Credit, Financial Conditions, and Monetary Policy Transmission*

David Aikman,[a] Andreas Lehnert,[b] Nellie Liang,[c]
and Michele Modugno[b]
[a]Bank of England
[b]Federal Reserve Board
[c]Brookings Institution

We show that the effects of financial conditions and monetary policy on U.S. economic performance depend nonlinearly on nonfinancial-sector credit. When credit is below its trend, an impulse to financial conditions leads to improved economic performance and monetary policy transmission works as expected. By contrast, when credit is above trend, a similar impulse leads to an economic expansion in the near term, but then a recession in later quarters. In addition, tighter monetary policy does not lead to tighter financial conditions when credit is above trend and is ineffective at slowing the economy, consistent with evidence of an attenuated transmission of policy changes to distant forward Treasury rates in periods of high credit. These results suggest that credit is an important conditioning variable for the effects of financial variables on macroeconomic performance.

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1. Introduction

The global financial crisis highlighted the importance of credit and financial conditions on the dynamics of macroeconomic performance. This phenomenon is not new. Empirical cross-country studies find that private nonfinancial-sector credit and asset prices are early-warning indicators of recessions and financial crises (Borio and Lowe 2002, Schularick and Taylor 2012, Drehmann and Juselius 2015). In addition, high credit growth and asset bubbles combined lead to significantly weaker economic recoveries (Jordà, Schularick, and Taylor 2013). The consequences of financial crises can be severe (Reinhart and Rogoff 2009), with estimates of the cost of the 2007–09 episode in the United States ranging from 40 to 90 percent of a year's gross domestic product (GDP), and larger if there is a permanent loss in output following the financial crisis (Atkinson, Luttrell, and Rosenblum 2013).

As a result, researchers and policymakers have been developing measures of the financial vulnerability of the economy, such as excess nonfinancial-sector credit or leverage of the financial system—often referred to as macrofinancial "imbalances" (Adrian, Covitz, and Liang 2015). When macrofinancial imbalances are high, the economy is seen as more fragile and less resilient to adverse shocks. The Basel Committee on Banking Supervision (2010) has encouraged using excess private nonfinancial credit as a measure of expected future losses to the banking system, and assigns this indicator an important role in setting the new countercyclical capital buffer. Researchers also are adding measures of financial imbalances to macroeconomic models, which have traditionally lacked a role for them (Brunnermeier and Sannikov 2014).

In this paper, we use a threshold vector autoregression (TVAR) model to study the influence of private nonfinancial credit in the dynamic relationship among financial conditions, monetary policy, and macroeconomic performance in the United States from 1975 to 2014. Specifically, we examine the role of private nonfinancial credit in conditioning the response of the U.S. economy to impulses to financial conditions and to monetary policy. Because much of the post-crisis literature has focused on the proposition that high levels of imbalances leave the economy more vulnerable to negative shocks, we test for nonlinear dynamics by dividing the sample into periods of high and low credit. We use a broad measure of credit to households and nonfinancial businesses provided by banks, other lenders, and market investors. We follow conventional practice to measure high credit by when the credit gap (credit-to-GDP ratio minus its estimated long-run trend) is above zero (see Borio and Lowe 2002, 2004; Borio and Drehmann 2009) and, alternatively, by when multi-year growth in the credit-to-GDP ratio is above its average.

To incorporate financial conditions, we construct a financial conditions index (FCI) combining information from asset prices and nonprice terms, such as lending standards, for business and household credit, following Aikman et al. (2017). In studies of monetary policy transmission, FCIs represent the ease of credit access, which will affect economic behavior and thus the future state of the economy. In our paper, we interpret shocks to the FCI as reflecting factors such as time-varying risk premiums of investors, which may be determined by bank capital constraints (He and Krishnamurthy 2012), or endogenous reactions of financial intermediaries via value-at-risk (VaR) constraints to episodes of low volatility (Brunnermeier and Pedersen 2009, Adrian and Shin 2014, and Brunnermeier and Sannikov 2014). For comparison, we also consider the excess bond premium (EBP) of Gilchrist and Zakrajsek (2012) as an alternative measure of financial conditions.

A primary result of our paper is that the transmission of impulses to financial conditions to the real economy depends in a strongly nonlinear way on nonfinancial credit. Specifically, the effect of positive shocks to financial conditions on output and inflation depends on credit-to-GDP, whether measured by its gap to an estimate of its trend or its growth rate. In the TVAR specifications, the expected expansionary effects from a positive impulse to financial conditions are evident when the initial credit-to-GDP gap is low. However, when the credit-to-GDP gap is high, the initial expansionary effects on macro performance dissipate and performance deteriorates in later quarters after credit rises even more. That is, consistent with the credit boom literature, we find that a more sustained increase in credit is followed by a sharper economic contraction, but only when the credit gap is already high.

