0.97. Since household and corporate balance sheets certainly evolved differently during the crisis (compare Figures 2 and 3 above), the high correlation strongly suggests a common determinant, which I take to be the general run on credit products by panicked investors and the subsequent fire sales. Consistent with this assessment, Longstaff (2010) finds strong evidence of contagion from subprime mortgages to other markets, and Manconi, Massa, and Yasuda (2012) find contagion from toxic securities to corporate bonds arising from changes in investor demands for liquidity.

Figure 9. Estimated Factors for Household and Corporate Credit Variables, 2006-2012[19]



How do the stages of the crisis forecast the economy?

We turn now to a key question: To what extent do the factors, estimated strictly from financial variables and intended to reflect the stages of the financial crisis, predict aspects of real economic activity?

To answer the question, I began with a list of monthly economic indicators, and I aggregated the daily financial factors to monthly averages. (See the Data Appendix for details and sources of economic data. Here, "GDP" is a monthly measure of real output constructed by Macroeconomic Advisers. All other series are from official sources.) For each economic indicator, I estimated a prediction equation over the 2006-2012 sample. Prediction equations, estimated by OLS, include a constant, two monthly lags of the predicted indicator, and the current value and two monthly lags of each of the factors sequentially.[20]

[19] Data show the first factors estimated from consumer and corporate non-mortgage credit separately.

[20] The results are qualitatively similar when multiple factors are included in the same prediction equation. Note that the factors are orthogonal by construction in daily data, but for sampling reasons are not precisely orthogonal when aggregated to monthly series.

Table 2 shows the statistical significance of each full-sample factor in the respective prediction equations, compared to the simple AR2 baseline. As the table shows, Factor 2 (which we identify with non-mortgage credit) and Factor 3 (short-term funding) are statistically significant at the 5% or 1% level for most variables. By this metric, Factor 1 (housing) and Factor 4 (bank solvency) do much worse. Factor 1 is significant at the 10% level only in the prediction equation for the ISM manufacturing index, and Factor 4 is predictive (at the 5% level) only for retail sales and capital goods orders. Not surprisingly, Factor 1 is the best predictor of housing starts, but none of the factors predicts housing starts at a statistically significant level.

Table 2. F-Statistics for Inclusion of Each Factor in Prediction Equations[21]

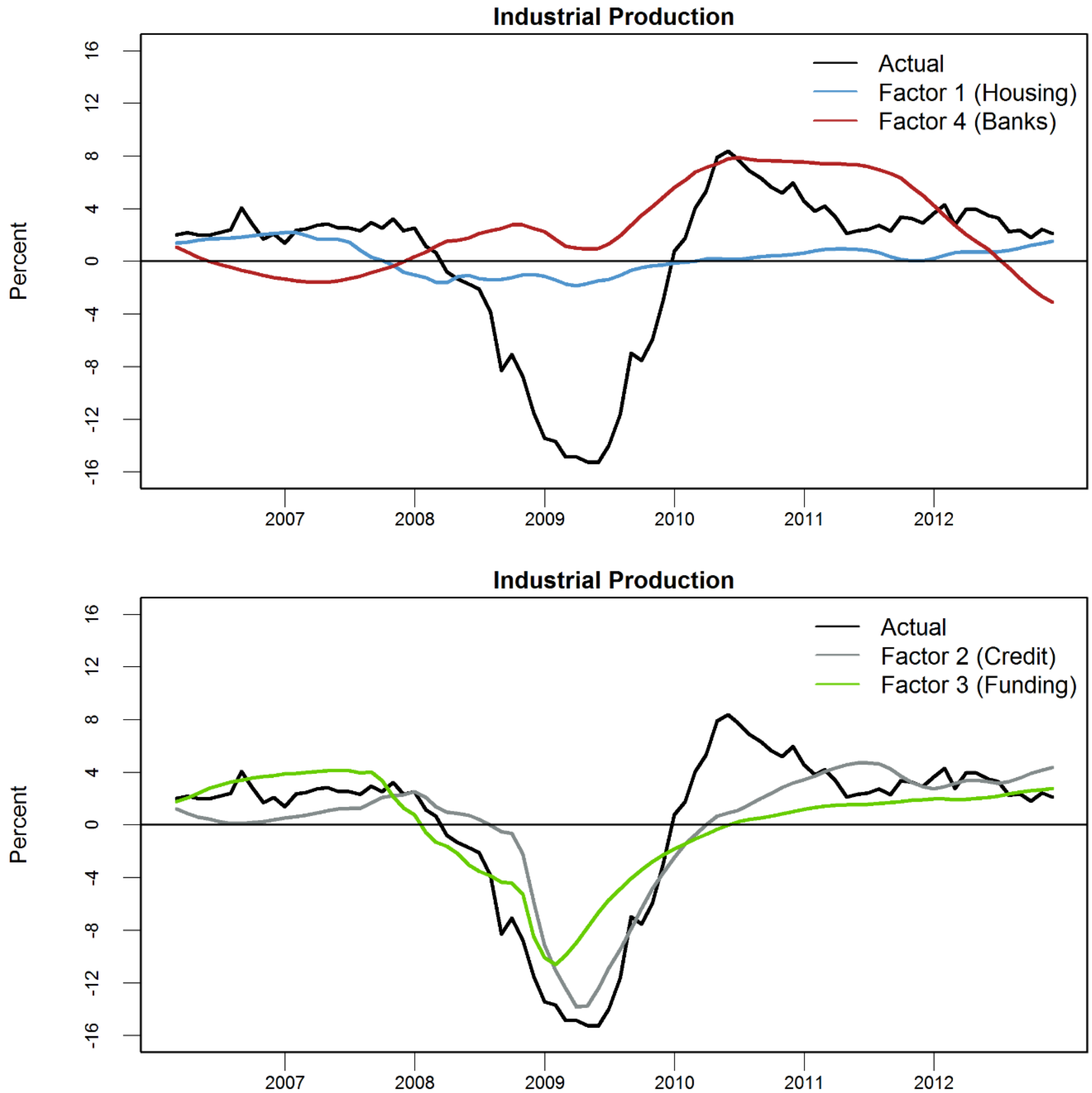
Forecasted variable	Factor 1 (Housing)	Factor 2 (Credit)	Factor 3 (Funding)	Factor 4 (Banks)
GDP	0.06	4.89***	3.27**	0.63
Industrial Production	0.40	7.06***	4.87***	1.50
Employment Ex Construction	1.29	9.61***	2.52*	0.61
Unemployment	1.60	11.33***	2.56*	1.26
Real PCE	0.58	3.68**	3.76**	0.78
Real PCE (Durables)	0.33	3.51**	3.66**	0.44
Retail Sales	0.14	10.36***	4.59***	3.29**
Housing Starts	1.89	1.72	0.93	1.73
Capital Goods Orders	0.71	7.99***	2.96**	3.85**
ISM Manufacturing Index	2.40*	22.69***	13.00***	2.16*
Core PCE Inflation	0.88	1.55	0.85	0.42
df	(3;76)	(3;76)	(3;76)	(3;76)

[21]F-statistics test the inclusion of each factor sequentially in a prediction equation that also contains two monthly lags of the forecasted variable. Statistical significance is indicated as ***, **, and * for p<0.01, p<0.05, and p<0.1.

Table 2 reports the *statistical* significance of the factors as predictors. To assess *economic* significance, I used the estimated prediction equations to create simulated forecasts of each macro variable for the sample period 2006-2012. The simulated forecasts are dynamic, that is, I simulate each prediction equation forward from the beginning of the sample, applying the autoregressive coefficients dynamically to simulated rather than actual values of the macro variables. Note that, in order to assess the importance of each factor in isolation, the dynamic forecasts use one factor at a time, implicitly assuming that other factors are zero.

