Credit Supply Shocks and Economic Activity in a Financial Accelerator Model

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Abstract

This paper uses the canonical New Keynesian macroeconomic model—augmented with the standard financial accelerator mechanism—to study the extent to which disruptions in financial markets can account for U.S. economic fluctuations during the 1985–2009 period. The key feature of the model is that financial shocks drive a wedge between the required return on capital and the safe rate of return on household savings. A widening of this wedge causes a decline in investment spending and a worsening in the quality of borrowers' balance sheets, factors that lead to a mutually-reinforcing deterioration in financial conditions. We employ the methodology developed by Gilchrist and Zakrajšek [2011b] to construct a measure of distress in the financial sector, which is used to simulate the model. Our simulations indicate that an intensification of financial stresses implies a sharp widening of credit spreads, a significant slowdown in economic activity, a decline in short-term interest rates, and a persistent disinflation. Moreover, such financial market disruptions account for the bulk of contraction in U.S. economic activity that occurred during the last three recessions; these disturbances also generate the investment booms that characterized the 1995–2000 and 2003–06 periods. We also consider the potential benefits of a monetary policy rule that allows the short-term nominal rate to respond to changes in financial conditions as measured by movements in credit spreads. We show that such a spread-augmented policy rule can effectively damp the negative consequences of financial disruptions on real economic activity.

JEL Classification: E30, E44, E52
Keywords: financial disruptions, economic activity, spread-augmented monetary policy rule

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1 Introduction

The acute financial turmoil that raged in global financial markets following the collapse of Lehman Brothers in the early autumn of 2008 plunged the United States into the most severe recession since the Great Depression. The roots of this economic calamity can be found in the meltdown of the subprime mortgage market in the wake of an unexpected and prolonged decline in house prices that materialized in late 2006. The ensuing financial stresses caused enormous liquidity problems in interbank funding markets and ultimately led to the sudden collapse of several major financial institutions and a sharp reduction in credit intermediation; see Brunnermeier [2009] and Gorton [2009] for a detailed account of the 2007–09 financial crisis. Responding to the cascade of massive shocks that roiled financial markets in the latter part of 2008, the U.S. government—in the hope of preventing the financial meltdown from engulfing the real economy—intervened in financial markets at an unprecedented scale, actions that continue to divide economists, policymakers, and the public at large.

In this paper, we assess the implications of such financial disruptions for the real economy. We first discuss the various linkages between the financial sector and the real economy and outline three main channels by which disruptions in financial markets influence macroeconomic outcomes: (1) a pullback in spending owing to reductions in wealth; (2) balance sheet mechanisms that lead to a widening of credit spreads, which curtails the ability of households and businesses to obtain credit; and (3) the direct effect of impairments in the ability of financial institutions to intermediate credit.

Although these channels are relatively well-understood from a theoretical perspective, assessing their quantitative implications remains a considerable challenge for macroeconomists. For example, a fall in output that follows a drop in lending associated with a major financial disruption reflects both supply and demand considerations. In addition, in a world characterized by a rapidly evolving financial landscape, it is difficult to gauge the extent to which various financial asset market indicators provide consistent and credible information about the relationship between the health of the financial system and economic activity.

The paper then describes, what is in our view, a particularly informative indicator of financial market distress. Building on our recent work (see Gilchrist and Zakrajšek [2011b]), we construct this indicator of financial market distress using secondary market prices of bonds issued by U.S. financial institutions. Specifically, using a flexible empirical credit-spread pricing framework, we decompose financial intermediary credit spreads into two components: (1) a component capturing the usual countercyclical movements in expected defaults; and (2) a component representing the cyclical changes in the relationship between default risk and credit spreads—the so-called *financial bond premium*—which, we argue, represents the shifts in the risk attitudes of financial intermediaries, the marginal investors pricing corporate debt claims.

To study the relationship between the financial bond premium and the macroeconomy, we use an identified vector autoregression (VAR) framework that, under reasonable assumptions, allow us to trace out the dynamic effect of an unexpected increase in the financial bond premium on the key macroeconomic and financial variables. In our terminology, such a "financial shock" is associated with a period of temporary, but significant, distress in financial markets. We also show that in response to such an unexpected increase in the financial bond premium—which, by construction, is contemporaneously uncorrelated with the current state of the economy—the net worth position of the nonfinancial sector deteriorates significantly, real economic activity slows appreciably, while both the short- and longer-term risk-free rates decline noticeably.

To provide further insight into the linkages between the financial sector and economic activity, we then study the effect of financial market disruptions in a macroeconomic framework that incorporates financial market frictions into an otherwise standard model of the macroeconomy along the lines of Christiano et al. [2005] (CEE hereafter) and Smets and Wouters [2007] (SW hereafter). The main purpose of this analysis is to disentangle movements in the supply and demand for credit by imposing a structural framework on macroeconomic data. In particular, using quarterly U.S. macroeconomic data, we study simulations of the U.S. economy over the 1985–2009 period based on the canonical New Keynesian model augmented with the financial accelerator framework developed Bernanke et al. [1999].[1]

In our simulation exercises, we use fluctuations in the estimated financial bond premium as a proxy for exogenous disturbances to the efficiency of private financial intermediation within the CEE/SW model augmented with the BGG financial accelerator. We calibrate the key parameters of the model, so that the responses of macroeconomic aggregates to our our measure of financial shocks match the corresponding responses that are estimated using the actual data. Using this realistic calibration of the U.S. economy, we explore the extent to which observable fluctuations in the financial bond premium—an indicator of financial market distress—can account for macroeconomic dynamics during the 1985–2009 period. The results indicate that the model can account well for the overall movements in consumption, investment, output, and hours worked that was observed during this period. The model also does well at matching the observed decline in inflation and nominal interest rates, as well as the sharp widening of nonfinancial credit spreads that typically occurs during recessionary periods.

Finally, we use this framework to analyze the potential benefits of an alternative monetary policy rule that allows for nominal interest rates to respond to changes in financial conditions as measured by movements in credit spreads. The results indicate that by allowing the nominal interest rate to respond to credit spreads, as suggested recently by Taylor [2008], McCulley and Toloui [2008], and Meyer and Sack [2008], monetary policy can effectively damp the negative consequences of financial disruptions on real economic activity, a result consistent with the recent empirical evidence that argues that increases in credit spreads may be one of the earliest and clearest aggregators of

[1] Other formulations of financial market frictions in macroeconomic models include, for example, Fuerst [1995], Carlstrom and Fuerst [1997], Kiyotaki and Moore [1997], and Cooley et al. [2004].

accumulating evidence of incipient recession.[2]

The remainder of the paper is organized as follows. Section 2 discusses the various channels by which financial factors may influence economic outcomes. Section 3 reviews the empirical methodology used to estimate the financial bond premium and provides evidence that financial shocks—identified vis-à-vis unexpected disturbances to the financial bond premium in a standard monetary VAR framework—have significant adverse consequences for the real economy. Section 4 outlines the macroeconomic framework used to study the impact of financial disturbances on the macroeconomy and presents the corresponding results. Section 5 offers a brief conclusion.

2 Finance and the Real Economy

The benchmark macroeconomic model used to study the behavior of firms and households is predicated on the assumption that the composition of agents' balance sheets has no effect on their optimal decisions. Within this Modigliani-Miller paradigm, households make consumption decisions based solely on permanent income—the sum of their financial wealth and the per-period income obtained from the present discounted value of future wages; movements in financial asset prices shape agents' spending decisions to the extent that they influence households' financial wealth, whereas changes in interest rates affect spending decisions because they alter the present discounted values and hence reflect appropriately calculated user-costs for financing real consumption expenditures. On the business side, firms make investment decisions by comparing the expected marginal profitability of new investment projects with the appropriately calculated after-tax user-cost of capital. The relevant interest rate used in such calculations reflects the maturity-adjusted risk-free rate of return appropriate to discount the future cash flows.

Financial market imperfections—owing to asymmetric information or moral hazard on the part of borrowers vis-à-vis lenders—provide a theoretical link between the financial health of households and firms and the amount of borrowing and hence economic activity in which they are able to engage. Although models differ on details, contracts between borrowers and lenders generally require that borrowers post collateral or maintain some stake in the project in order to mitigate the contracting problems associated with such financial market imperfections. For example, when the borrower's net worth is low relative to the amount borrowed, the borrower has a greater incentive to default on the loan. Lenders recognize these incentive problems and, consequently, demand a premium to provide the necessary external funds.

In general, the external finance premium is increasing in the amount borrowed relative to the borrower's net worth. Because net worth is determined by the value of assets in place, declines in asset values during economic downturns result in a deterioration of borrowers' balance sheets and a rise in the premiums charged on the various forms of external finance. The increases in external

[2]See, for example, Gertler and Lown [1999], King et al. [2007], Mueller [2009]; Gilchrist et al. [2009], Gilchrist and Zakrajšek [2011b], and Faust et al. [2011].

finance premiums, in turn, lead to further cuts in spending and production. The resulting reduction in economic activity causes asset values to fall further and amplifies the economic downturn—the so-called financial accelerator mechanism.

Although the theoretical impact of changes in financial conditions on household and business spending decisions through the financial accelerator mechanism is well understood, quantifying the overall strength of this mechanism remains a challenge for macroeconomists. This task is complicated by the fact that it is very difficult to distinguish the effect of a slowdown in economic activity on household and firm spending owing to the usual demand channels absent financial market frictions from the effect that such a slowdown may have through the financial accelerator itself. Nonetheless, a careful assessment of the empirical implications of models that allow for financial frictions—relative to those that assume perfect capital markets—have allowed researchers to make substantial progress in assessing the empirical relevance of changes in financial conditions for real activity.

On the household side, the permanent income model of consumption has stark implications for the responsiveness of consumption to both income and asset values. Transitory changes in income should have very little effect on permanent income and hence consumption. Reasonably calibrated versions of such models imply that households are relatively insensitive to changes in asset values, suggesting that households should increase consumption by three to four cents for every dollar increase in their financial wealth. More importantly, to a first approximation, the value of housing does not represent net wealth for the household sector because an increase in home values is also an increase in the implicit rental cost of housing. As a result, the household sector is no better or worse off when home values rise; see Buiter [2010] for a thorough discussion.

Empirical research provides compelling evidence against the permanent income model of consumption in favor of models in which the quality of household balance sheets plays an important role in determining their consumption decisions. A variety of studies has shown that household consumption is excessively sensitive to movements in transitory income. Whereas the exact cause of this excess sensitivity is subject to a considerable debate, the excess sensitivity is generally attributed to the fact that at least a subset of households faces significant borrowing constraints or engages in precautionary-savings behavior because of imperfect insurance.

In contrast to the predictions of the permanent income model, both microeconomic and macroeconomic studies also suggest an important link between house prices and household consumption (see, for example, Case et al. [2005]; Campbell and Cocco [2008]; and Carroll et al. [2011]). Estimates of the housing wealth effect vary but generally imply that household consumption increases by an amount ranging from 3 to 10 cents for every dollar increase in housing wealth. This response is generally attributed to the fact that at higher equity levels, households can obtain larger home mortgage loans and thus maintain high consumption levels while financing a home. Similarly, existing home owners may engage in mortgage equity withdrawals to finance high levels of consumption relative to their income.

Empirical research also provides evidence that supports the notion that corporate balance sheets influence investment spending, though this evidence is more contentious. It is well known that business investment spending is strongly correlated with corporate cash flow. Earlier research, initiated by Fazzari et al. [1988], has argued that cash flows stimulate investment because internal funds are a cheaper source of finance than external funds. Critics, however, point out that current cash flows may also provide signals about future profits, which, in turn, determine the firm's net worth and hence the strength of its balance sheet. That said, the available evidence suggests that the cash flow mechanism is quite strong for smaller firms, firms with a limited access to corporate credit and equity markets, or firms with weak balance sheets (see, for example, Gilchrist and Himmelberg [1995]).

More recent research has questioned the macroeconomic relevance of this effect by arguing that for large firms that account for the bulk of investment spending, current cash flows serve mainly as signals about future profit opportunities rather than indicators of the strength of their balance sheets (see, for example, Cummins et al. [2006] and Rebelo et al. [2008]). Nonetheless, studies that analyze investment spending during financial crises show that large negative shocks to firms' balance sheets can have important adverse consequences for the investment decisions of large firms, at least during periods of acute financial distress (see, for example, Aguiar [2005] and Gilchrist and Sim [2007]). At the same time, credit spreads on a wide variety of corporate debt instruments typically widen significantly in recessionary periods, a development that is consistent with a deterioration in the overall financial condition of the corporate sector or a worsening of conditions within the financial sector that serves as an originator and guarantor of corporate debt instruments. Although macroeconomic evidence offers mixed guidance on the importance of interest rates for investment spending, recent work by Gilchrist and Zakrajšek [2007] using firm-level data shows that capital formation is highly responsive to changes in corporate credit spreads.

The financial mechanism linking balance sheet conditions of borrowers to real activity is often described as the "broad credit channel." Financial institutions are also likely to suffer from asymmetric information and moral hazard problems when raising funds to finance their lending activities. The focus of this so-called "narrow credit channel" is the health of financial intermediaries and its impact on the ability of financial institution to extend credit. In a fractional reserve banking system, deposits provide a source of funds for lending with only a small fraction of total deposits held as reserves. Because a tightening of monetary policy drains reserves from the banking system, poorly capitalized banks that are unable to raise external funds cut back on their lending. As a result, bank-dependent borrowers, in particular small firms and households that have few alternative sources of credit, reduce spending.[3]

In an important paper, Kashyap and Stein [2000] document the empirical validity of this mech-

[3]See, for example, Bernanke and Blinder [1988], Bernanke and Lown [1991], Kashyap and Stein [1994, 2000], Peek and Rosengren [1995a,b, 2000], Ashcraft [2005], and Gilchrist and Zakrajšek [2011a].

anism by showing that small U.S. commercial banks that are poorly capitalized are especially sensitive to changes in the stance of monetary policy. Although this bank lending channel appears to have important effects on the lending behavior of smaller banks, such banks account for only a small fraction of total bank lending in the United States, which suggests that the bank lending channel may not be a quantitatively important channel through which monetary policy affects the real economy. In a recent paper, however, Cetorelli and Goldberg [2012] argue that this lending channel may also be at work at large commercial banks operating primarily in domestic markets. In contrast, commercial banks with global operations are able to offset declines in domestic deposits through internal funds obtained from their global subsidiaries. In times of a worldwide financial distress, however, the ability of global subsidiaries to provide internal funds to U.S. financial institutions is also likely to be limited in scope, a development that would further strengthen the bank lending channel in the United States.