This result highlights a distinction between the effects of looser financial conditions and high credit. The credit gap reacts with a lag to financial conditions. When credit growth is sustained and the credit-to-GDP gap builds following looser financial conditions, the economy becomes more prone to a recession, perhaps because households and businesses are more fragile as a consequence of their higher leverage. The importance of credit for macroeconomic dynamics holds whether we use the fairly broad FCI described above or one narrowly focused on risk premiums in corporate bonds, such as the EBP.

Another key result is that the monetary policy transmission channel also depends in a nonlinear way on the credit gap. When the credit gap is low, impulses to monetary policy lead, as expected, to an increase in unemployment, a contraction in GDP, and a decline in credit. However, when the credit gap is high, a tightening in monetary policy does not lead to tighter financial conditions and lower output and inflation, or credit. The failure of financial conditions to tighten works against the contractionary effect of the monetary policy shock.

We investigate further why monetary policy transmission is weakened in high credit gap periods. Following Hanson and Stein (2015), we use high-frequency data to identify monetary policy shocks and decompose the transmission by maturity to Treasury bond yields. They argue that the apparently excessive moves of forward rates at far horizons in reaction to monetary policy shocks can be attributed to a class of investors requiring steady income streams who remove duration by selling longer-maturity Treasuries following a short-term rate increase, leading to an increase in far forward yields and in the term premium. We test whether the transmission of monetary policy to forward Treasury rates differs significantly between high and low credit gap periods, and find there is less impact in high credit gap states. This finding is consistent with investors making fewer adjustments to holdings of Treasury securities when there are ample credit products available to investors to earn additional yield when the credit gap is high.

Our results are robust to many alternative specifications. In particular, we highlight that our results are robust to using the EBP as an alternative financial conditions indicator and an alternative ordering of the FCI and monetary policy shocks in the TVAR. The results also are robust to measuring high credit periods using credit-to-GDP growth computed over long periods, such as eight years, and alternative measures of excess credit, including a specification with the (log) level of credit. We discuss alternative robustness tests below.

Overall, this paper is the first (to our knowledge) to document the joint nonlinear dynamics of credit, financial conditions, and monetary policy transmission. It adds to other studies that have identified a role for shocks to credit aggregates, asset prices, or investor risk sentiment to contribute to business cycle fluctuations. Our results are consistent with an intuitively appealing story in which an impulse to financial conditions when credit is high stimulates economic growth but also, over time, stimulates even more borrowing by households and businesses, which leaves the economy vulnerable to a shock and negative spillovers, precipitating a recession. High credit also interferes with the monetary policy transmission mechanism. One possible explanation for this attenuated effect, as described above, is that high credit periods also feature ample credit products, reducing the need for yield-oriented investors to adjust the duration of their portfolios in reaction to changes in short-term rates.

Our paper is related to several strands of the literature. Our empirical results that both private nonfinancial sector credit and financial conditions matter for real activity, inflation, and employment in the United States support the literature with financial frictions and a role for credit given asymmetric information (starting with Bernanke and Gertler 1989; see Brunnermeier, Eisenbach, and Sannikov 2013 for a broad survey of macro models with financial frictions). Moreover, in models with collateral constraints and pecuniary externalities, an economic expansion increases the value of borrowers' collateral and leads to excessive borrowing, which can result in more borrower defaults when asset prices fall and thus sharper economic contractions (Jeanne and Korinek 2010, Bianchi and Mendoza 2011). In addition, individuals do not consider the effects on aggregate credit or negative spillovers of their defaults when they make their borrowing decisions (as suggested in a model by Korinek and Simsek 2014). Our findings also are consistent with models that show financial conditions can affect macroeconomic performance when frictions lead to borrowing being driven by changes in the supply of credit (Brunnermeier and Pedersen 2009, He and Krishnamurthy 2012, Adrian and Shin 2014, and Brunnermeier and Sannikov 2014).