Figure 10 shows graphically the results of the dynamic simulation exercise for one macroeconomic variable, industrial production. This variable is selected because the results are typical. In both panels of the figure, the black line shows the actual, historical path of (the growth rate of) industrial production for the period 2006-2012. The other lines in the figure show the dynamically forecast path of IP based on each full-sample factor, taken one at a time. As the top panel of Figure 10 shows, dynamic forecasts based on Factor 1 (housing) and Factor 4 (banks) do not capture much of the variation in IP. This result is not surprising, given the low statistical significance for these factors seen in Table 2. In contrast, the bottom panel shows the better fit of the forecasts conditional on Factor 2 (non-mortgage credit) and Factor 3 (funding). In particular, both factors capture much of the decline in activity in the second half of 2008 and the recovery in mid-2009. The funding factor captures a bit less of this decline than the non-mortgage credit factor but also leads the downturn by a bit more. Again, these qualitative results are typical for these simulations. Table 3 shows the correlations of the forecasted macro variables with the dynamic simulations of those variables.

Figure 10. Dynamic Simulations: Industrial Production, 2006-2012[22]



[22] Data show dynamic simulations of a model regressing industrial production on two lags of itself and on each factor and two lags of each factor. Forecasts are dynamic in that the lagged values are predicted rather than realized. Dependent variables are in year-over-year percent changes.

Table 3. Correlation of Actual Values of Forecasted Variables with Simulated values

Forecasted variable	Factor 1 (Housing)	Factor 2 (Credit)	Factor 3 (Funding)	Factor 4 (Banks)
GDP	0.46	0.88	0.80	0.07
Industrial Production	0.65	0.88	0.86	0.22
Employment Ex Construction	0.67	0.94	0.69	0.23
Unemployment	0.90	0.99	0.93	0.90
Real PCE	0.66	0.84	0.86	0.25
Real PCE (Durables)	0.54	0.85	0.86	-0.17
Retail Sales	0.55	0.94	0.79	0.37
Housing Starts	0.77	0.59	0.59	0.46
Capital Goods Orders	0.49	0.85	0.69	0.44
ISM Manufacturing Index	0.61	0.92	0.87	0.03
Core PCE Inflation	0.67	0.73	0.62	0.41

Rather than show analogous figures for each of the macro variables, I consider next a somewhat different comparison. At some level, all the major elements of the crisis were driven by the housing boom and bust and the associated mortgage lending. However, as discussed in the introduction to this paper, the housing and mortgage bust affected the economy through at least two broad channels. First, as in the “financial fragility” narrative of the introduction, actual and potential mortgage losses, together with vulnerabilities such as high leverage and dependence on short-term funding, collapsed investor confidence not only in mortgages but in a much broader set of securities. The loss of investor confidence led to indiscriminate runs, disintermediation, and fire sales that sharply reduced the prices and increased the yields on most forms of private credit, not just residential mortgages. In the present analysis, this “panic” channel can be represented by the combination of Factor 3 (which reflects stresses in markets for wholesale funding) and Factor 2 (which captures the broader run on securitized credit, especially non-mortgage credit).

Second, even in the absence of a panic, the housing and mortgage bust would have affected the economy by damaging sectoral balance sheets. The damage to household balance sheets was particularly severe—this is the "household leverage" narrative of the introduction—and presumably constrained consumer spending. In addition, even in the absence of a panic, mortgage losses would have reduced the capital of banks and other lenders and thus limited the supply of credit. In the analysis presented here, the "non-panic" effects of developments in housing and mortgage markets are represented by full-sample Factor 1, and additional developments regarding the solvency of banks are captured by Factor 4. In the horse races below, we combine the predictive power of Factors 1 and 4 and refer to them in tandem as the "balance sheet channel", that is, together they reflect developments in the balance sheets of both households and banks. However, the inclusion of Factor 4 makes only a modest difference, and the results reported below are not much changed if only Factor 1 is included.

To compare the economic importance of these two channels, we look at the predictive power for our list of economic indicators of the "panic factors" (Factors 2 and 3) versus the "balance sheet factors" (Factors 1 and 4). Again, we estimate prediction equations for each monthly economic indicator. Each equation includes two lags of the predicted variable, plus the current value and two lags of 1) both panic factors or 2) both balance-sheet factors. Table 4 shows the resulting F-statistics for the joint inclusion of the factors against an AR2 baseline.

Table 4. F-Statistics for Inclusion of Pairs of Factors in Prediction Equations[23]

	Panic Factors (Factors 2 and 3)	Balance Sheet Factors (Factors 1 and 4)
GDP	3.57***	0.37
Industrial Production	5.29***	1.20
Employment Ex Construction	5.07***	1.46
Unemployment	8.09***	1.99*
Real PCE	3.75***	0.88
Real PCE (Durables)	6.00***	0.36
Retail Sales	8.50***	1.94*
Housing Starts	1.48	1.63
Capital Goods Orders	4.55***	2.46**
ISM Manufacturing Index	15.66***	2.05*
Core PCE Inflation	1.01	0.72
df	(6;73)	(6;73)

Not surprisingly, given the earlier results, the predictive power of the two "panic factors" greatly exceeds that of the two "balance sheet factors." Exclusion of the panic factors from the prediction equations is rejected at the 1% level for all of the economic indicators, except for housing starts and core inflation. The balance sheet factors are significant at the 10% level for unemployment and the ISM manufacturing index, at the 5% level only for capital goods orders.