Although monetary policy may not have a large direct impact through the bank-lending channel, reductions in bank capital during economic downturns can also reduce lending activity. As economic growth slows and defaults and delinquencies rise, the quality of bank loan portfolios deteriorates. Banks seeking to shore up their capital or to meet regulatory capital requirements tighten their credit standards and cut back on lending, an inward shift in loan supply that curtails spending of bank-dependent borrowers; see, for example, Van den Heuvel [2007, 2012] and Bassett et al. [2010].

The strength of this mechanism, of course, depends on the overall health of the banking sector and on the extent to which firms and households are bank dependent. In the United States, the bulk of investment spending is financed by relatively large firms that rely primarily on corporate bond and equity markets to finance their capital expenditures. Nonetheless, certain corporate debt instruments—most notably commercial paper—are typically backed by lines of credit at commercial banks. In addition, a substantial portion of business financing through commercial and industrial loans relies on such credit lines. In times of financial turmoil, even large nonfinancial firms may have a difficult time raising capital in arms-length markets. As these firms tap their backup lines of credit to finance inventories or operating expenditures in the face of falling revenues, banks may be forced to make further cuts in lending to bank-dependent borrowers (see, for example, Ivashina and Scharfstein [2010]).

The direct effect of falling values of assets held by the financial sector is more difficult to assess. Although there is clear evidence that reductions in bank capital have important implications for the lending behavior of small banks, there is less direct evidence to support the claim that a capital channel has important implications for the lending behavior of large banks and nonbank financial intermediaries. Nonetheless, a sharp pullback in lending by large commercial banks and nonbank financial institutions during the recent financial crisis—owing to lack of liquidity in the interbank funding markets or a retrenchment in lending as these institutions seek to replenish depleted capital—very likely caused a severe slowdown in economic activity by constricting the supply of credit.

More generally, spurred by the extraordinary events of the 2007–09 financial crisis, an emergent theoretical literature emphasizes the implications of the capital position of financial intermediaries for asset prices. For example, He and Krishnamurthy [2009, 2010] show that adverse macroeconomic conditions, by depressing the capital base of financial intermediaries, can reduce the risk-bearing capacity of the marginal investor, causing a sharp increase in the conditional volatility and correlation of asset prices and a drop in risk-free interest rates. Relatedly, Acharya and Viswanathan [2010] develop a theoretical framework in which financial intermediaries—in response to a sufficiently severe aggregate shock—are forced to de-lever by selling their risky assets to better-capitalized firms, causing asset markets to clear only at "cash-in-the-market" prices (cf. Allen and Gale [1994, 1998]). Brunnermeier and Pedersen [2009] and Garleanu and Pedersen [2009], in contrast, explore how margins or haircuts—the difference between the security's price and collateral value that must be financed with the trader's own capital—interact with liquidity shocks in determining asset price dynamics.

Empirical support for this type of mechanisms is provided by the recent work of Gilchrist and Zakrajšek [2011b] (GZ hereafter), who employ a large panel of unsecured corporate bonds issued by U.S. nonfinancial firms to decompose the associated credit spreads into two components: a default-risk component capturing the usual countercyclical movements in expected defaults, and a non-default-risk component that captures the cyclical fluctuations in the relationship between default risk and credit spreads. According to their results, the majority of the information content of credit spreads for future economic activity is attributable to movements in this excess bond premium—that is, to deviations in the pricing of corporate debt claims relative to the expected default risk of the issuer. Moreover, shocks to this premium that are orthogonal to the current macroeconomic conditions are shown to cause economically and statistically significant declines in economic activity and inflation, as well as in risk-free rates and broad measures of equity valuations.

Importantly, GZ also show that fluctuations in their excess bond premium are closely related to the financial condition of broker-dealers, highly leveraged financial intermediaries that play a key role in most financial markets, according to Adrian and Shin [2010].[4] Taken together, the evidence presented by GZ supports the notion that deviations in the pricing of long-term corporate bonds relative to the expected default risk of the underlying issuer reflect shifts in the effective risk aversion of the financial sector. Increases in risk aversion, in turn, lead to a contraction in the supply of credit, both through the corporate bond market and the broader commercial banking sector.

[4]Broker-dealers are financial institutions that buy and sell securities for a fee, hold an inventory of securities for resale, and differ from other types of institutional investors by their active pro-cyclical management of leverage. As documented by Adrian and Shin [2010], expansions in broker-dealer assets are associated with increases in leverage as broker-dealers take advantage of greater balance sheet capacity; conversely, contractions in their assets are associated with de-leveraging of their balance sheets.

3 Financial Bond Premium as an Indicator of Financial Stress

The origins of the 2007–09 crisis undoubtedly lie within the U.S. financial sector, which, after a massive buildup in leverage, a prolonged period of loose underwriting standards and mispricing of risk, underwent an abrupt de-leveraging process that sharply curtailed the availability of credit to businesses and households. To measure the cyclical fluctuations in the risk-bearing capacity of the financial sector, we apply the GZ methodology to credit spreads on bonds issued by a broad set of U.S. financial institutions. We then use the excess bond premium based on financial intermediary spreads—which we term the *financial bond premium*—as a summary statistic for distress in the financial system.

The key information underlying our analysis comes from a sample of fixed income securities issued by U.S. financial corporations.[5] Specifically, for the period from January 1985 to June 2010, we extracted from the Lehman/Warga (LW) and Merrill Lynch (ML) databases month-end prices of outstanding financial corporate bonds that are actively traded in the secondary market.[6] To guarantee that borrowing costs of different firms are measured at the same point in their capital structure, we restricted our sample to include only senior unsecured issues with a fixed coupon schedule. After eliminating a small number of extreme observations, our sample contains 886 individual securities, issued by 193 distinct financial firms. (For a complete description of the data and the construction of financial intermediary credit spreads see Gilchrist and Zakrajšek [2011c].)

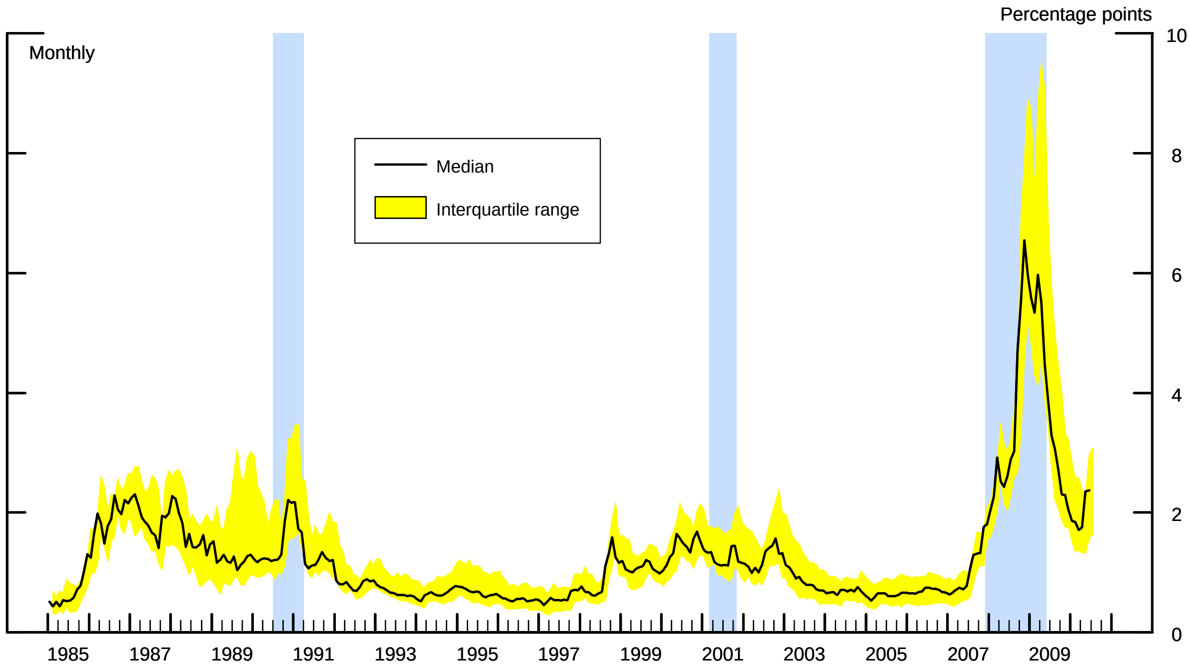
We focus the analys on the period from the mid-1980s onward, a period marked by a stable monetary policy regime and by significant deregulation of financial markets (e.g., the repeal of Regulation Q (1986); the Riegle-Neal Act (1994); the Gramm-Leach-Bliley Act (1999)). In addition, rapid advances in information technology over the past quarter century have significantly lowered the information and monitoring costs of investments in public securities, thereby increasing the tendency for corporate borrowing to take the form of negotiable securities issued directly in capital markets. By improving liquidity in both the primary and secondary markets, these changes in the financial landscape have facilitated more efficient price discovery and have likely improved the information content of credit spreads, both for future economic outcomes and as indicators of financial market distress.

Figure 1 depicts the time-series evolution of credit spreads for our sample of bonds. With the exception of the recent financial crisis, the median credit spread on bonds issued by financial

[5]The definition of the financial sector encompasses publicly-traded financial firms in the following 3-digit NAICS codes: 522 (Credit Intermediation & Related Activities); 523 (Securities, Commodity Contracts & Other Financial Investments & Related Activities); 524 (Insurance Carriers & Related Activities); and 525 (Funds, Trusts & Other Financial Vehicles). Government-sponsored entities, such as Fannie Mae and Freddie Mac, are excluded from the sample.

[6]These two data sources are used to construct benchmark corporate bond indexes used by market participants. Specifically, they contain secondary market prices for a vast majority of dollar-denominated bonds publicly issued in the U.S. corporate cash market. The ML database is a proprietary data source of daily bond prices that starts in 1997. By contrast, the LW database of month-end bond prices has a somewhat broader coverage and is available from 1973 through mid-1998 (see Warga [1991] for details).

Figure 1: U.S. Financial Intermediary Credit Spreads



NOTE: Sample period: Jan1985–Jun2010. The solid line depicts the median spread on senior unsecured bonds issued by 193 financial firms in our sample, and the shaded band depicts the corresponding interquartile range. The shaded vertical bars denote the NBER-dated recessions.

institutions—although countercyclical—fluctuated in a relatively narrow range. In spite of focusing on a relatively narrow segment of the U.S. financial system—namely, the publicly-traded financial corporations with senior unsecured debt trading in the secondary market—the interquartile range of spreads indicates a fair amount of dispersion in the price of debt across different institutions, information that is potentially useful for identifying shocks to the financial system.

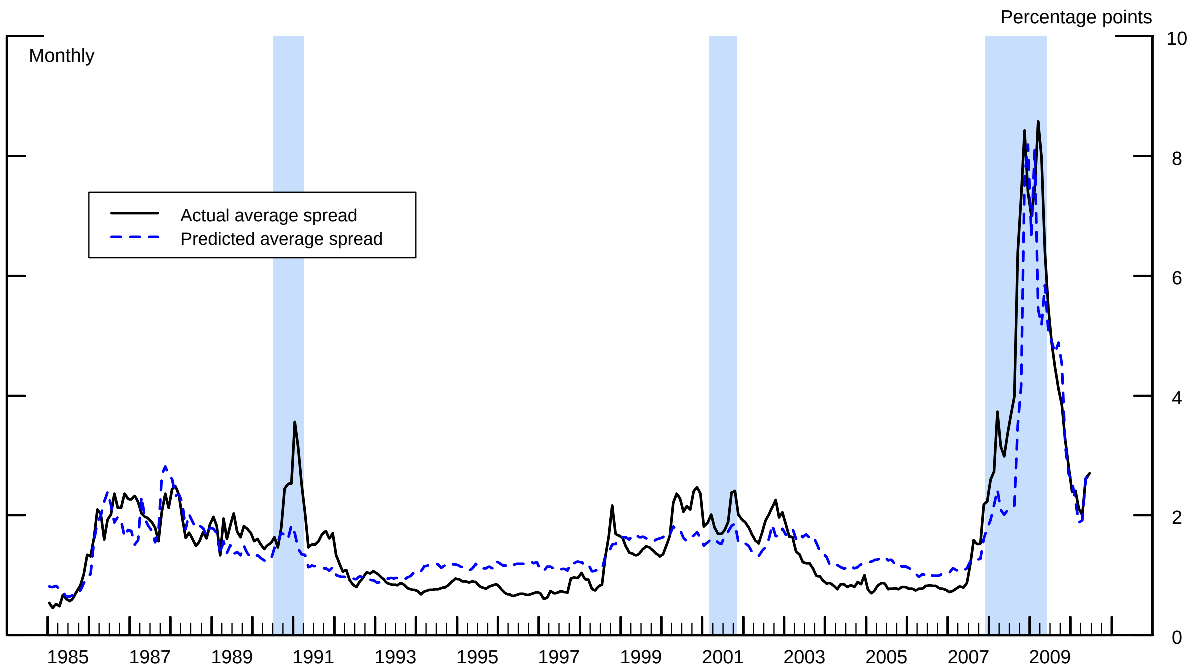
3.1 The Financial Bond Premium

Before presenting our indicator of financial stress, we briefly outline the empirical methodology underlying the construction of the financial bond premium. The GZ decomposition of credit spreads is based on the credit-spread regression of the following type:

$$\ln S_{it}[k] = -\beta DD_{it} + \boldsymbol{\lambda}' \mathbf{Z}_{it}[k] + \epsilon_{it}[k],$$

where $S_i[k]$ denotes the credit spread on bond k (issued by firm i); DD_{it} is the *distance-to-default* for firm i; $\mathbf{Z}_{it}[k]$ is a vector of bond-specific characteristics that controls for the optionality features embedded in most corporate securities as well as for potential term and liquidity premiums; and

Figure 2: Actual and Predicted Financial Intermediary Credit Spreads



NOTE: Sample period: Jan1985–Jun2010. The solid line depicts the average credit spread on senior unsecured bonds issued by 193 financial firms in our sample. The dashed line depicts the predicted average credit spread using the methodology in Gilchrist and Zakrajšek [2011b]. The shaded vertical bars denote the NBER-dated recessions.