Empirical studies of U.S. macroeconomic performance have evaluated the effects of financial conditions on growth and inflation assuming standard monetary policy transmission channels (English, Tsatsaronis, and Zoli 2005). Some studies view financial conditions as primarily reflecting the variation over time of binding capital constraints of financial intermediaries (Gilchrist and Zakrajsek 2012; López-Salido, Stein, and Zakrajsek 2015). In addition, looser financial conditions can forecast downside risks to GDP growth, consistent with endogenous risk-taking of financial intermediaries when risk-management constraints are not binding (Adrian, Boyarchenko, and Giannone 2016). Cross-country studies also show the significance of financial conditions or credit on the probability of a recession or a financial crisis and the severity of recessions (Schularick and Taylor 2012; Jordà, Schularick, and Taylor 2013; Krishnamurthy and Muir 2017). In addition, Brunnermeier et al. (2017) find that U.S. output contractions that follow credit expansions reflect mostly monetary policy and risk spreads, suggesting a small separate effect for credit. We add to this empirical work by focusing on the role of both nonfinancial credit and financial conditions as linkages between the financial sector and real economic activity, and allow for effects to differ across high and low credit periods. We also include both monetary policy and financial conditions and allow for nonlinear dynamics.

Our paper is also related to the growing empirical literature that finds that transmission channels for financial conditions and monetary policy may operate differently depending on underlying conditions. Using firm-level data on U.S. nonfinancial corporations, Ottonello and Windberry (2017) find that the level and distribution of business debt affect the monetary policy transmission mechanism, with more indebted firms using the opportunity afforded by a decrease in rates to pay down debt rather than invest. In a study of household debt, residential investment, and house prices, Alpanda and Zubairy (2017) find that the transmission of monetary policy in the United States is attenuated in periods when household debt is high. In a cross-country study, Bauer and Grazienga (2016) show that an unexpected tightening of monetary policy can be destabilizing in the short term by increasing the credit-to-GDP gap, which in turn leads to a higher probability of a crisis with larger effects when the credit gap is already high.[1]

The ineffectiveness of monetary policy in a high credit gap state is relevant for evaluating the use of monetary policy or macroprudential policies to reduce vulnerabilities and future crises. Recent work on financial and macroeconomic stability emphasizes the welfare benefits of separate roles for macroprudential policies to manage credit growth and financial-sector resilience, while monetary policy should focus on price stability and output (Smets 2014 and Svensson 2016; see Adrian and Liang 2018 for a survey). Our results suggest the importance of successful macroprudential policies for limiting macrofinancial imbalances, such as the credit-to-GDP gap or growth, for ensuring effective monetary policy transmission. They may also suggest that if macroprudential policy is unavailable or ineffective at preventing excess credit buildups, monetary policymakers should consider larger potential downside risks to output from high credit levels.

The remainder of our paper is organized as follows: in section 2 we describe our data and specification; in section 3 we characterize the dynamics of the system with respect to impulses to financial conditions based on the credit-to-GDP gap and credit-to-GDP growth. In section 4, we characterize the transmission of monetary policy in low and high credit states. Section 5 describes some robustness tests and section 6 concludes.

2. Data and Specification

In this section we describe the data, particularly the construction of our financial conditions measure, the credit-to-GDP gap, and credit-to-GDP growth. Our outcomes of interest are subpar economic performance—contractions in real GDP and increases in the unemployment rate—rather than full-blown financial crises. This focus is because there are relatively few financial crises in the U.S. data since 1975 and because severe recessions also are costly because

[1]Hubrich and Tetlow (2015) use a regime-switching model and find that the effects of monetary policy are relatively weak when the economy is in a financial crisis state. They do not evaluate regimes based on nonfinancial credit.

they may have permanent depressing effects on trend growth (Blanchard, Cerutti, and Summers 2015). Of the five U.S. recessions in our sample, only the 2007 to 2009 episode is defined to be a financial crisis by Reinhart and Rogoff (2009). The wave of bank failures that began in 1984 and culminated in 1988–92 with the failure of almost 1,600 depository institutions associations has also been labeled a crisis (see Laeven and Valencia 2012), suggesting that perhaps the 1990 recession could also be associated with a financial crisis. Jordà, Schularick, and Taylor (2013) find that roughly 30 percent of recessions in their sample of 14 advanced economies from 1870 to 2008 involve financial crises.

2.1 Credit-to-GDP Measures

We follow the literature in defining the credit-to-GDP gap as the difference between the ratio of nonfinancial private-sector debt to nominal GDP and an estimate of its trend, designed to be slow moving. This definition of the credit gap is consistent with the Basel III recommendation for evaluating credit excesses for implementing the countercyclical capital buffer.