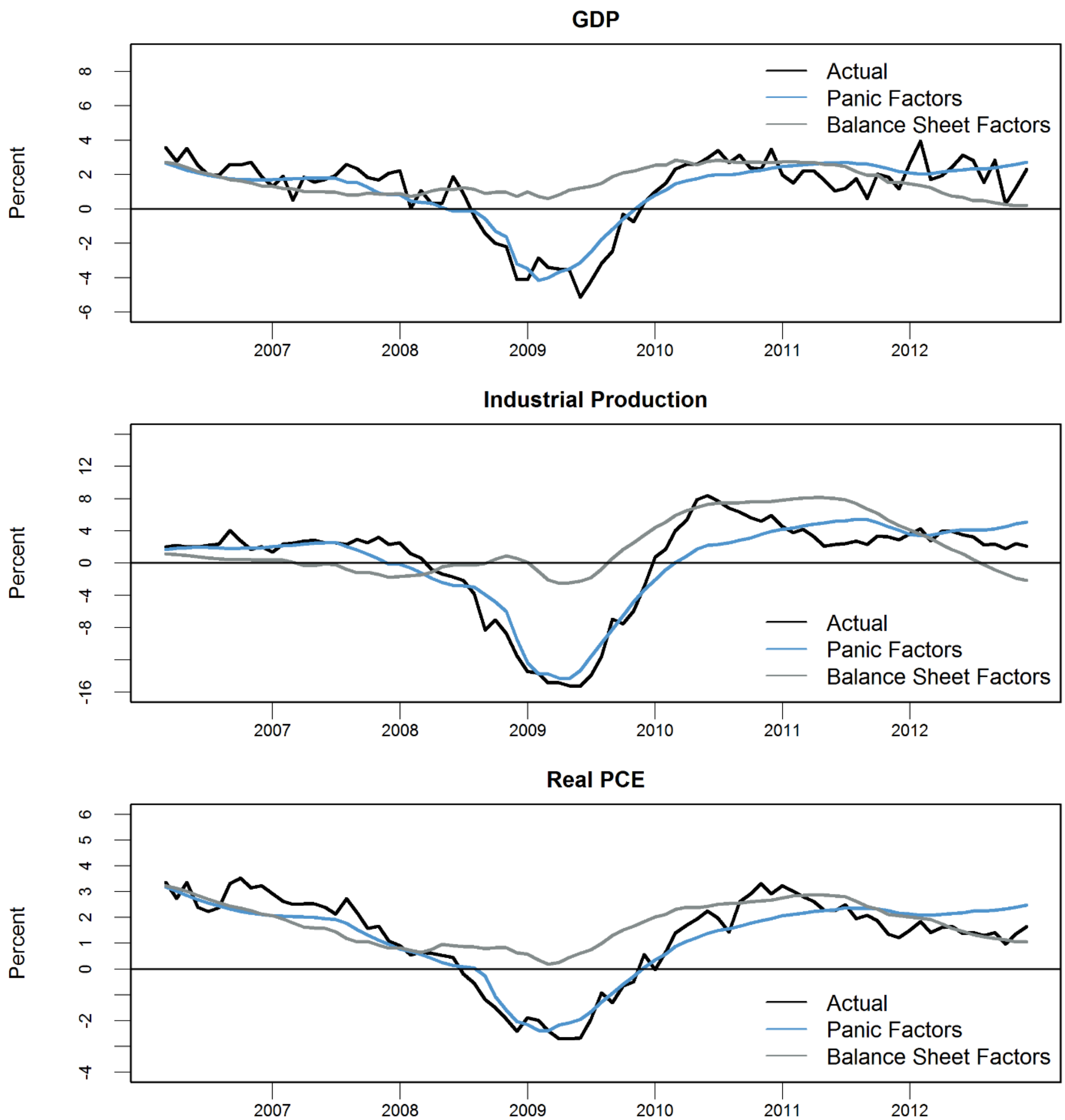
Figure 11 below shows the results of running dynamic simulations for some representative economic indicators, conditional on the estimated values of, separately, the balance sheet factors

[23] Note: F-stats are relative to an AR2 baseline. Statistical significance is shown as *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

and the panic factors. Each figure shows, for the 2006-2012 sample period, the actual path of the economic indicator in question, compared to the simulated values.

Consistent with Table 4, the comparisons are quite one-sided. For housing starts (in the last panel of the figure), the balance sheet variables provide a better fit in the first part of the sample, but not after late 2008. For all the other variables shown, as well as for those omitted for space, the panic factors provide uniformly better (and quite close) fits.

Figure 11. Dynamic Simulations: Panic and Balance Sheet Factors, 2006-2012[24]



[24] Panic factors include Factors 2 (non-mortgage credit) and 3 (funding). Balance sheet factors include Factor 1 (housing) and 4 (bank solvency). Simulations are as in Figure 10.

Figure 11. Dynamic Simulations: Panic and Balance Sheet Factors, 2006-2012 (cont.)

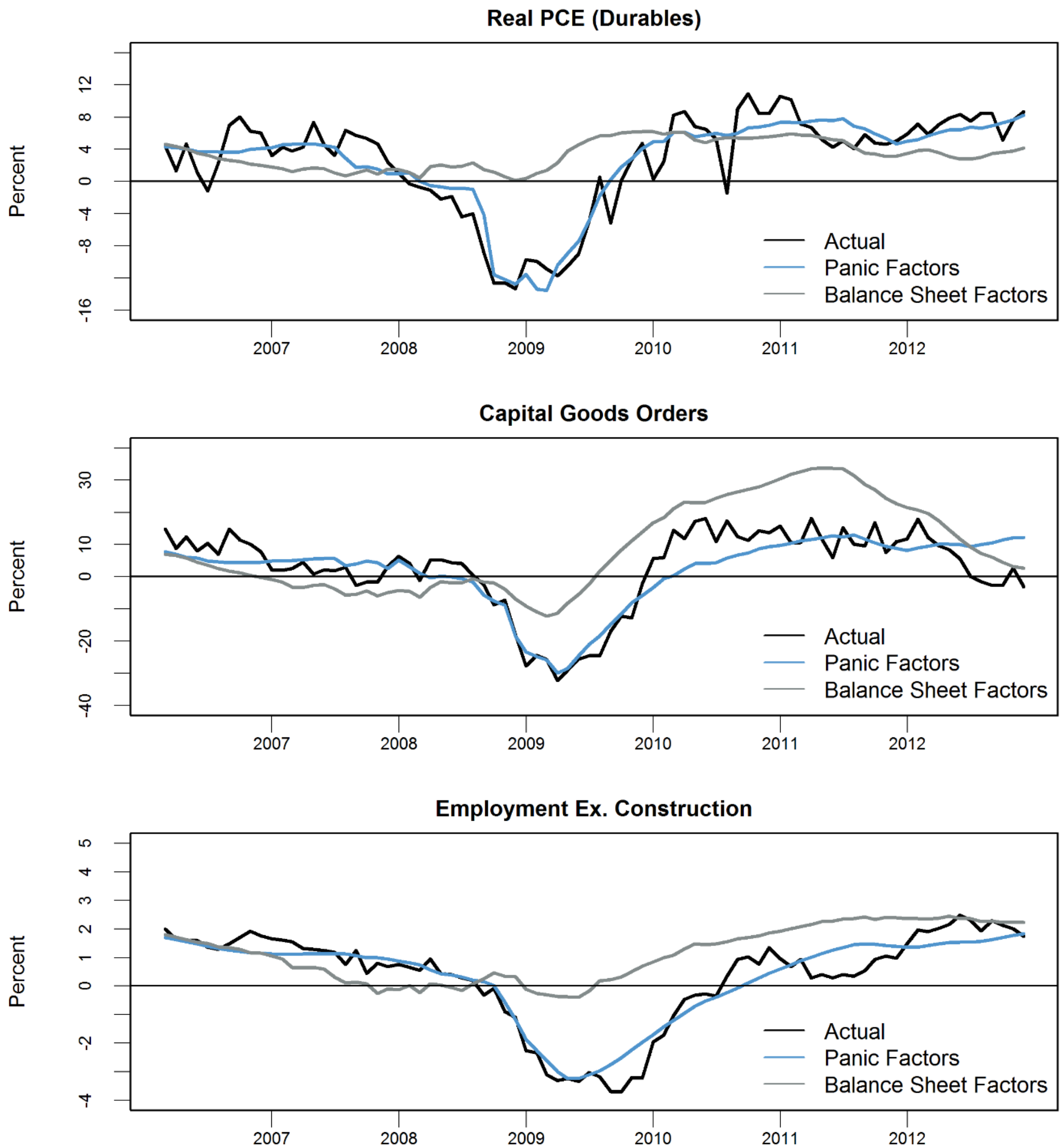
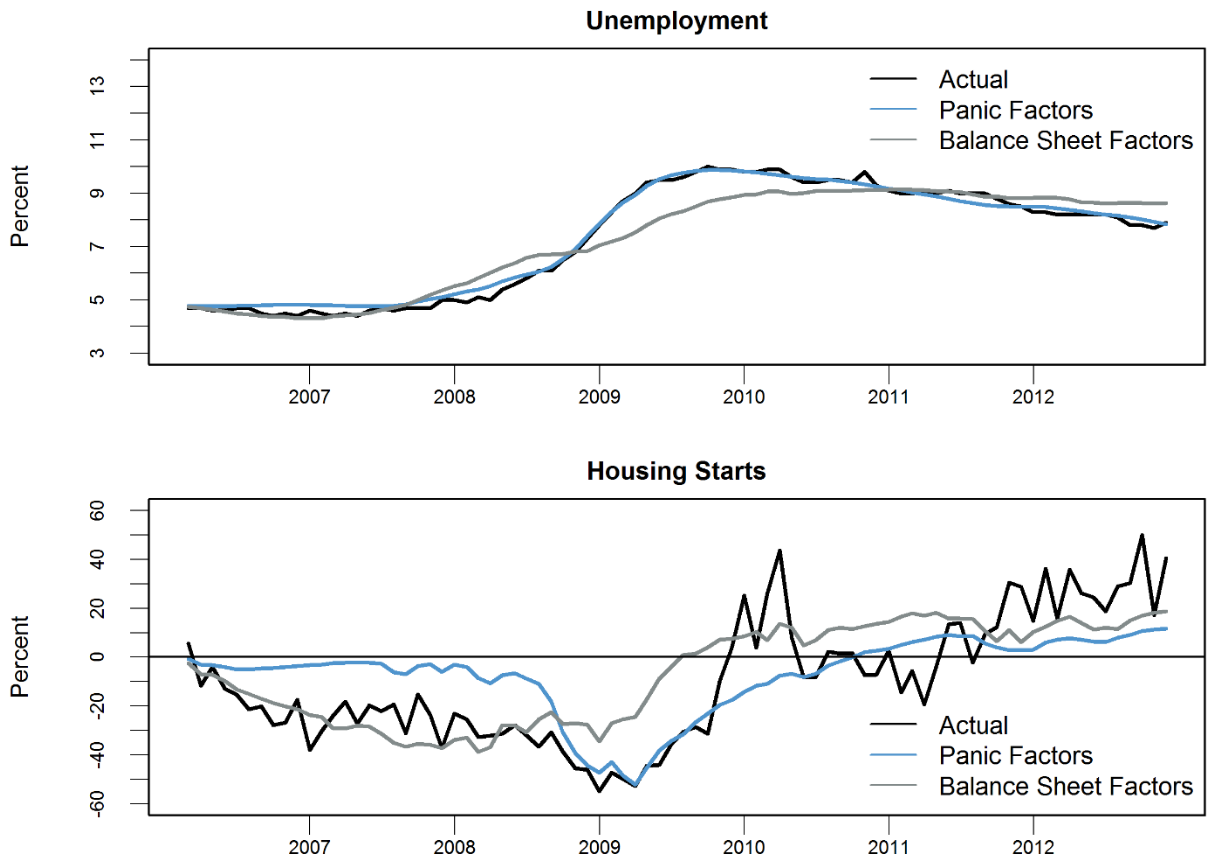