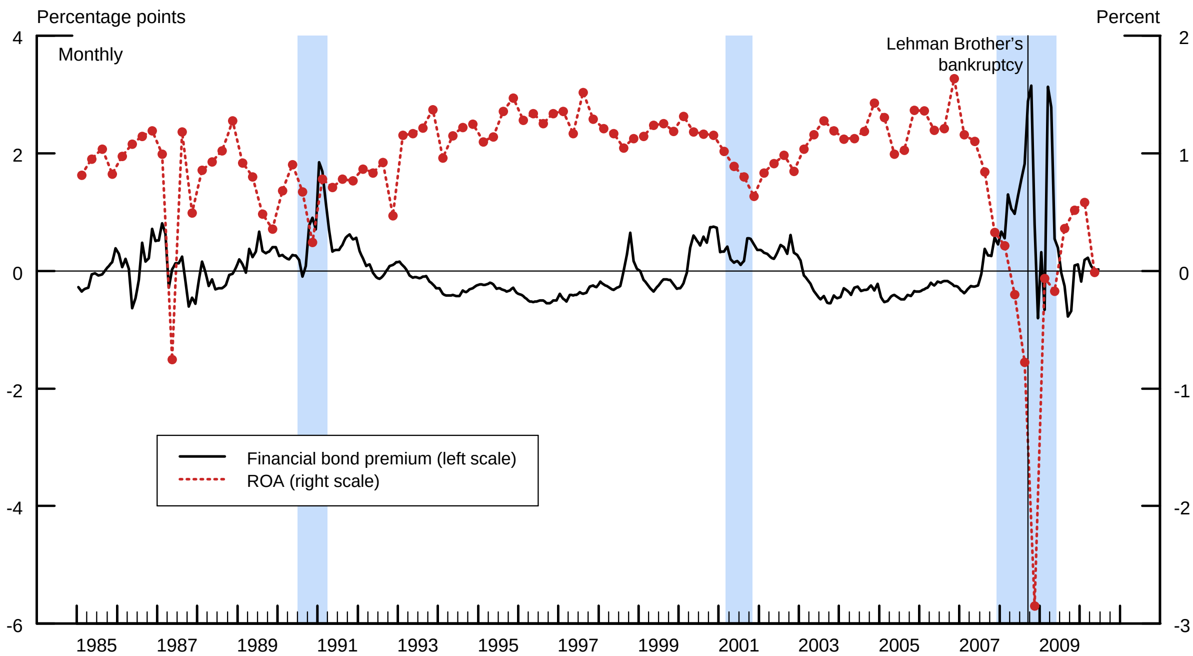
$\epsilon_{it}[k]$ is a credit-spread "pricing error." The key feature of the GZ approach is that the firm-specific credit risk is captured by the distance-to-default (DD), a market-based indicator of default risk based on the option-theoretic framework developed in the seminal work of Merton [1974].

Using the estimated parameters of the credit-spread regression model, the financial bond premium in month t is defined by the following linear decomposition:

$$FBP_t = \bar{S}_t - \widehat{\bar{S}}_t,$$

where $\bar{S}_t$ denotes the average credit spread in month t and $\widehat{\bar{S}}_t$ is its predicted counterpart. As shown in Figure 2, the empirical credit-spread pricing model used by GZ explains a substantial portion of the cyclical fluctuations in financial intermediary credit spreads, a result indicating that the distance-to-default provides an accurate measure of default risk. Note also that the financial bond premium is, by construction, uncorrelated with the observed measures of default risk, so that movements in the financial bond premium likely reflect variation in the price of default risk rather than changes in the risk of default in the U.S. financial sector.

Figure 3: Financial Bond Premium and Financial Sector Profitability



NOTE: Sample period: Jan1985–Jun2010. The solid line depicts the estimated financial bond premium based on financial intermediary credit spreads. The solid dots depict the quarterly (annualized) return on assets (ROA) for the U.S. financial corporate sector, calculated using quarterly firm-level Compustat data. The shaded vertical bars denote the NBER-dated recessions.

The solid line in Figure 3 shows the estimated monthly financial bond premium—the difference between the solid and dotted lines in Figure 2—while the overlayed solid dots denote the quarterly (annualized) return on assets (ROA) in the U.S. financial corporate sector. The high degree of negative comovement between this broad measure of profitability of the financial sector and the financial bond premium is consistent with the view that risk premiums in asset markets fluctuate closely in response to movements in capital and balance sheet conditions of financial intermediaries, a fact also emphasized by Adrian and Shin [2010] and Adrian et al. [2010a,b].

Note that the financial bond premium appears to be a particularly timely indicator of strains in the financial system. The sharp run-up in the premium during the early 1990s, for example, is consistent with the view that capital pressures on commercial banks in the wake of the Basel I capital requirements significantly exacerbated the 1990–91 economic downturn by reducing the supply of bank-intermediated credit (Bernanke and Lown [1991]). In contrast, the robust health of the financial system at the start of the 2001 recession has been cited as an important factor for the absence of a "credit crunch," which, in turn, likely contributed to the fact that the downturn remained localized in certain troubled industries, particularly the high-tech sector (Stiroh and Metli

[2003]).

In regard to the recent financial crisis, the intensifying downturn in the housing market and the emergence of significant strains in term funding markets in the United States and Europe during the summer of 2007 precipitated a sharp increase in the financial bond premium. At that time, banking institutions, in addition to their mounting concerns about actual and potential credit losses, recognized that they might need to take a large volume of assets onto their balance sheets, given their existing commitments to customers and the heightened reluctance of investors to purchasing an increasing number of securitized products. The recognition that the ongoing turmoil in financial markets could lead to substantially larger-than-anticipated calls on their funding capacity and investors' concerns about valuation practices for opaque assets were the primary factors behind the steady climb of the financial bond premium during the remainder of 2007 and over the subsequent year. Once these funding pressures receded and conditions in financial markets—following the unprecedented government interventions in the financial system—stabilized, the financial bond premium returned to its pre-crisis level.

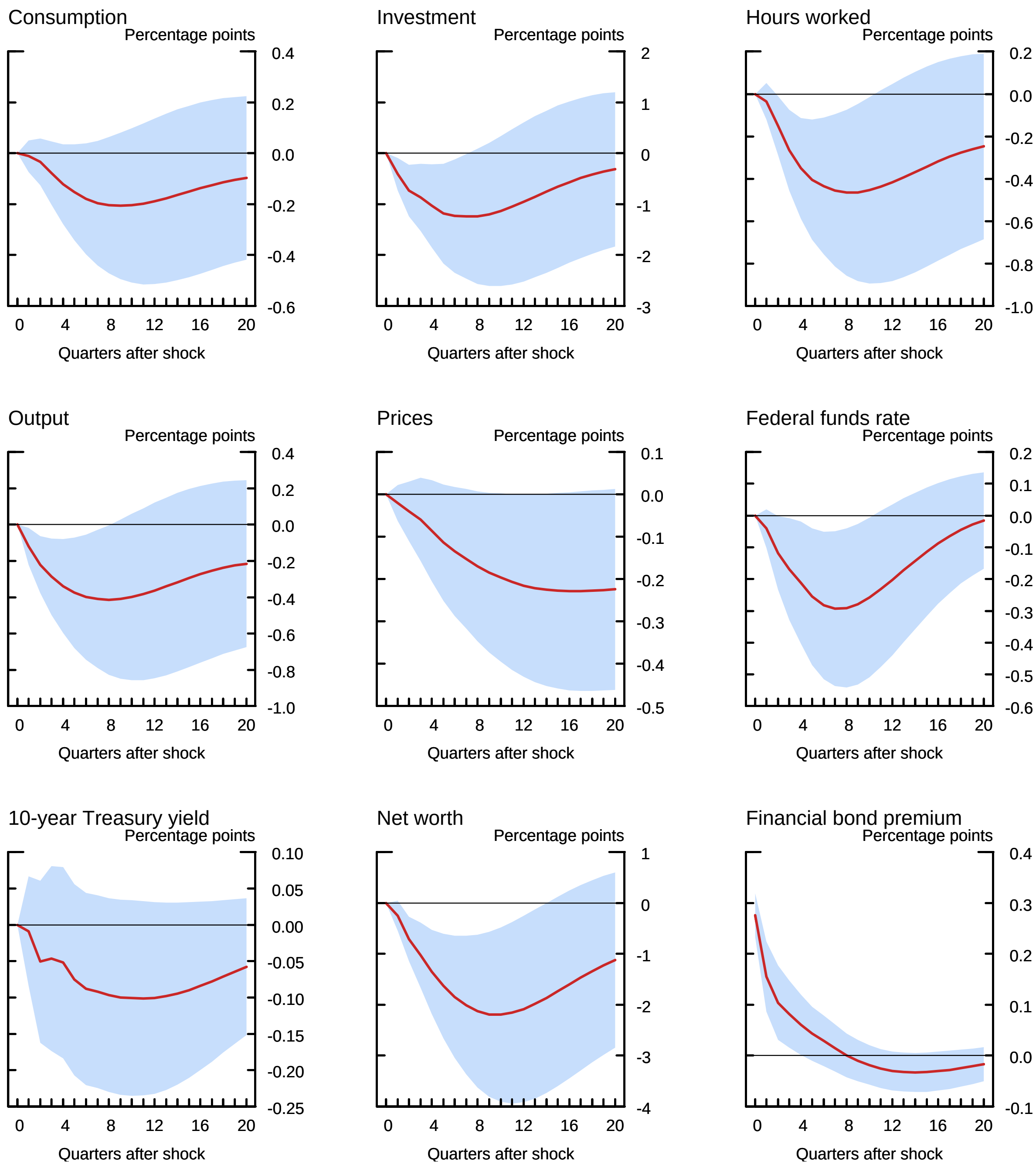
3.2 The Financial Bond Premium and the Macroeconomy

To examine systematically the macroeconomic consequences of financial disturbances, we include the financial bond premium into an otherwise standard VAR. The specification includes the following endogenous variables: (1) consumption growth as measured by the log-difference of real personal consumption expenditures on nondurable goods and services; (2) investment growth as measured by the log-difference of real private investment (residential and business) in fixed assets; (3) the log-difference of hours worked in the nonfarm business sector; (4) output growth as measured by the log-difference of real GDP; (5) inflation as measured by the log-difference of the GDP price deflator; (6) the growth of the market value of net worth in the nonfinancial (nonfarm) corporate sector; (7) the 10-year (nominal) Treasury yield; (8) the effective (nominal) federal funds rate; and (9) the financial bond premium.[7]

The choice of endogenous variables is motivated, in part, by the macroeconomic framework considered in the next section—a New Keynesian model augmented with the financial accelerator mechanism formulated by Bernanke et al. [1999]—which emphasizes credit constraints for nonfinancial borrowers and treats financial intermediaries largely as a veil. Although recent work by Gertler and Kiyotaki [2010], Cúrdia and Woodford [2010], Gertler and Karadi [2011] has made important strides in incorporating a financial intermediary sector into a canonical macroeconomic framework, the highly-stylized nature of the credit intermediation process in these models poses significant challenges for the quantitative evaluation of financial shocks. Our approach, by contrast, sidesteps these difficult calibration issues by assuming that fluctuations in the estimated financial

[7]Consumption and investment series are constructed from the underlying NIPA data using the chain-aggregation methods outlined in Whelan [2002]. The market value of net worth is taken from the U.S. Flow of Funds Accounts.

Figure 4: Macroeconomic Implications of a Financial Shock



NOTE: The figure depicts the impulse response functions from a 9-variable VAR(2) model to a 1 standard deviation orthogonalized shock to the excess financial bond premium (see text for details). Shaded bands denote 95-percent confidence intervals based on 1,000 bootstrap replications.

bond premium provide an adequate description of the disruptions in the financial intermediation process.

The cost of this simplifying assumption is that it ignores the intricacies surrounding the significant dislocations—and their implications for asset prices, monetary and fiscal policy, financial stability, and the real economy—experienced by many asset markets during the 2007–09 crisis. Also, by including only the net worth of the nonfinancial corporate sector, it abstracts from the massive de-leveraging in the household sector that occurred in the wake of the bursting of the housing bubble.[8] With these caveats in mind, we use the multivariate framework specified above to trace out the effect of an unexpected increase in the financial bond premium that is contemporaneously uncorrelated with measures of economic activity and inflation, the balance sheet position of the nonfinancial sector, and the level of short- and long-term interest rates. The responses of key macroeconomic aggregates to an impact of such a financial shock will then provide a benchmark for the calibration of the macroeconomic model considered in the next section.

Figure 4 depicts the responses of the nine endogenous variables to such an unanticipated increase in the financial bond premium. These responses are based on a VAR(2) model estimated over the 1985:Q1–2010:Q2 period, and in which the financial bond premium is ordered last. An unanticipated increase of one standard deviation in the financial bond premium—almost 30 basis points—is associated with a significant slowdown in economic activity. In economic terms, the implications of this financial disruption are substantial: Although the decline in consumption is relatively mild, total private fixed investment drops significantly, bottoming out a full percentage point below trend about five quarters after the shock; hours worked also decelerate markedly, and the output of the economy as a whole does not begin to recover until about a year and a half after the initial impact.

The downturn in economic activity is amplified in part by the substantial drop in the net worth of nonfinancial firms. Moreover, the repair of corporate balance sheets is slow and protracted, as evidenced by the fact that net worth remains significantly below its trend four years after the shock. The combination of the economic slack and appreciable disinflation in the wake of the financial shock elicits a significant easing of monetary policy, as evidenced by the decline in the federal funds rate.

4 A Macroeconomic Framework

The impulse response functions shown in Figure 4 are consistent with important linkages between changes in financial conditions and macroeconomic outcomes. Quantifying these links, however, requires structural models of the macroeconomy that can distinguish between movements in credit supply and demand and that can account for the feedback effects between developments in the finan-

[8]In a small nod to the importance of the housing market during the recent downturn, our measure of aggregate investment includes both residential and business fixed investment.

cial and real sectors of the economy. Recent work by Queijo von Heideken [2009], De Graeve [2008], Christensen and Dib [2008], and Christiano et al. [2009] seeks to quantify these mechanisms by estimating medium-scale macroeconomic models that incorporate credit market imperfections through the financial accelerator mechanism described in Carlstrom and Fuerst [1997] and Bernanke et al. [1999].[9]

Although details differ in terms of model specification, all of these papers document an important role for financial factors in business cycle fluctuations. Queijo von Heideken [2009], for example, shows that the ability of a model with a rich array of real and nominal rigidities to fit both the U.S. and the Euro-area data improves significantly if one allows for the presence of a financial accelerator mechanism; and Christiano et al. [2009] demonstrate that shocks to the financial sector have played an important role in economic fluctuations over the past two decades, both in the United States and in Europe.

For tractability, the model used in our analysis is kept purposefully simple. As in BGG, it allows for a household sector that consumes, saves, and supplies labor; an investment goods sector that produces new capital goods from current output; and a retail sector that faces nominal price rigidities that result in a standard New Keynesian Phillips curve. The model also allows for gradual adjustment of consumption by assuming that households find it costly to change their consumption levels relative to past consumption (i.e., habit formation); gradual adjustment of business investment is achieved by assuming that capital-goods producing firms face increasing marginal costs when the investment goods producing sector expands rapidly (i.e., higher-order investment adjustment costs). These adjustment costs imply that asset prices—the value of capital in place—increase during economic expansions. Monetary policy in the model is conducted according to a modified Taylor-like rule that assumes that the monetary authority, given interest-rate smoothing, adjusts nominal short-term interest rates in response to changes in current inflation and output growth.

As in BGG, the model also allows for an entrepreneurial sector that faces significant credit market frictions in the process of owning and operating the existing capital stock. These frictions give rise to an external finance premium that creates a wedge between the required return on capital—the rate at which entrepreneurs can borrow to finance capital accumulation—and the risk-free rate of return received by the household sector for its savings. In this environment, an expansion in output causes an increase in the value of assets in place and, as result, an increase in the entrepreneurial net worth. As entrepreneurs' net worth expands relative to their borrowing, the external finance premium falls, causing a further increase in both asset values and investment demand. These feedback effects, in turn, further amplify the financial accelerator mechanism.

The key parameters of the model are chosen so that the responses of macroeconomic aggregates to a financial disruption roughly match the corresponding responses shown in Figure 4. Using this

[9] In an alternative approach, Levin et al. [2004] employ firm-level data on credit spreads, EDFs, and leverage to estimate directly the structural parameters of the debt-contracting problem underlying the financial accelerator model of BGG.

procedure, we explore the extent to which observable fluctuations in the financial bond premium can account for the business cycle dynamics of the U.S. economy during the 1985–2009 period. We then use this framework to analyze the potential benefits of an alternative monetary policy rule, a rule that allows for nominal interest rates to respond to changes in financial conditions as measured by movements in credit spreads.

This analysis is prompted by the observation that the behavior of key private interests rates during the recent crisis diverged markedly from their usual comovement with the federal funds rate. In response, a number of prominent observers have suggested that credit spreads should be given independent weight in monetary policy decisions. Most notably, Taylor [2008] has argued that the intercept term of his famous rule should be adjusted downward in proportion to observed movements in the spread of term Libor over rates on comparable-maturity overnight index swaps (OIS).[10] Others have suggested that monetary policy should pay close attention to the balance sheets of financial intermediaries. Christiano et al. [2008], for example, develop a model in which financial disruptions are an important source of economic fluctuations and where a Taylor rule modified to include a response to aggregate credit delivers superior macroeconomic outcomes.

In our framework, disturbances in the financial intermediation sector are the sole source of cyclical fluctuations. To assess the degree to which this type of modification of our baseline policy rule would improve macroeconomic stability, we consider a policy rule in which monetary authorities also respond to movements in observed credit spreads. Specifically, the monetary authority allows the nominal interest rate r^n_{t+1} to respond to inflation (π_t), output growth (y_t), and the credit spread (s_t), according to

$$r^n_{t+1} = r^n + \phi_r r^n_t + \phi_\pi \pi_t + \phi_y y_t + \phi_s s_t,$$

where $0 < \phi_r < 1$ is the parameter governing the degree of interest rate smoothing, while $\phi_\pi > 0$, $\phi_y > 0$, and $\phi_s \leq 0$ determine the response of the policy interest rate to inflation, output growth, and changes in financial conditions, respectively, where the latter is summarized by the movements in credit spreads.[11] Note that this adjustment implies that the policy rate be reduced—relative to what our baseline policy rule would prescribe—when credit spreads are higher than normal; conversely, the policy rate should be raised in response to an unusual easing of financial conditions.[12]

[10] The Libor-OIS spread is a conventional measure of counterparty credit risk in interbank funding markets; see, for example, Taylor and Williams [2009].

[11] By specifying the rule in which the short-term interest rate responds to output *growth*—as opposed to the output *gap*—the monetary authority is assumed to follow a robust first-difference rule of the type proposed by Orphanides [2003]. As shown by Orphanides and Williams [2006], such first-difference rules are highly successful in stabilizing economic activity in the presence of imperfect information regarding the structure of the economy; moreover, according to the simulations reported by Orphanides and Williams [2006], such a robust monetary policy rule yields outcomes for the federal funds rate that are very close to those seen in the actual data, especially for the period since the mid-1980s.

[12] The view that the central bank should raise short-term interest rates to "prick" asset bubbles is widely rejected by today's profession, because monetary policy is too blunt of a tool to allow the type of surgical intervention required to deflate a bubble without plunging the economy into a recession. Nevertheless, modifications of simple policy rules to include a measure(s) of economy-wide financial conditions have been proposed by the advocates of the "leaning

Of course, in the case where $\phi_s = 0$—the baseline case—the monetary authority does not respond directly to changes in financial conditions.

4.1 Baseline Results

Figure 5 shows the impulse responses of the selected macroeconomic variables implied by the model in response to a financial shock, assuming the baseline specification of the monetary policy rule (i.e., $\phi_s = 0$). We show impulse responses for two hypothetical economies that differ only in the extent to which the credit intermediation process is subject to frictions arising from the agency problem in financial markets. In our framework, the severity of financial frictions is governed by the value of parameter $0 \leq \chi < 1$, with $\chi = 0.05$, implying a relatively modest degree of financial market imperfections, while $\chi = 0.10$ implies a somewhat greater inefficiency in the process of credit intermediation.[13]

According to these results, the model with a relatively high degree of financial market frictions captures remarkably well the shape of the corresponding responses based on the actual data shown in Figure 4. Consumption, investment, hours, and output all exhibit significant declines in responses to an adverse financial shock, with the peak decline in the response of each variable closely matching its empirical counterpart. Although the model delivers the qualitative dynamics for each of those variables that are consistent with those observed in the data, the model does produce a peak response that is somewhat earlier than the peak response observed in Figure 4.

The decline in the price level implied by the model with a relatively high degree of financial market frictions also roughly matches the deceleration prices seen in the data. Furthermore, given the estimated baseline policy rule—in which the coefficient on the credit spread $\phi_s = 0$—the model-implied dynamics for inflation and output generate a path for the nominal short-term interest rate that is broadly in line with the estimated response of the federal funds rate to an unanticipated increase in the financial bond premium.

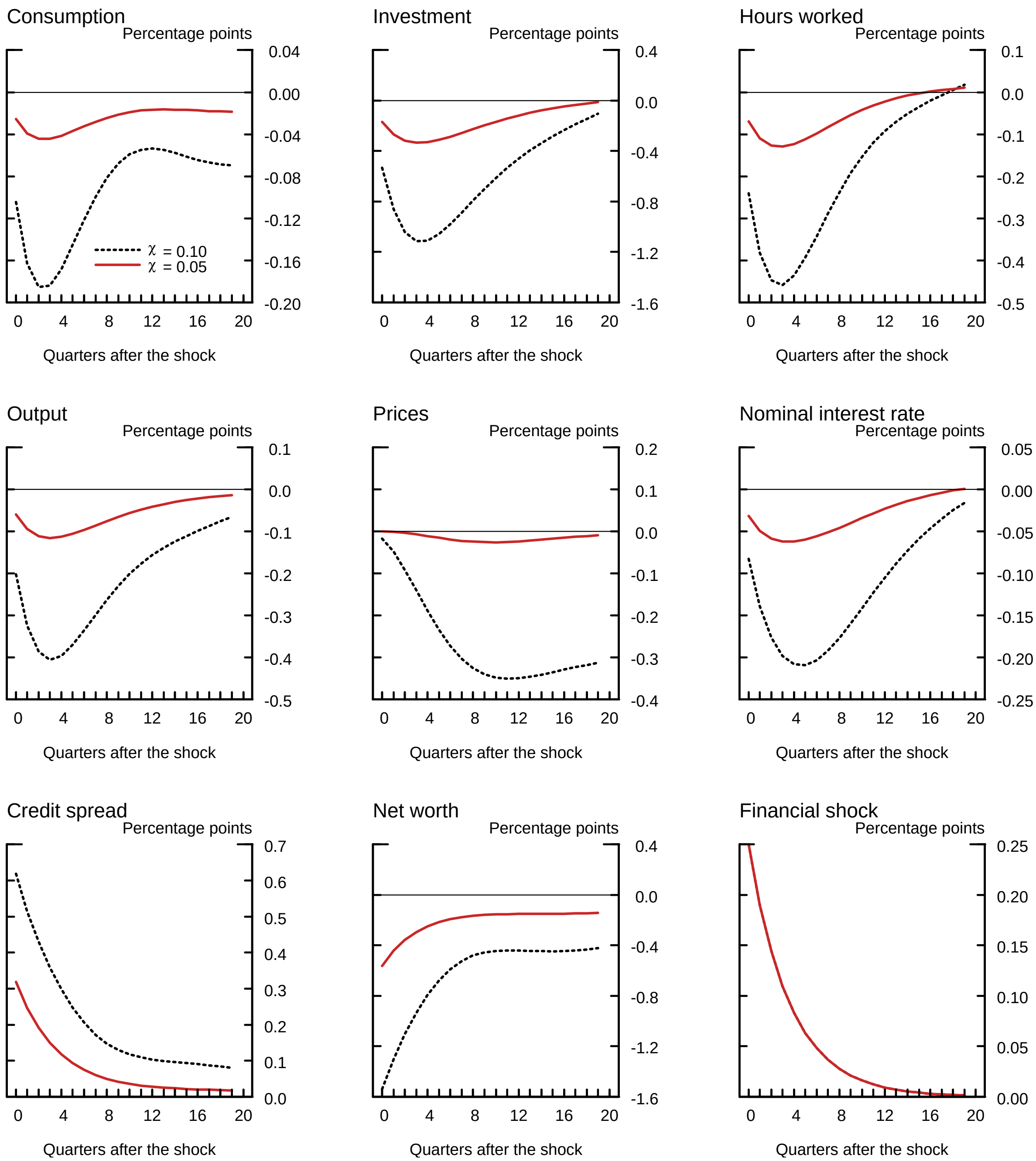
We now consider the ability of the model with a relatively high degree of financial market frictions ($\chi = 0.10$) to explain economic activity over the 1985–2009 period. To do so, we first initialize the model to be in steady state as of the end of 1984. We then feed in the model, as disturbances to the efficiency of the credit intermediation process, the actual innovations to the financial bond premium (based on the AR(1) model) over the 1985:Q1–2009:Q4 period. Figure 6 shows the evolution of the key macroeconomic variables of the U.S. economy over this period, while Figure 7 shows the corresponding path for the model-implied variables.

against the wind" principle, which argues that the central banks should cautiously raise interest rates beyond the level necessary to maintain price stability over the short to medium run, when a potentially detrimental asset price boom has been identified (cf. Borio and Lowe [2002, 2006]). Importantly, the proponents of this view stress the non-linear nature of the policy response, as positive and negative asset price shocks have asymmetric macroeconomic effects, as well as the strong informational requirements concerning the properties of the emerging bubble.

[13] A model with frictionless financial markets corresponds to $\chi = 0$; see Gilchrist and Zakrajšek [2011c] for a detailed discussion.