Figure 11. Dynamic Simulations: Panic and Balance Sheet Factors, 2006-2012 (cont.)



The F-statistics shown in Tables 2 and 4, and the dynamic simulations shown in Figure 11, are the main results of this part of the paper. I interpret these results (and the robustness checks discussed below) primarily as affirmation of the role of the panic in explaining the severity of the economic downturn in late 2008 and early 2009. In intuitive terms, we see that financial markets showed large, discontinuous breaks at certain points during the sample period; these breaks were closely associated with variables indicative of panic in funding and securitization markets; and these shifts in turn are strongly predictive of a range of macroeconomic variables. The finding of the centrality of the panic helps to explain why the recession, which initially was not precipitous, became so deep.

Importantly, although balance sheet factors do not forecast economic developments well in my setup, I do not think that a conclusion that these channels of transmission were unimportant is warranted, even putting aside the point that the housing boom and bust helped to trigger the panic in the first place. First, the full-sample factor analysis finds that the factor most closely identified with housing (Factor 1) explains the largest share of the variation of the financial variables considered over the 2006-2012 sample period; and, in particular, that the housing factor dominates this variability during the first part of the sample (Figure 8). Evidently, market participants viewed developments in housing and mortgages as having significant economic consequences, even during the period before they became concerned about broader financial instability. Second, as already discussed, diverse empirical studies have found significant links between household leverage and employment, including Mian and Sufi (2010, 2014b), Hatzius (2008), Haltenhof, Lee, and Stebunovs (2014), and Juselius and Drehmann (2015). Beyond work based on the U.S. experience, several studies have used international and historical data to draw connections between household leverage buildups and subsequent recession (Jordà, Schularick, and Taylor, 2016; Mian and Sufi, 2018a). With all this (and other) evidence taken into account, a plausible conclusion is that the deterioration of household balance sheets contributed to the early declines in consumer spending, particularly on consumer durables, and proved a drag on the pace of recovery, while the panic explains the acute phase of the economic downturn. Likewise, I would not conclude from the poor predictive performance of Factor 4 that the balance sheets of banks (outside of their effects on the probabilities of panic) were not economically important, for very much the same set of reasons. It may be that both household and bank balance sheets evolve too slowly and (comparatively) smoothly for their effects to be picked up in the type of analysis presented in this paper.

Two robustness checks. I briefly report next on a couple of robustness checks of this paper’s key finding, that the panic phase of the crisis was central to explaining the damage that the crisis wrought on the real economy.

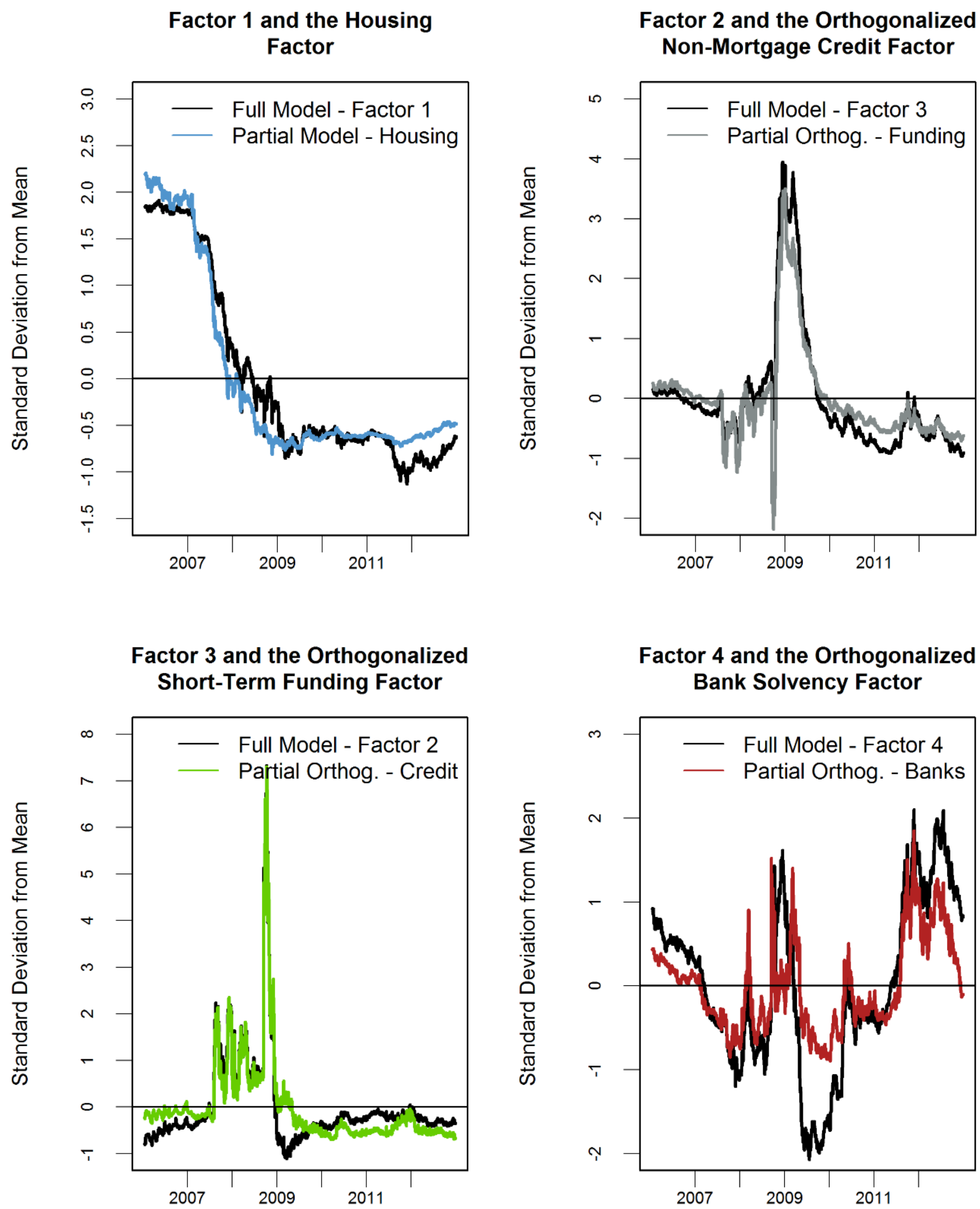
First, the results above use the factors estimated from the full sample of 75 financial variables. Alternatively, we can use the factors estimated separately on each of the four sub-samples to represent the stages of the crisis. Since the subsample factors (unlike the full-sample factors, by construction) are not orthogonal, we orthogonalize them in the order: housing, funding, non-mortgage credit, bank solvency. This ordering is consistent with the hypothesized sequencing of the crisis (see the discussion of Figure 5). In particular, by ordering first the factor estimated in the housing subsample, this procedure attributes co-movements of the housing variables and other variables entirely to the housing factor. This likely understates the effects of the panic, since it excludes the possibility that the panic itself was the cause of some of the decline in the housing market.