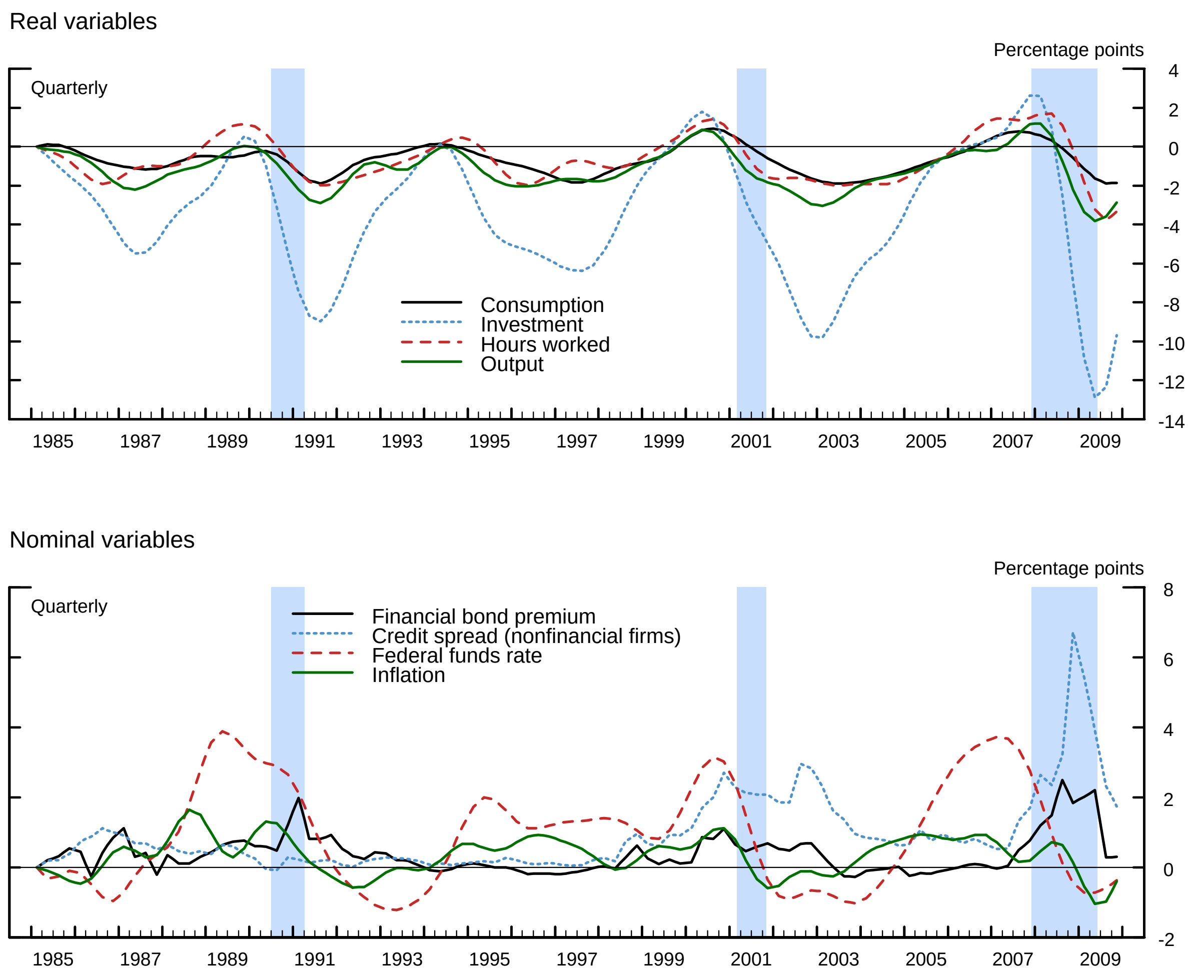
Figure 5: Model-Based Impulse Responses to a Financial Shock

(*Baseline Monetary Policy Rule*)



NOTE: The figure depicts the model-based impulse response functions—for a different degree of financial market frictions—of selected variables to a 1 standard deviation financial shock for the baseline specification of the monetary policy rule, a case in which the monetary authority does not respond to credit spreads—that is, $\phi_s = 0$ (see text for details). All variables are expressed in percentage-point deviations from their respective steady-state values.

Figure 6: U.S. Macroeconomic Performance

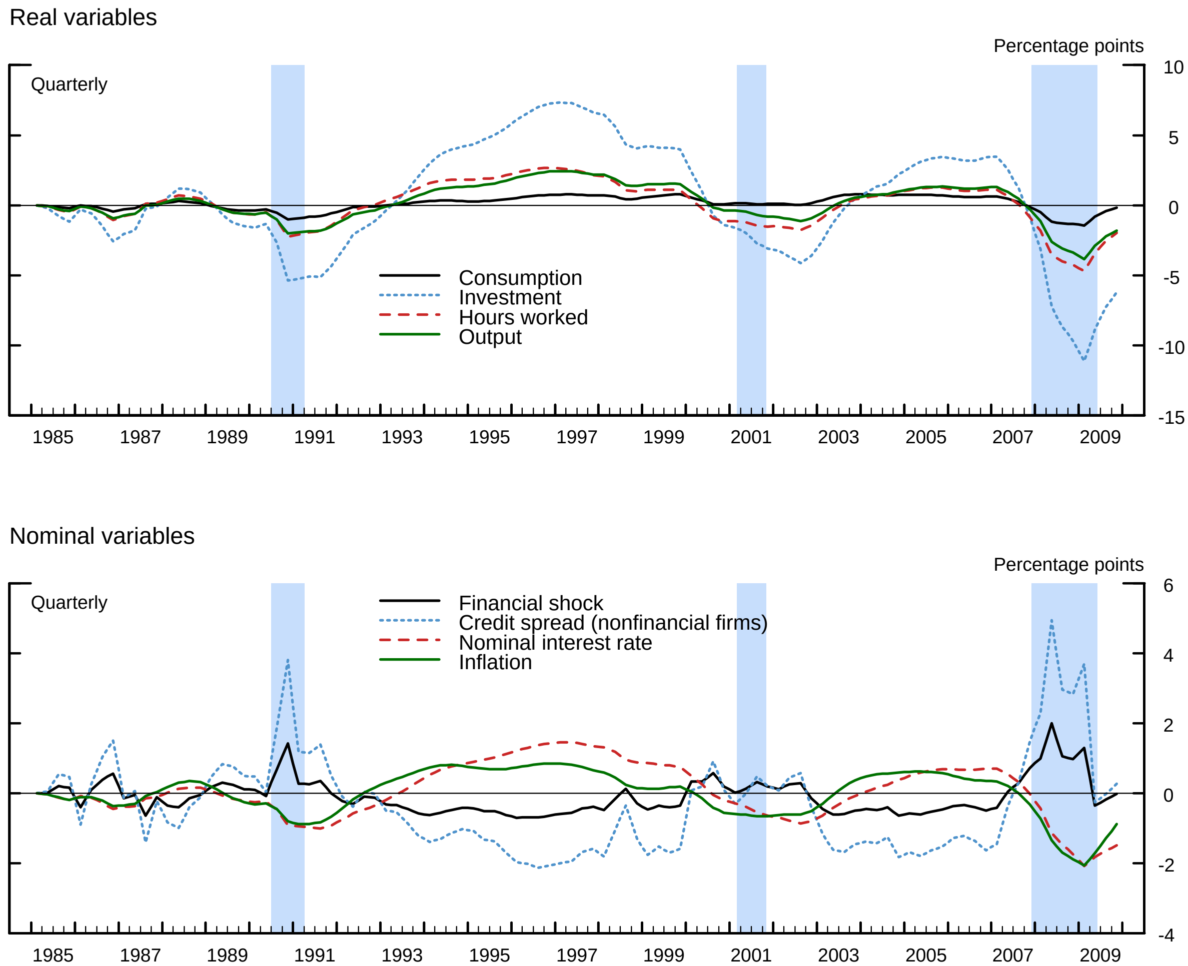


NOTE: The figure depicts the path of actual U.S. macroeconomic and financial variables. Cyclical fluctuations have been eliminated from all real variables, as well as from inflation and the nominal funds rate, using the Corbae and Ouliaris [2006] frequency-domain filter. All variables are set to equal zero in 1985:Q1. The shaded vertical bars denotes the NBER-dated recessions.

According to the model, the economy experienced contractions in economic activity during all of the three NBER-dated recessions during our sample. In these episodes, a contraction in investment spending drives the business cycle: Relative to its trend, business investment falls about five percentage points during the 1990 recession, a bit more than three percentage points during the 2001 downturn, and more than 10 percentage points during the most recent crisis. Consumption declines slightly during the 1990 recession, holds up well during the dot-com bust, and declines modestly during the 2007–09 recession.

Roughly speaking, model-implied fluctuations in output are also in line with their historical

Figure 7: Model-Based Simulation of a Financial Shock
(*Baseline Monetary Policy Rule*)



NOTE: The figure depicts the model-implied path of selected macroeconomic variables in response to the estimated financial shocks for the baseline specification of the monetary policy rule, a case in which the monetary authority does not respond to credit spreads ($\phi_s = 0$). The degree of financial market frictions $\chi = 0.10$ (see text for details). All variables are expressed in percentage-point deviations from their respective steady-state values. The shaded vertical bars denotes the NBER-dated recessions.

experience: A mild contraction in output on the order of two percentage points during the 1990 recession; a one percentage point decline during the bursting of the tech bubble in 2001, and a decline of about four percentage points decline during the most recent recession. Interestingly, financial shocks imply a strong investment boom in the mid- and late 1990s and during the 2003–06 period.

On the whole, financial disruptions appear to be able to account for a substantial fraction of fluctuations in real economic activity during these last three recessions. The depth and timing of the contraction in the early 1990s coincide well with the historical experience, as is the case of the 2007–09 downturn. In contrast, investment spending implied by the model clearly contracted earlier than that seen in the data during the 1999–2001 period, which is the tail end of the dot-com boom. On the other hand, investment also exhibits a substantial drag on the economy during the subsequent recovery—which, in turn, implies sluggish employment—a result consistent with the jobless recovery emphasized during that time period.

The model also does well at capturing observed movements in nominal interest rates, inflation, and credit spreads over this time period. Short-term nominal interest rates decline substantially in each recession, and inflation declines during these contractionary phases. Credit spreads exhibit substantially more variation than the underlying financial shock and spike up during the 1990 and 2007–09 recessions. Credit spreads also widen notably in the late 1990 and early 2000 but are driven to their all time lows during the investment booms of the mid-1990s and mid-2000s.

An important aspect of the recent crisis that is omitted from our analysis is the fact that since December 2008, the FOMC has maintained a target range for the federal funds rate of 0 to 1/4 percent—that is, monetary policy has been effectively constrained by the presence of a zero lower bound (ZLB) on nominal interest rates. While our empirical results are qualitatively and quantitatively robust to the exclusion of that period from our sample, the binding ZLB constraint raises important questions for the conduct of monetary policy in any model used to analyze the macroeconomic and financial developments over this period.

As emphasized by Eggertsson and Woodford [2003] and Nakov [2008], forward guidance regarding the anticipated future path of short-term nominal interest rates provides a very effective way to stabilize the output gap and inflation within the New Keynesian framework. By announcing that the policy rate will be kept low during the initial phase of economic recovery, such a commitment provides stimulus to the economy by lowering expected future real interest rates, thereby avoiding deflation in the near term, while producing only mildly elevated rates of inflation once the economy has fully recovered.

However, as shown by Levin et al. [2010], when the economy is hit by a large and persistent natural rate shock—the kind experienced during the recent crisis—forward guidance alone delivers relatively poor macroeconomic outcomes. According to their simulations, a combination of forward guidance and other policy measures—such as large-scale asset purchases, for example—is needed to deliver a sufficient macroeconomic stimulus in situations where the economy experiences a "Great Recession"-style shock and the near-term path of the policy rate is constrained by the zero lower bound. While incorporating the ZLB and unconventional monetary policy actions into the analysis lies beyond the scope of our paper, our next set of simulation results would suggest that an aggressive and timely response of monetary policy to changes in financial conditions—in our context measured by movements in credit spreads—may reduce the likelihood of interest rate policy being subsequently constrained by the zero lower bound.

4.2 The Spread-Augmented Monetary Policy Rule

To recap briefly, our baseline simulations imply that shocks to the efficiency of the intermediation process, as measured by innovations to the financial bond premium, can account quite well for the broad movements in hours worked, consumption, investment, and output during the 1985–2009 period. In our view, the model dynamics are sufficiently close to the actual economic outcomes to provide a useful guide for alternative policy rules that may be used to stabilize the economy in the wake of disruptions in financial markets.

In this section, we consider one such rule proposed in the literature—namely, the adjustment to the first-difference rule so that monetary policy responds to changes in financial developments as measured by the movements in credit spreads (see, for example, Cúrdia and Woodford [2010]). Specifically, we augment the baseline first-difference rule by allowing for a direct response of the policy rate to the measured credit spread. The response coefficient on the spread ϕ_s is set equal to -0.5, so that the nominal rate offsets the increase (or decrease) in financial market stress by declining 10 basis points for every increase of 20 basis points in credit spreads. It is important to note this rule is not derived formally from a welfare-maximization problem.[14] Rather, our aim is to evaluate whether adding a response to credit spreads, as proposed by Taylor [2008] and McCulley and Toloui [2008] can improve equilibrium responses of the macroeconomy to shocks emanating from the financial sector.

The solid lines in Figure 8 depict the model-based impulse responses to a financial shock under the spread-augmented monetary policy rule, while the dotted lines denote the corresponding responses under the baseline first-difference rule (i.e., $\phi_s = 0$), replicated, for comparison purposes, from Figure 5. The comparison of responses reveals that including the credit spread in the policy rule provides substantial stabilization of the real side of the economy. Importantly, the price level, in response to a financial shock, increases about one-half of a percentage point, rather than falling 0.3 percentage points, as in the baseline case.

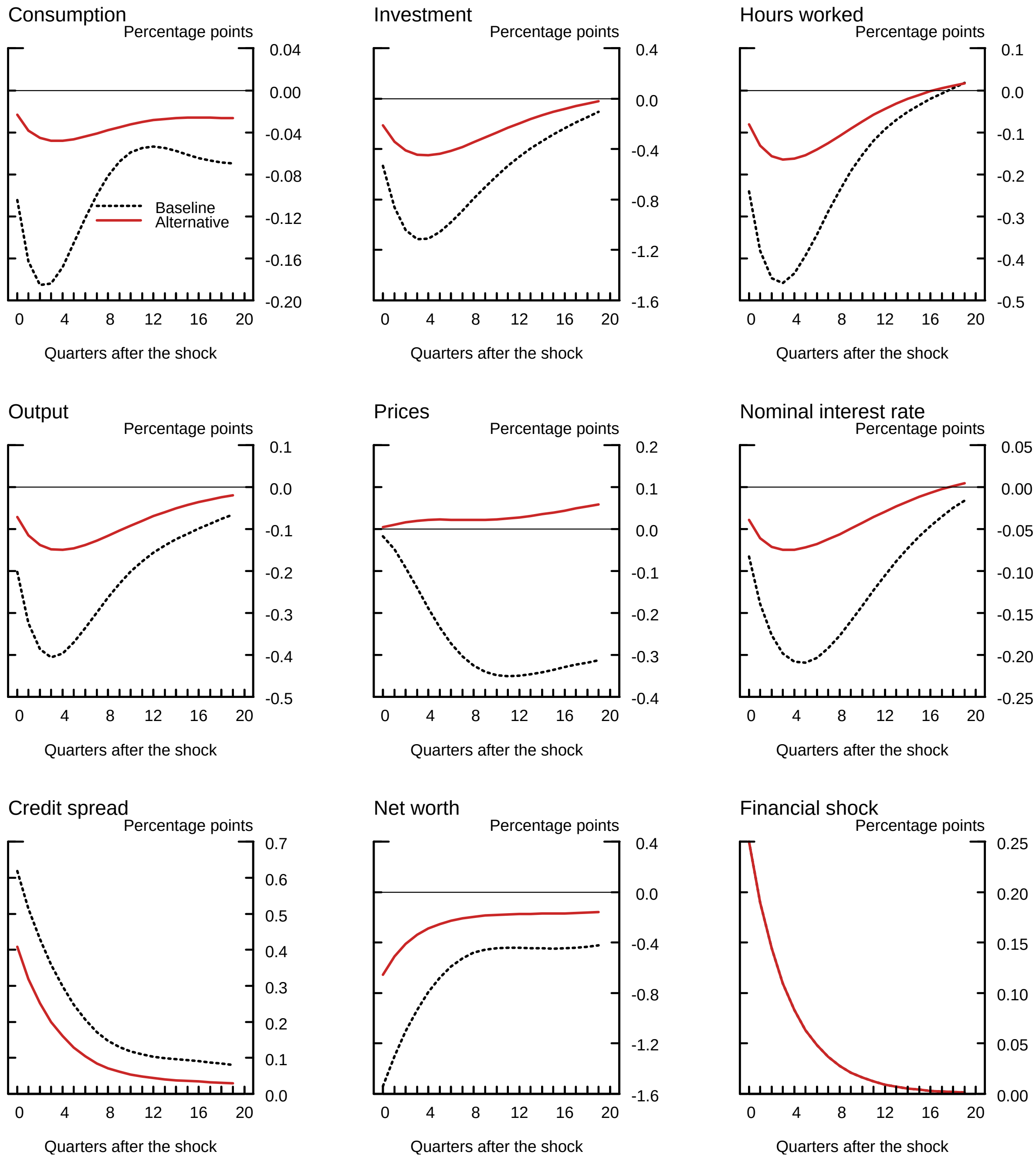
In effect, this stabilization policy achieves a substantial reduction in output volatility and almost no variation in inflation. As a result, the implied movements in both nominal and real rates are also quite modest—on the order of only five basis points. In contrast, under the baseline policy rule, the monetary authority, by not reacting directly to credit market conditions, has to ease significantly more in response to an adverse financial shock, as evidenced by the decline in the short-term rate of about 20 basis points.

The spread-augmented policy rule works through agents' expectations. In response to an adverse financial shock, agents anticipate that the monetary authority will ease policy. These expectations lead to a modest reduction in real interest rates but, at the same time, to a relatively large offsetting

[14] In the case in which credit spreads are endogenous, both financial and nonfinancial shocks will cause credit spreads to fluctuate, and the magnitude of spread adjustment to the policy rate will have important implications for the economy's response to various types of disturbances; see Cúrdia and Woodford [2010] for detailed analysis and discussion.

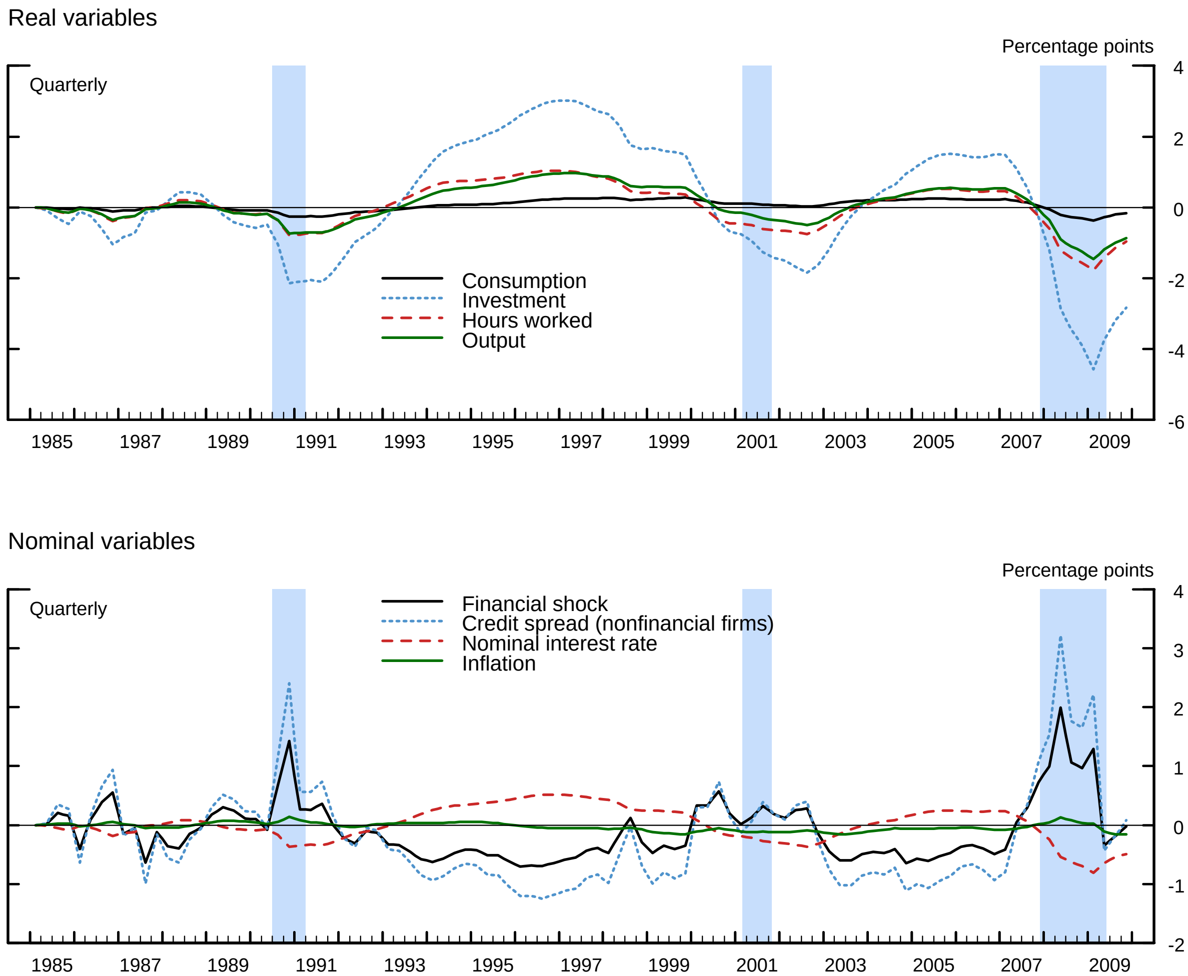
Figure 8: Model-Based Impulse Responses to a Financial Shock

(*Baseline vs. Spread-Augmented Monetary Policy Rule*)



NOTE: The solid lines depict the model-based impulse response functions of selected variables to a 1 standard deviation financial shock for the alternative specification of the monetary policy rule, a case in which the monetary authority responds to credit spreads, with the reaction coefficient $\phi_s = -0.5$; the dotted lines correspond to impulse responses under the baseline specification of the monetary policy rule ($\phi_s = 0$). The degree of financial market frictions $\chi = 0.1$ (see text for details). All variables are expressed in percentage-point deviations from their respective steady-state values.

Figure 9: Model-Based Simulation of a Financial Shock
(*Spread-Augmented Monetary Policy Rule*)



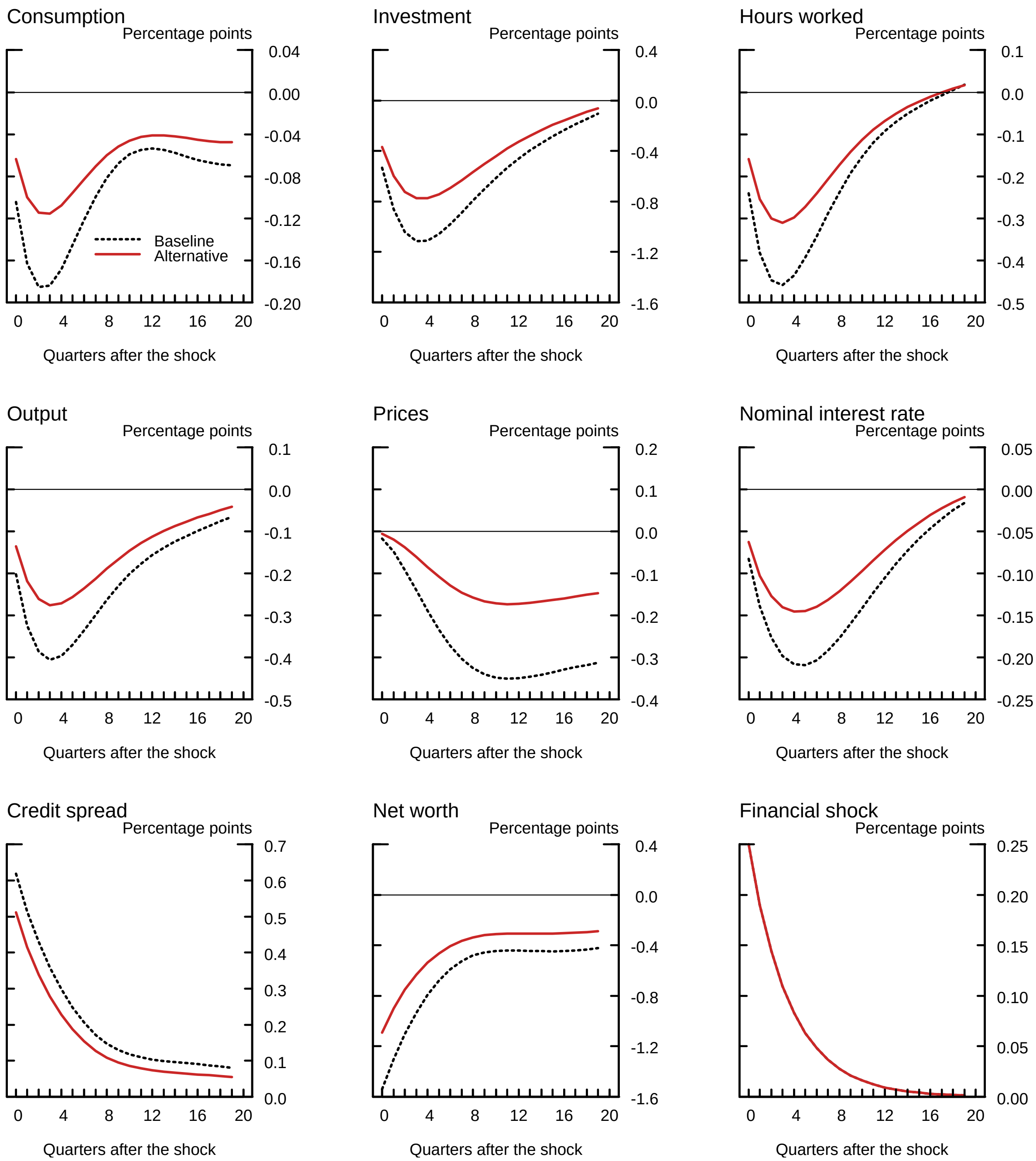
NOTE: The figure depicts the model-implied path of selected macroeconomic variables in response to the estimated financial shocks for the alternative specification of the monetary policy rule, a case in which the monetary authority responds to credit spreads, with the reaction coefficient $\phi_s = -0.5$. The degree of financial market frictions $\chi = 0.1$ (see text for details). All variables are expressed in percentage-point deviations from their respective steady-state values. The shaded vertical bars denotes the NBER-dated recessions.

increase in asset values and thus to a much smaller decline in net worth than one sees under the baseline monetary policy rule. As a result, the response of the credit spread under the alternative policy rule basically mimics the response of the financial shock, resulting in very little additional amplification through the financial accelerator mechanism.