Table 5 shows the correlations of the full-sample factors with the orthogonalized sub-sample factors, and graphical comparisons of the full-sample factors with the orthogonalized sub-sample factors are shown in Figure 12. The correlations of the first three full-sample factors with the housing, non-mortgage credit, and funding sub-sample factors respectively remains high, consistent with Table 1. Interestingly, however, the fourth full-sample factor now lines up reasonably well with the factor estimated from the bank solvency sub-sample. (Recall that, in contrast, in Table 1, Factor 1 had the greatest correlation with the banks factor.) Intuitively, the orthogonalization procedure appears to have isolated movements in bank balance sheets that are independent of housing and mortgage developments, and these movements in turn appear to constitute an independent (though relatively small) determinant of financial-market outcomes during the crisis.

Table 5. Correlations of Full-sample Factors with Orthogonal Sub-sample Factors

	Factor 1 (Housing)	Factor 2 (Credit)	Factor 3 (Funding)	Factor 4 (Banks)
Housing	0.97	-0.07	-0.14	0.13
Funding (Orth.)	0.13	0.28	0.94	0.01
Credit (Orth.)	0.04	0.95	-0.27	-0.05
Banks (Orth.)	-0.16	0.09	-0.07	0.87

Figure 12. Estimated Factors: Full Sample versus Sub-samples, 2006-2012[25]



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[25] The figure compares estimated full-sample factors with estimated factors from the sub-samples, where the latter have been orthogonalized in the ordering (housing, funding, credit, banks).

Table 6. F-Statistics for Inclusion of Pairs of Factors in Prediction Equations[26]

	Panic Factors (Orthogonalized)	Balance Sheet Factors (Orthogonalized)
GDP	3.21***	0.18
Industrial Production	4.45***	0.81
Employment Ex. Construction	5.23***	0.25
Unemployment	7.52***	2.32**
Real PCE	3.25***	0.97
Real PCE (Durables)	5.16***	0.28
Retail Sales	7.31***	1.09
Housing Starts	1.70	1.18
Capital Goods Orders	4.10***	1.29
ISM Manufacturing Index	13.69***	1.96*
Core PCE Inflation	1.07	0.91
df	(6;73)	(6;73)

Table 6 reports the results of an exercise analogous to that of Table 4, comparing the predictive power for monthly macroeconomic indicators of the two "panic" factors (funding and non-mortgage credit) and the two "balance sheet" factors (housing and bank solvency), except that here the orthogonalized sub-sample factors are used in place of the full-sample factors. Again, the predictive power of the panic factors is extremely strong, significant at the 1 percent

[26] Panic and balance sheet factors are the orthogonalized partial factors. F-stats are for inclusion of pairs of factors, relative to an AR2 baseline. Statistical significance is shown for *** p<0.01, ** p<0.05, * p<0.1.

level for all variables except housing starts and core inflation. The performance of the balance sheet factors is again much weaker.

For a second robustness check, I also considered proxies for the panic and for balance sheet developments that make no use of factor analysis. Table 7 shows F-statistics for prediction equations, constructed in analogy to Tables 4 and 6, but using (in lieu of estimated factors) monthly values of the FHFA housing price index, the three-month mortgage delinquency rate (from Fannie Mae), and the Gilchrist-Zakrajšek excess bond premium (see Figure 1). The first two variables capture developments in housing and household balance sheets. Recall that the GZ excess bond premium is a measure of corporate bond interest rate spreads which controls for estimated default probabilities and thus reflects primarily investor appetite for corporate credit. We take this measure as a proxy for the panic; its sensitivity to the panic is evident in Figure 1.

In Table 7, the predictive power of (the log levels of) house prices and mortgage delinquencies are assessed (separately) in the first two columns, and that of the excess bond premium (EBP) in the third column. The fourth column shows the predictive power of orthogonalized EBP, that is, the residual when EBP is regressed against both house prices and delinquencies. This procedure has the effect of attributing any joint explanatory power of EBP and the first two variables to the first two variables alone.

Table 7 shows that EBP, even when orthogonalized, is a strong predictor of macro variables; its exclusion from the prediction equations is rejected at $p < .01$ for nine of the eleven variables, with the exceptions being housing starts and core inflation. Interestingly, house prices forecast housing starts and (at lower statistical significance) GDP, durables consumption, and total consumption. Delinquencies forecasts unemployment but not employment ex construction employment. The results look very similar to those obtained from the factor analysis.

Table 7. F-Statistics for Inclusion of Alternative Crisis Measures in Prediction Equations[27]

	House Prices	Delinquencies	EBP	EBP (Ortho.)
GDP	2.62*	1.54	7.85***	7.72***
Industrial Production	1.98	1.37	11.12***	15.89***
Employment Ex Construction	0.75	1.49	8.44***	8.33***
Unemployment	1.71	3.74**	15.24***	9.31***
Real PCE	2.51*	1.10	7.56***	7.42***
Real PCE (Durables)	2.55*	1.02	6.1***	5.06***
Retail Sales	1.30	0.85	8.93***	10.08***
Housing Starts	3.52**	1.68	1.71	2.04
Capital Goods Orders	1.08	1.39	7.91***	10.19***
ISM Manufacturing Index	1.81	1.04	15.47***	12.39***
Core PCE Inflation	1.01	1.71	1.86	1.21
df	(3;76)	(3;76)	(3;76)	(3;76)

IV. Conclusions and Policy Implications

Ten years after the peak of the financial crisis, this paper has reviewed the role of credit factors in the crisis and in macroeconomics generally. A substantial body of evidence now suggests that such factors are important for the behavior of households, firms, and financial intermediaries. Macroeconomic modeling and analysis will have to consider such factors or risk substantial forecast misses, as were seen in 2008.

More specifically, the empirical portion of this paper has shown that the financial panic of 2007-2009, including the runs on wholesale funding and the retreat from securitized credit, was highly disruptive to the real economy and was probably the main reason that the recession was so

[27] Note: F-stats are relative to an AR2 baseline. Statistical significance is shown for *** p<0.01, ** p<0.05, * p<0.1.

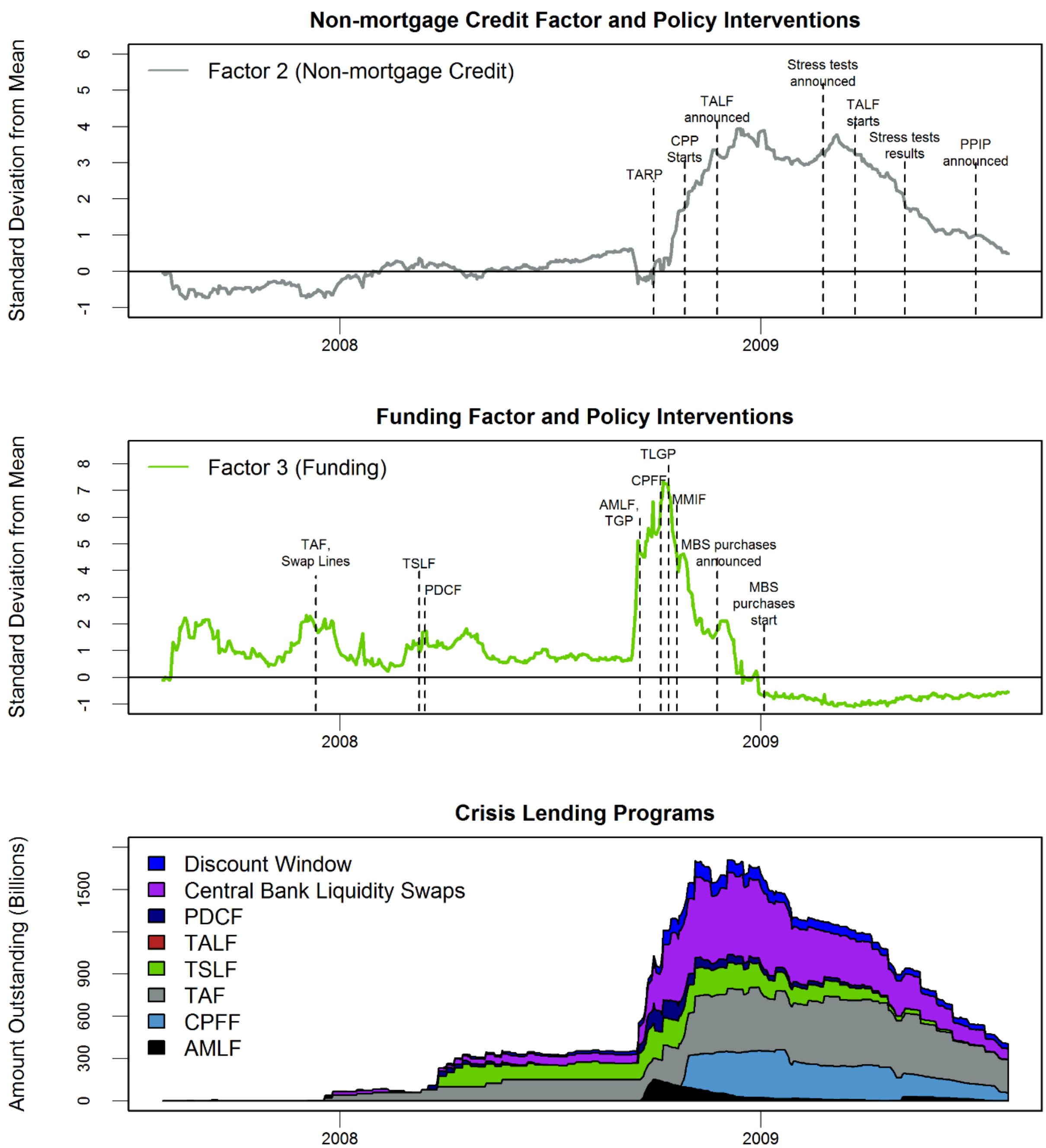
unusually deep. Presumably, the effects of the panic and the associated disintermediation of credit were transmitted through a spike in the economy-wide external finance premium, together with sharp increases in risk aversion and liquidity preference. The results thus support the modeling of Gertler and Kiyotaki (2015), among others. Again, the identification of the effects of the panic in this analysis is based on the evident discontinuities defining the key stages of the crisis. Although the panic was certainly not an exogenous event, its timing and magnitude were largely unpredictable, the result of diverse structural and psychological factors. Nor does it seem plausible that the panic happened because investors suddenly began to expect a severe deepening of the recession (i.e., no reverse causality). Consequently, the fact that the panic preceded a broad-based downturn, and that the end of the panic preceded an improvement in macroeconomic conditions, is *prima facie* evidence that the panic had significant real effects.

Although variables related to housing and household financial distress do not forecast well in my setup, it is worth re-emphasizing that concluding these factors were unimportant is not justified, even putting aside their role as triggers for the panic. On balance, the cross-sectional evidence (and some more-limited time series evidence) supports the conclusion that the state of household balance sheets is an important determinant of spending decisions, including before and during the Great Recession. In particular, it seems plausible that the weakening of household balance sheets was a leading reason for the slowing consumer spending in the period leading up to the crisis (Mian, Rao, and Sufi, 2013), and that the need for household deleveraging and balance sheet repair was a significant headwind to recovery. Because balance sheet conditions usually evolve relatively slowly and continuously, however, identifying their macroeconomic effects by time-series methods (like mine) is difficult, particularly over a short period

The findings concerning the importance of the panic have important policy implications, both retrospective and prospective. Retrospectively, policymakers (including the Federal Reserve and the Treasury) took aggressive and often highly unpopular measures to arrest the financial panic, including expanding lending well beyond the banking system and undertaking a series of interventions to recapitalize the banking system and to avoid the collapse of systemically important financial institutions. The stated rationale for these actions was policymakers' fears that, if not arrested, the panic would do severe and lasting damage to the economy, perhaps resulting in a new Great Depression.

The results of this paper provide some after-the-fact support for policymakers' claims. Figure 13 provides a schematic of the panic and the policy response. The top two panels show the full-sample estimated factors corresponding to non-mortgage credit and to funding. These are the two "panic factors" whose predictive power for the economy was shown above. Also shown in the top two figures are vertical lines indicating some important policy initiatives taken by the Fed, Treasury, and FDIC. Box 1 briefly defines and describes these initiatives. As a metric of the policy response, the bottom panel of the figure shows the portion of the Federal Reserve's balance sheet associated with its various emergency lending programs (but excluding asset purchases associated with quantitative easing or the stabilization of Bear Stearns or AIG).

Figure 13. Policy Interventions, 2007-2009



Box 1. Policy responses to the panic

Programs referenced in Figure 13 include:

1. Discount window lending by the Federal Reserve, including primary, secondary, and seasonal credit. Available to depository institutions only.