Although asset prices are forward looking, they influence the condition of firms' balance sheets—and hence the strength of the financial accelerator—immediately. Consequently, a reduction in

Figure 10: Model-Based Impulse Responses to a Financial Shock

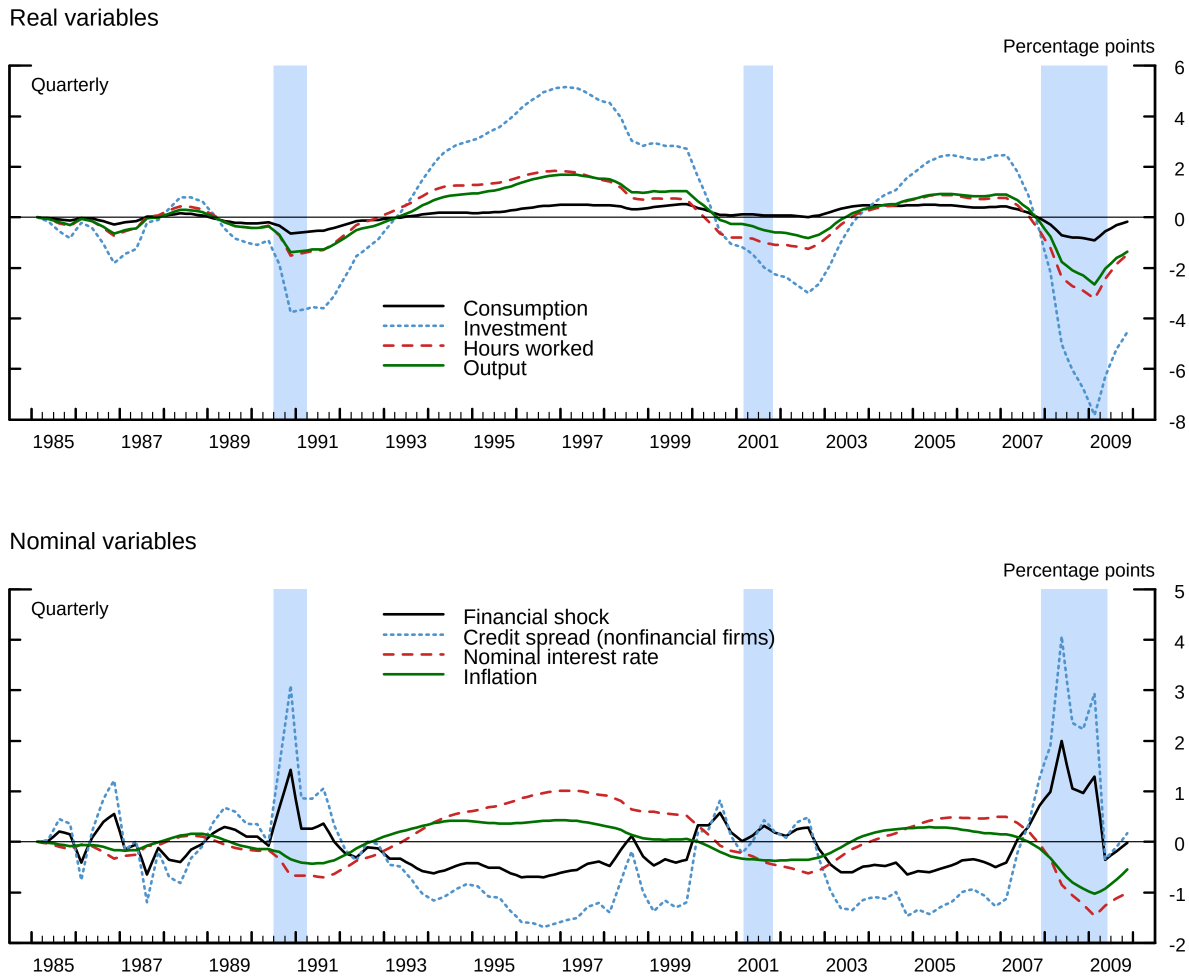
(*Baseline vs. Shock-Augmented Monetary Policy Rule*)



Note: The solid lines depict the model-based impulse response functions of selected variables to a 1 standard deviation financial shock for the alternative specification of the monetary policy rule, a case in which the monetary authority responds to the financial bond premium, with the reaction coefficient $\phi_s = -0.5$; the dotted lines correspond to impulse responses under the baseline specification of the monetary policy rule ($\phi_s = 0$). The degree of financial market frictions $\chi = 0.1$ (see text for details). All variables are expressed in percentage-point deviations from their respective steady-state values.

Figure 11: Model-Based Simulation of a Financial Shock

(*Shock-Augmented Monetary Policy Rule*)



Note: The figure depicts the model-implied path of selected macroeconomic variables in response to the estimated financial shocks for the alternative specification of the monetary policy rule, a case in which the monetary authority responds to the financial bond premium, with the reaction coefficient $\phi_s = -0.5$. The degree of financial market frictions $\chi = 0.1$ (see text for details). All variables are expressed in percentage-point deviations from their respective steady-state values. The shaded vertical bars denotes the NBER-dated recessions.

expected future real interest rates can be very effective in offsetting an emerging disruption in credit markets. This point is made explicit in Figure 9, which shows the model-implied path of the key macroeconomic aggregates during the 1985–2009 period under the spread-augmented policy rule. Consistent with the results presented in Figure 8, such a rule leads to a substantial reduction in the variability of output, hours worked, and investment. Furthermore, the model does quite well at stabilizing inflation over this time period.

To be sure, actual disruptions in financial markets, as evidenced by the recent financial crisis, are far more complex than simple shocks to the credit spread modeled in our framework. Nevertheless, the above results suggest that a monetary policy regime that is committed, in advance, to fully offset shocks to the financial system through active interest rate policy can be quite beneficial in mitigating the deleterious consequences of financial market disruptions.

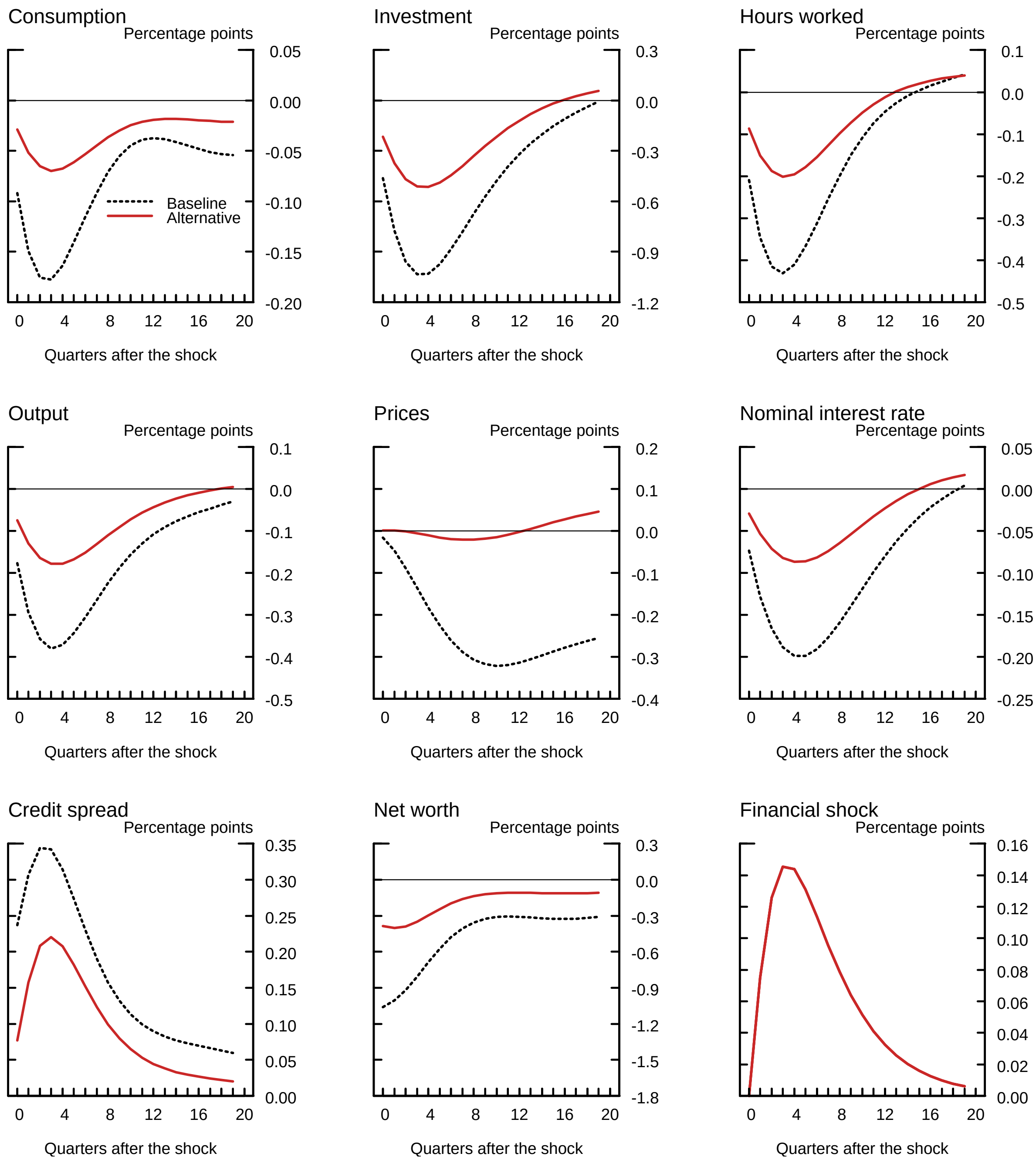
In the simulations reported above, financial shocks are surprise events that result in an immediate increase in credit spreads, a jump that exceeds the size of the underlying financial shock because of the endogenous response of asset prices in the financial accelerator model. This raises the question of whether it would be more beneficial if the monetary authority responded directly to the exogenous component of the credit spread—that is, to the underlying disruption in the credit intermediation process. To address this question, we replace the observed credit spread in the first-difference rule with the actual financial shock. For comparison purposes, we maintain the same elasticity of interest-rate response—the coefficient ϕ_s—of -0.5 as before.

The impulse responses produced by this exercise are displayed in Figure 10. Comparing these results to those in Figure 8 shows that the same policy response applied to the exogenous component of financial shocks results in an appreciably less stable macroeconomic environment. This is also true in the model simulation, which are shown in Figure 11. Although economic fluctuations are damped relative to the baseline model in which the monetary authority is assumed to follow the standard first-difference rule, swings in real economic activity are substantially more pronounced than those implied by the spread-augmented policy rule. This result reflects the fact that by responding to the underlying financial disturbance—as opposed to the observed credit spread—the monetary authority does not take into account the endogenous decline in asset values, which depresses the entrepreneurs' current net worth and thereby exacerbates the effect of financial frictions on real economic activity.

As a final exercise, we consider explicitly the role that expectations play in how the economy responds to the spread-augmented monetary policy rule. We do so by considering the benefits of such a policy in an environment where there is "news" regarding a probable deterioration in financial conditions. Agents in the economy—firms, households, and the monetary authority—interpret this news as a signal of a gradual deterioration in financial conditions that will occur sometime in the future. In this context, we again consider the macroeconomic implications of a spread-augmented policy rule with the response coefficient $\phi_s = -0.5$. Figure 12 depicts the results of this exercise, with the trajectory of the financial "news shock" shown in the lower right panel. For comparison, the dotted lines depict impulse responses of the key macroeconomic variables to such news in the baseline case, in which the monetary authority does not commit itself to responding directly to movements in credit spreads.

According to these results, the deterioration in financial conditions is gradual, with the financial shock building steadily and peaking at about 15 basis points a year after the initial news. Under the

Figure 12: Model-Based Impulse Responses to Adverse Financial News
(*Baseline vs. Spread-Augmented Monetary Policy Rule*)



NOTE: The figure depicts the model-based impulse response functions of selected variables to adverse financial news. The solid lines correspond to the alternative specification of the monetary policy rule, a case in which the monetary authority responds to credit spreads, with the reaction coefficient $\phi_s = -0.5$; the dotted lines correspond the baseline specification of the monetary policy rule ($\phi_s = 0$). The degree of financial market frictions $\chi = 0.1$ (see text for details). All variables are expressed in percentage-point deviations from their respective steady-state values.

baseline policy rule, this news causes a significant reduction in output, investment, consumption, and hours worked, with the responses of these variables matching closely—in terms of both their timing and magnitude—the responses in the case when the economy is hit by an unanticipated financial shock. Again, the main driving force of these macroeconomic dynamics is the effect of bad news about future financial conditions on asset prices, which works through expectations. Upon release of the news, asset prices fall immediately, causing an immediate and significant decline in net worth. As net worth falls, borrower balance sheets become impaired and economic activity slows. In contrast to the previous exercises that did not involve such news, the gradual deterioration in financial conditions engenders a slow and progressive widening of credit spreads, which indicates that credit spreads by themselves do not provide an immediate signal regarding the severity of the unfolding news event.

Nonetheless, as can be seen by the solid lines in Figure 12, a policy that commits the monetary authority in advance to responding to changes in financial conditions has significant stabilization benefits—the decline in output is roughly one-third of the decline that occurs under the baseline policy rule. Note that the fall in asset prices is also reduced by about one third, so that there is very little immediate effect on credit spreads. Although the gradual deterioration in financial conditions does ultimately cause credit spreads to widen appreciably, the widening is significantly less pronounced than under the baseline policy rule.

Perhaps the most striking results is that by committing to adjusting the short-term nominal interest rates in response to a deterioration in financial conditions, the monetary authority only needs to lower the policy rate about 10 basis points, compared with the easing of 20 basis points implied by the baseline first-difference rule. In other experiments (not shown), when we allow the monetary authority to respond even more aggressively to movements in credit spreads, we obtain virtually no change in the nominal short-term rate in response to adverse news about future financial conditions. In effect, by committing to an aggressive stabilization policy, the monetary authority can achieve its goals without resorting to large adjustments in the policy rate. The anticipation by households and firms that the monetary authority will respond aggressively to adverse financial developments leads to an understanding that the recession will not be as severe, and, as a result, asset prices decline only modestly. In turn, this development improves the overall economic conditions, leading to a mutually-reinforcing beneficial feedback loop.