2. Term auction facility (TAF), under which discount window credit was auctioned. See Armantier, Krieger, and McAndrews (2008) for details. McAndrews et al. (2017) find that TAF-related events were associated with downward moves in LIBOR.

3. Term securities lending facility (TSLF). In this program, the Fed lent Treasury securities to primary dealers, taking mortgage-related securities as collateral. Fleming et al. (2010) found that TSLF loans reduced repo spreads, but Wu (2008) reported that the TSLF and PDCF (below) had negligible effects on interbank funding spreads when compared to the larger effects of the TAF.

4. Primary dealer credit facility (PDCF), instituted after the near-failure of Bear Stearns, provided overnight credit to dealers. See Adrian and Schaumburg (2012) for a discussion.

5. Asset-backed commercial paper and money market liquidity facility (AMLF), provided collateralized loans to depository institutions willing to purchase ABCP from money-market funds. Duygan-Bump et al. (2010) find that the program helped stabilize money market funds and improved liquidity in the ABCP market.

6. Swap lines by the Fed with foreign central banks. Goldberg, Kennedy, and Miu (2011) summarize the evidence on the effectiveness of the swap lines, finding that their establishment reduced funding pressures abroad and domestically.

7. Term asset-backed securities loan facility (TALF). A joint Fed-Treasury operation, TALF involved Fed loans to holders of AAA-rated ABS. The Fed lent the market value of the ABS less a haircut, and received $20 billion in credit protection

through TARP from Treasury. Covitz et al. (2011) provide some evidence that TALF aided ABS market confidence.

8. Commercial paper funding facility (CPFF). A vehicle through which the Fed purchased highly-rated unsecured and asset-backed commercial paper, secured either via assets or issuer fees. Adrian, Kimbrough, and Marchioni (2011) describe the program and document associated declines in spreads for the classes of purchased paper.

9. Money market investor funding facility (MMIF). A complement to AMLF, the MMIF aimed to provide liquidity to the secondary money market. However, it was never drawn upon.

10. Temporary guarantee program for money market funds (TGP). To stop the run on MMFs, Treasury guaranteed share prices of participating funds.

11. Temporary liquidity guarantee program (TLGP). Under this program, the FDIC insured new senior unsecured debt of depository institutions and their holding companies and guaranteed non-interest-bearing transactions accounts in full.

12. Troubled asset relief program (TARP). Under TARP, Congress authorized up to $700 billion to acquire troubled assets. Funds were used for capital injections in financial institutions, as well as for mortgage relief and to stabilize automobile companies.

13. Capital purchase program (CPP). Used TARP funds to put capital into both large and small banks.

14. MBS purchase program. A precursor to quantitative easing, under this program the Fed purchased mortgage-related securities issued or guaranteed by the GSEs. Hancock and Passmore (2011) found that the program lowered mortgage rates significantly in late 2008.

15. Stress tests (SCAP). A joint effort by the Fed, OCC, and FDIC, with backing of Treasury, to evaluate the ability of large banks to withstand stress scenarios. Banks

that failed the tests were required to raise private capital or accept capital from TARP. See Clark and Ryu (2015) for a description. Morgan, Peristiani, and Savino (2014) study the relationship between stress test announcements and bank stock returns.

16. Public-private investment program (PPIP). In this program, Treasury committed equity and debt financing to public-private funds that would acquire "legacy" residential and commercial MBS.

As can be seen in Figure 13, in the first year or so of the crisis, from August 2007 to August 2008, policy mostly took the form of lender-of-last resort activity, with the Federal Reserve extending its set of allowable counterparties beyond the banking system. Notably, the Fed provided liquidity to primary dealers—large broker-dealers that transact directly with the Fed—through its TSLF and PDCF programs. To overcome the stigma for banks of borrowing from the discount window, the Fed also started a program of auctioning term discount-window credit (TAF). The Fed also reacted to global money-market tensions by instituting currency swap programs with 14 foreign central banks, including four in emerging markets. These liquidity programs did not end the funding crisis but, as Figure 13 suggests, stresses did not worsen significantly over the year.

However, funding problems intensified severely after the failure of Lehman and the rescue of AIG in September 2008.[28] After a money market fund holding Lehman commercial paper "broke the buck," a broad-based run developed in the sector, to which the Treasury responded with a guarantee program and the Fed with new liquidity programs. Increasingly, though, funding concerns were morphing into solvency problems, with investors losing faith in a number of large institutions (Sarkar and Shrader, 2010). The policy responses during this period evolved accordingly. Importantly, passage of the TARP legislation gave Treasury the resources to put

[28] The government takeover of Fannie and Freddie in August 2008 is viewed by some as the seminal event of the crisis. Mishkin (2011) argues that the struggle to pass the TARP in the weeks after Lehman exacerbated market uncertainties as well.

capital into the banking system, through its Capital Purchase Program; it would later use TARP funds also to support mortgage modifications and to prevent the failure of two large auto companies. Two additional steps helped to stabilize the banking system: the guarantees of new senior bank debt by the FDIC, through its TLGP, and the stress tests of the banks conducted by the regulators (with the support of the Treasury) in the spring of 2009. The Fed and the Treasury also collaborated to support the asset-backed securities market through the TALF program.

A substantial literature has evaluated the various programs, in most cases finding that the programs worked as intended (see Box 1 for selected references; see also Logan, Nelson, and Parkinson, 2018, for an overview). Many of these articles rely on event studies, however, which do not always give sharp results. In that vein, we matched up the dates of significant policy announcements or policy implementations with our estimated daily factors, looking for evidence that particular policies were linked to sharp movements in one or more of the factors. We found some evidence of beneficial effects of some specific policies, including the Capital Purchase Program, the FDIC's loan guarantee program, the guarantee of money market funds, the announcement of stress test results, the TSLF, and the TALF. However, the results were not always robust, reflecting the usual difficulties in assessing the extent to which program announcements surprised markets, as well as the fact that many programs were introduced at similar times and in the presence of confounding developments in financial markets.[29] More work, preferably in the context of a consistent overarching framework, is needed to ascertain the relative importance and effectiveness of the various policies brought to bear during the crisis.

The gross fact, though, apparent in Figure 13, is that the panic was brought under control relatively quickly. Funding conditions were substantially improved by the end of 2008, as is evident from the middle panel of Figure 13. As the top panel of the figure shows, stresses in non-mortgage credit markets continued into 2009, but following interventions including the introduction of the TALF and the successful stress testing of the banks, that aspect of the panic subsided as well. Given the results of this paper, which show the strong association of the panic

[29] It is also sometimes difficult to identify when a program was "introduced": when it was announced, when it was implemented, or when its terms or size was changed, for example.

factors and the economy, the suite of policies that controlled the panic likely prevented a much deeper recession than (the already very severe) downturn that we suffered.[30]

Looking forward, the findings of this paper argue for continued vigilance in ensuring financial stability. The costs of a financial crisis, particularly one that includes a sustained financial panic, are very high. Policymakers should err on the side of conservatism in ensuring that financial institutions are well capitalized, do not rely excessively on short-term funding, and have good systems for measuring and managing risk. Regulators should work to shine a light on "dark corners" of the financial system and to take a systemic or macroprudential approach to thinking about risks. Although healthy debates continue, for example on the appropriate level of bank capital, I think post-crisis reforms have significantly improved the resilience of our financial system to future shocks.