5 Conclusion

This paper examined the extent to which the canonical New Keynesian macroeconomic model with financial frictions is able to account for the U.S. macroeconomic dynamics during the 1985–2009 period. We showed that by carefully constructing a sequence of financial shocks using financial intermediary credit spreads, a reasonably calibrated version of the CEE/SW framework augmented with the BGG financial accelerator can account for the broad movements in consumption, investment, hours worked, and output observed during this period. The model also does well at matching the observed countercyclical movements in inflation and short-term nominal interest rates, as well as the strong pro-cyclicality of credit spreads on bonds issued by nonfinancial firms.

Although the model is relatively simple compared with the recent work in this area, our findings nonetheless provide considerable insight into the importance of financial factors in business cycle fluctuations. In particular, our simulations suggest that by allowing the nominal interest rate to respond to credit spreads—a primary measure of financial stress in our framework—monetary policy can effectively ameliorate the negative consequences of financial market shocks on real economic activity, while experiencing very little offsetting inflationary pressures.

References

Acharya, V. V. and S. Viswanathan (2010): "Leverage, Moral Hazard, and Liquidity," *Journal of Finance*, 66, 99–138.

Adrian, T., E. Moench, and H. S. Shin (2010a): "Financial Intermediation, Asset Prices, and Macroeconomic Dynamics," Federal Reserve Bank of New York Staff Report No. 422.

——— (2010b): "Macro Risk Premium and Intermediary Balance Sheet Quantities," *IMF Economic Review*, 58, 179–207.

Adrian, T. and H. S. Shin (2010): "Liquidity and Leverage," *Journal of Financial Economics*, 19, 418–437.

Aguiar, M. (2005): "Investment, Devaluation, and Foreign Currency Exposure: A Case of Mexico," *Journal of Development Economics*, 78, 95–113.

Allen, F. and D. Gale (1994): "Liquidity Preference, Market Participation, and Asset Price Volatility," *American Economic Review*, 84, 933–955.

——— (1998): "Optimal Financial Crises," *Journal of Finance*, 53, 1245–1284.

Ashcraft, A. B. (2005): "Are Banks Really Special? New Evidence from the FDIC-Induced Failure of Healthy Banks," *American Economic Review*, 95, 1712–1730.

Bassett, W. F., M. B. Chosak, J. C. Driscoll, and E. Zakrajšek (2010): "Changes in Bank Lending Standards and the Macroeconomy," Available at SSRN: http//ssrn.co/abstract=1758832.

Bernanke, B. S. and A. S. Blinder (1988): "Credit, Money, and Aggregate Demand," *American Economic Review*, 78, 435–439.

Bernanke, B. S., M. Gertler, and S. Gilchrist (1999): "The Financial Accelerator in a Quantitative Business Cycle Framework," in *The Handbook of Macroeconomics*, ed. by J. B. Taylor and M. Woodford, Amsterdam: Elsevier Science B.V, 1341–1393.

Bernanke, B. S. and C. S. Lown (1991): "The Credit Crunch," *Brookings Papers on Economic Activity*, 2, 205–239.

Borio, C. E. and P. W. Lowe (2002): "Asset prices, Financial and Monetary Stability: Exploring the Nexus," Working Paper No. 114, Bank for International Settlements.

——— (2006): "Monetary and Financial Stability: Here to Stay?" *Journal of Banking and Finance*, 30, 3407–3414.

Brunnermeier, M. and L. H. Pedersen (2009): "Market Liquidity and Funding Liquidity," *Review of Financial Studies*, 22, 265–292.

Brunnermeier, M. K. (2009): "Deciphering the Liquidity and Credit Crunch of 2007–08," *Journal of Economic Perspectives*, 23, 77–100.

Buiter, W. H. (2010): "Housing Wealth Isn't Wealth," *Economics: The Open-Access, Open-Assessment E-Journal*, 4.

Campbell, J. Y. and J. Cocco (2008): "How Do House Prices Affect Consumption? Evidence From Micro Data," *Journal of Monetary Economics*, 54, 591–621.

Carlstrom, C. T. and T. S. Fuerst (1997): "Agency Costs, Net Worth, and Business Cycle Fluctuations: A Computable General Equilibrium Analysis," *American Economic Review*, 87, 893–910.

Carroll, C. D., M. Otsuka, and J. Slacalek (2011): "How Large is the Housing Wealth Effect? A New Approach," *Journal of Money, Credit, and Banking*, 43, 55–79.

Case, K. E., J. M. Quigley, and R. J. Shiller (2005): "Comparing Wealth Effects: The Stock Market versus the Housing Market," *The B.E. Journal of Macroeconomics*, 5, Article 1.

Cetorelli, N. and L. S. Goldberg (2012): "Banking Globalization and Monetary Transmission," Forthcoming *Journal of Finance*.

Christensen, I. and A. Dib (2008): "Monetary Policy in an Estimated DSGE Model with a Financial Accelerator," *Review of Economic Dynamics*, 11, 155–178.

Christiano, L. J., M. Eichenbaum, and C. L. Evans (2005): "Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy," *Journal of Political Economy*, 113, 1–45.

Christiano, L. J., C. Ilut, R. Motto, and M. Rostagno (2008): "Monetary Policy and Stock Market Boom-Bust Cycles," Working Paper No. 955, European Central Bank.

Christiano, L. J., R. Motto, and M. Rostagno (2009): "Financial Factors in Economic Fluctuations," Working Paper, Dept. of Economics, Northwestern University.

Cooley, T. F., R. Marimon, and V. Quadrini (2004): "Aggregate Consequences of Limited Contract Enforceability," *Journal of Political Economy*, 112, 817–847.

Corbae, D. and S. Ouliaris (2006): "Extracting Cycles from Nonstationary Data," in *Econometric Theory and Practice: Frontiers of Analysis and Applied Research*, ed. by D. Corbae, S. N. Durlauf, and B. E. Hansen, Cambridge, UK: Cambridge University Press, 167–177.

Cummins, J. G., K. A. Hassett, and S. D. Oliner (2006): "Investment Behavior, Observable Expectations, and Internal Funds," *American Economic Review*, 96, 796–810.

Cúrdia, V. and M. Woodford (2010): "Credit Spreads and Monetary Policy," *Journal of Money, Credit, and Banking*, 42, 3–35.

De Graeve, F. (2008): "The External Finance Premium and the Macroeconomy: U.S. Post-WWII Evidence," *Journal of Economic Dynamics and Control*, 32, 3415–3440.

Eggertsson, G. B. and M. Woodford (2003): "The Zero Bound on Interest Rates and Optimal Monetary Policy," *Brookings Papers on Economic Activity*, 34, 139–211.

Faust, J., S. Gilchrist, J. H. Wright, and E. Zakrajšek (2011): "Credit Spreads as Predictors of Real-Time Economic Activity: A Bayesian Model-Averaging Approach," NBER Working Paper No. 16725.

Fazzari, S. M., R. G. Hubbard, and B. C. Petersen (1988): "Financing Constraints and Corporate Investment," *Brookings Papers on Economic Activity*, 1, 141–195.

Fuerst, T. S. (1995): "Money and Financial Interactions in the Business Cycle," *Journal of Money, Credit, and Banking*, 27, 1321–1338.

Garleanu, N. and L. H. Pedersen (2009): "Margin-Based Asset Pricing and Deviations from the Law of One Price," Working Paper, Stern School of Business, New York University.

Gertler, M. and P. Karadi (2011): "A Model of Unconventional Monetary Policy," *Journal of Monetary Economics*, 58, 17–34.

Gertler, M. and N. Kiyotaki (2010): "Financial Intermediation and Credit Policy in Business Cycle Analysis," in *Handbook of Macroeconomics*, ed. by B. M. Friedman and M. Woodford, Amsterdam: North-Holland, Elsevier, vol. 3, 547–599.

Gertler, M. and C. S. Lown (1999): "The Information in the High-Yield Bond Spread for the Business Cycle: Evidence and Some Implications," *Oxford Review of Economic Policy*, 15, 132–150.

Gilchrist, S. and C. P. Himmelberg (1995): "The Role of Cash Flow in Reduced-Form Investment Equations," *Journal of Monetary Economics*, 36, 541–572.

Gilchrist, S. and J. W. Sim (2007): "Investment During the Korean Financial Crisis: A Structural Econometric Analysis," NBER Working Paper No. 13315.

Gilchrist, S., V. Yankov, and E. Zakrajšek (2009): "Credit Market Shocks and Economic Fluctuations: Evidence From Corporate Bond and Stock Markets," *Journal of Monetary Economics*, 56, 471–493.

Gilchrist, S. and E. Zakrajšek (2007): "Investment and the Cost of Capital: New Evidence from the Corporate Bond Market," NBER Working Paper No. 13174.

——— (2011a): "Bank Lending and Credit Supply Shocks," Working Paper, Dept. of Economics, Boston University.

——— (2011b): "Credit Spreads and Business Cycle Fluctuations," NBER Working Paper No. 17021, Forthcoming *American Economic Review*.

——— (2011c): "Monetary Policy and Credit Supply Shocks," *IMF Economic Review*, 59, 194–232.

Gorton, G. (2009): "Information, Liquidity, and the (Ongoing) Panic of 2007," *American Economic Review*, 99, 567–572.

He, Z. and A. Krishnamurthy (2009): "A Model of Capital and Crisis," Working Paper, Kellog School of Management, Northwestern University.

——— (2010): "Intermediary Asset Pricing," Working Paper, Kellog School of Management, Northwestern University.

Ivashina, V. and D. Scharfstein (2010): "Bank Lending During the Financial Crisis of 2008," *Journal of Financial Economics*, 97, 319–338.

Kashyap, A. K. and J. C. Stein (1994): "Monetary Policy and Bank Lending," in *Monetary Policy*, ed. by N. G. Mankiw, Chicago: The University of Chicago Press, 221–262.

——— (2000): "What Do a Million Observations on Banks Say About the Transmission of Monetary Policy?" *American Economic Review*, 90, 407–428.

King, T. B., A. T. Levin, and R. Perli (2007): "Financial Market Perceptions of Recession Risk," Finance and Economics Discussion Series Paper 2007-57, Federal Reserve Board.

Kiyotaki, N. and J. H. Moore (1997): "Credit Cycles," *Journal of Political Economy*, 105, 211–248.

Levin, A. T., F. M. Natalucci, and E. Zakrajšek (2004): "The Magnitude and Cyclical Behavior of Financial Market Frictions," Finance and Economics Discussion Series Paper 2004-70, Federal Reserve Board.

Levin, A. T., E. M. Nelson, D. López-Salido, and T. Yun (2010): "Limitations on the Effectiveness of Forward Guidance at the Zero Lower Bound," *International Journal of Central Banking*, 6, 143–189.

McCulley, P. A. and R. Toloui (2008): "Chasing the Neutral Rate Down: Financial Conditions, Monetary Policy, and the Taylor Rule," *Global Central Bank Focus*, February 20.

Merton, R. C. (1974): "On the Pricing of Corporate Debt: The Risk Structure of Interest Rates," *Journal of Finance*, 29, 449–470.

Meyer, L. H. and B. P. Sack (2008): "Updated Monetary Policy Rules: Why Don't They Explain Recent Monetary Policy," *Monetary Policy Insights*, Macroeconomic Advisors, March 7.

Mueller, P. (2009): "Credit Spreads and Real Activity," Working Paper, London School of Economics.

Nakov, A. (2008): "Optimal and Simple Monetary Policy Rules with Zero Floor on the Nominal Interest Rates," *International Journal of Central Banking*, 4, 73–128.

Orphanides, A. (2003): "Historical Monetary Policy Analysis and the Taylor Rule," *Journal of Monetary Economics*, 50, 983–1022.

Orphanides, A. and J. C. Williams (2006): "Monetary Policy with Imperfect Knowledge," *Journal of the European Economic Association*, 4, 366–375.

Peek, J. and E. S. Rosengren (1995a): "Bank Regulation and the Credit Crunch," *Journal of Banking and Finance*, 19, 679–692.

——— (1995b): "The Capital Crunch: Neither a Borrower nor a Lender Be," *Journal of Money, Credit, and Banking*, 27, 625–638.

——— (2000): "Collateral Damage: Effects of the Japanese Bank Crisis on Real Activity in the United States," *American Economic Review*, 90, 30–45.

Queijo von Heideken, V. (2009): "How Important are Financial Frictions in the U.S. and the Euro Area?" *Scandinavian Journal of Economics*, 111, 567–586.

Rebelo, S., J. C. Eberly, and N. Vincent (2008): "Investment and Value: A Neoclassical Benchmark," Working Paper, Kellogg School of Management, Northwestern University.

Smets, F. and R. Wouters (2007): "Shocks and Frictions in U.S. Business Cycle: A Bayesian DSGE Approach," *American Economic Review*, 97, 586–606.

Stiroh, K. J. and C. Metli (2003): "Now and Then: The Evolution of Loan Quality for U.S. Banks," *Current Issues in Economics and Finance, Federal Reserve Bank of New York*, 9, 1–7.

Taylor, J. B. (2008): "Monetary Policy and the State of the Economy," Testimony before the Committee on Financial Services, U.S. House of Representatives.

Taylor, J. B. and J. C. Williams (2009): "A Black Swan in the Money Market," *American Economic Journal: Macroeconomics*, 1, 58–83.

Van den Heuvel, S. J. (2007): "The Bank Capital Channel of Monetary Policy," Working Paper, The Wharton School, University of Pennsylvania.

——— (2012): "Banking Conditions and the Effects of Monetary Policy: Evidence from U.S. States," Forthcoming, *The B.E. Journal of Macroeconomics: Advances*.

Warga, A. D. (1991): "A Fixed Income Database," Working Paper, University of Houston.

Whelan, K. (2002): "A Guide to the Use of Chain-Aggregated NIPA Data," *Review of Income and Wealth*, 48, 217–233.