Even if financial crises are less likely than in the past, policymakers need to have appropriate tools to fight the next crisis, whenever it may occur. On this count, I am somewhat less sanguine. The orderly liquidation authority, created by the Dodd-Frank law, provides policymakers with important new authorities to help wind down a failing, systemic institution in an orderly way. These new authorities have not been tested, and some have doubts about their efficacy in the context of a systemic panic; but I think, nevertheless, that they are a significant improvement from the improvised authorities available during the last crisis. Other firefighting tools, however, have actually been cut back since the crisis. For example, the Treasury can no longer guarantee money market funds nor can the FDIC guarantee bank debt, as both did to very positive effect during the crisis. The Fed's emergency lending authorities have been limited to some degree; and, importantly, new disclosure requirements have probably stigmatized the discount window and other lending facilities to the point that they might prove useless in a crisis, as even troubled institutions would be reluctant to borrow.

The limitations on firefighting tools mostly reflect a (fully understandable) political reaction to some of the policy interventions of the crisis. However, the evidence of this paper supports the view that those interventions were largely necessary to protect the broader economy. I hope

[30] Using a macroeconomic model with financial frictions, Del Negro et al. (2017) conclude that the Fed's liquidity facilities in particular may have prevented a significantly worse economic collapse than occurred.

that, as time passes, legislators will find it possible to conduct a balanced review and assessment of the tools available to fight the next crisis, making adjustments as needed.

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Data Appendix

Data for the factor model is at a daily frequency, stripped of holidays (when present), and forward filled for missing values. Quarter-end dates for repo data are replaced with the preceding day's value to control for window dressing. All data used in the factor model is standardized over the period from 2006-2012. The factor analysis estimates 4 factors using a varimax rotation, with a lower bound on uniqueness for optimization of 0.05.

Series	Source	Raw Source	Mnemonic Form	Adjustment	Notes
S&P 500	Haver	Standard and Poors	SP500@DAILY	Indexed to January 2007	In raw data, 1941-43=10; Not used directly in factor model
Homebuilder and Subprime Lender Stock Prices	Yahoo Finance; Bloomberg	None	DHI, LEN, PHM, KBH, TOL, FNMA, FMCC, AHMI	Indexed to January 2007, taken as a percent of S&P 500	Using R function quantmod::getSymbols to pull directly from Yahoo Finance API. Subprime Lenders come from Bloomberg. Additional market-cap weighted index (as of 2006:Q4) constructed using CWD, AHMI, NEW
REIT Prices	Yahoo Finance; Bloomberg	None	AVB, EQR, UDR, BBREMTG	Indexed to January 2007, taken as a percent of S&P 500	Using R function quantmod::getSymbols to pull directly from Yahoo Finance API. Bloomberg REIT index from Bloomberg
ABX Indices	Bloomberg	Markit	ABX [Rating] CDSI S6-1 PRC Corp	None	ABX HE BBB 06-01 and ABX AAA HE 06-01
Home Equity ABS Yields	Haver	ICE/BofA/ML	FMLSC@DAILY	For fixed rate, spread over 10-year treasury yield; for floating rate, spread over 3-month LIBOR	Effective Yield
Libor	Haver	ICE	FLOD3@DAILY	Libor-OIS	Yields in percent per annum based on USD; include 3-month, 1-month, and 1 week

Commercial Paper Rates	Haver	Fed	FLCP1D@DAILY	Spread over 1-month OIS	Yields in percent per annum; include 1-day, 7-day, 15-day, 30-day for AA financial, AA asset-backed, and A2P2 non-financial
Treasury Yields	Haver	WSJ	F30JON@DAILY	None	Yields in percent per annum; on-the-run treasury ; Not used directly in factor model
OIS rate	Bloomberg	OTC composite (NY)	USSO[maturity]	None	USD overnight index fixed/float rate swap, where the index rate is the federal funds rate; Not used directly in factor model
GCF Repo Rates	DTCC	None	None	MBS and Agency rates taken as a spread over treasury rate	MBS, Agency, and Treasury collateral; par weighted average based on overnight trades in dollars; http://www.dtcc.com/charts/dtcc-gcf-repo-index
Bank CDS Spreads	Bloomberg	Bloomberg CDS Intraday (NY)	[Ticker] CDS USD SR 5Y D14 Corp	None	Senior 5-year D14 single name CDS for JPM, BofA, WFC, Citi, HBSC, GS, MS, DB, ML, UBS, CS
Bank Stock Prices	Bloomberg	None	JPM, BAC, C, HSBC, WFC, GS, MS, UBS, DB, CS	Indexed to January 2007, taken as a percent of S&P 500	Pull directly from Bloomberg
Corporate Bond Yields	Haver	ICE/BofA/ML	FMLC3A@DAILY	Spread over 10-year treasury yield	Effective Yield; using total corporate bonds by rating; AAA, AA, A, BBB, HY Master II, BB, B, CCC, BB/B
ABS Yields	Haver	ICE/BofA/ML	FMLSC@DAILY	For fixed rate, spread over 10-year treasury yield; for floating rate, spread over 3-month LIBOR	Effective Yield; using fixed and floating rates; Student Loan (float only), Credit Card (fixed and floating), Auto (fixed and floating)

ABS Indices	Bloomberg	Bloomberg/Barclays	LA [asset] TRUU (raw index)	None	Bloomberg's Option-Adjusted Spread; using ABS Auto and Credit Card Total Return Indices
CDX Indices	Bloomberg	OTC composite (NY)	CDX [rating] CDSI GEN 5Y PRC Corp	None	CDX IG in percent, CDX HY in index level; 5-year maturity
Commercial Paper Rates	Haver	Fed	FLCP1D@DAILY	Spread over 1-month OIS	Yields in percent per annum; include 1-day, 7-day, 15-day, 30-day for A2P2 nonfinancial

Data Appendix (continued)

Series	Source	Raw Source	Mnemonic Form	Adjustment	Notes
GDP	Haver	Macroeconomic Advisers	MGDP@USECON	YoY Percent Growth	
Industrial Production	Haver	Federal Reserve	IP@USECON	YoY Percent Growth	
Employment (Ex. Construction)	Haver	BLS	EA16@EMPL; EAC16@EMPL	YoY Percent Growth	Monthly, seasonally-adjusted Household data
Housing Starts	Haver	Department of Commerce	HST@USECON	YoY Percent Growth	New Residential Construction, Table 3. New privately owned housing units started, seasonally adjusted at annual rates
Unemployment	Haver	BLS	LR@USECON	Percent (level)	Household Survey, Table A
Retail Sales	Haver	Department of Commerce	NRST@USECON	YoY Percent Growth	Monthly retail sales and food services; adjusted for seasonal, holiday, and trading-day differences
Core PCE Inflation	Haver	BEA	JCXFEBM@USECON	YoY Inflation	Excluding Food and Energy
Home Prices	Haver	FHFA	USPHPIM@USECON	YoY Percent Growth	Monthly, Seasonally-Adjusted House Price Purchase-only Index
Real PCE	Haver	BEA	CBHM@USECON	YoY Percent Growth	Monthly, Seasonally-adjusted annual rates; Personal Income & Outlays Tables 1 and 7
Real PCE Durables	Haver	BEA	CDBHM@USECON	YoY Percent Growth	Monthly, Seasonally-adjusted annual rates; Personal Income & Outlays Tables 1 and 7
Capital Goods Orders (Nondefense,	Haver	Census	NMOCNX@USECON	YoY Percent Growth	Monthly Advance Report on Durable Goods (NAICS), seasonally-adjusted

Excluding Aircraft)					
ISM Composite Index	Haver	Institute for Supply management	ISMC@USECON	Percent (index level), seasonally-adjusted	Values above 50 indicate growth.