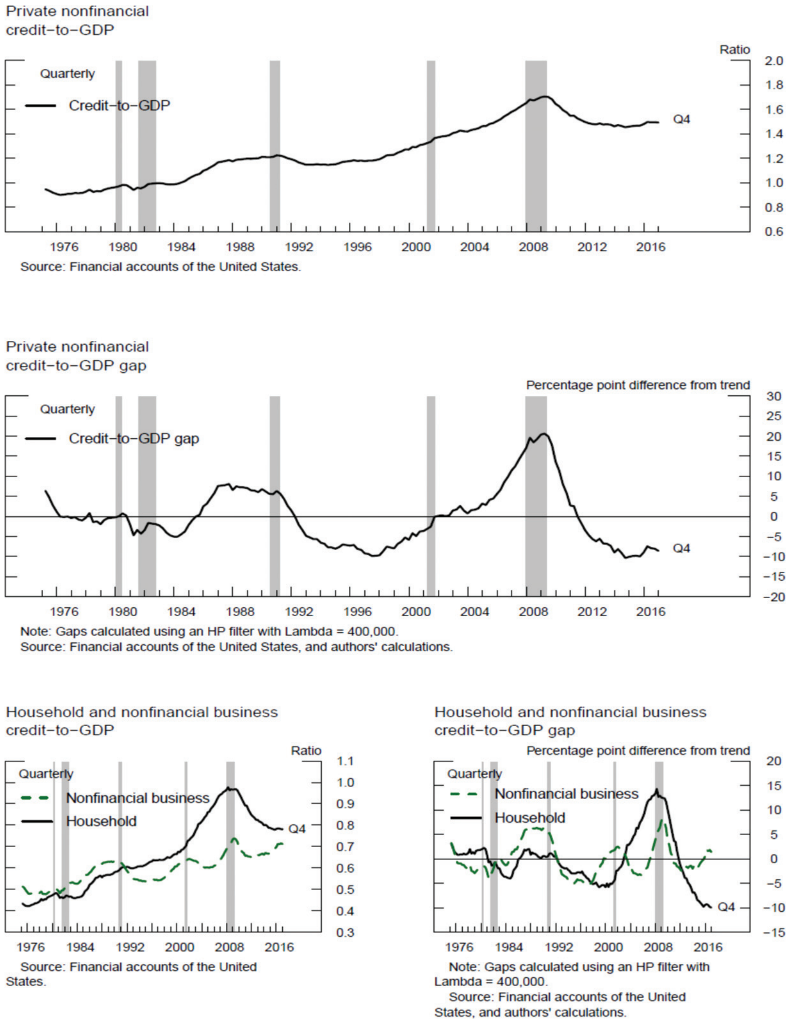
As shown in figure 1, the credit-to-GDP ratio since 1975 shows two distinct buildups: the first starts in the early 1980s and ends in the recession of 1990–91; the second starts in the late 1990s and accelerates for a sustained period until the Great Recession. Even after falling significantly from its peak in 2009, the level remains elevated relative to previous decades.

The estimated gap, the ratio less a trend estimated with a Hodrick-Prescott filter with a smoothing parameter of 400,000, shows a similar pattern over history, with peaks ahead of the recessions of 1990–91 and 2007–09 (middle panel). The gap we report, consistent with the Basel III recommendation, is based on final estimates of credit-to-GDP.[2]

A concern with using measures based on credit-to-GDP is the upward trend in the ratio. As an empirical matter, this is dealt with by focusing on the gap with respect to an estimate of the trend

[2]Real-time estimates provided an earlier warning than final estimates, and showed the sustained increase starting earlier during the mid-1990s (see Edge and Meisenzahl 2011).

Figure 1. Credit-to GDP Ratio and Credit Gap



Note: The panels in the figure give various measures of the ratio of credit to GDP from 1975 to 2014, and the ratio relative to a trend, at a quarterly frequency with National Bureau of Economic Research (NBER) recessions shaded.

designed to be slow moving. As a theoretical matter, the trend is often ascribed to financial deepening, as credit markets have evolved to make loans more accessible to previously unserved households and businesses.

As shown in the bottom panels of figure 1, the household credit-to-GDP ratio has nearly doubled since 1975, while the increase in the business credit-to-GDP ratio has been more modest, indicating the trend appears to be driven mainly by household credit. Household credit rose both because of the extensive margin—more households became homeowners—and because of the intensive margin—existing homeowners took on more debt.[3] On the extensive margin, the homeownership rate also rose, from 64.0 in 1990:Q1 to a peak of 69.2 in 2004:Q4 (since then it has fallen steadily, returning to its 1990 level).

In addition, the household and business credit-to-GDP gaps highlight the lower frequency of cycles in the household credit gap relative to the business credit gap, as well as the differences in amplitude of changes.

Given some uncertainty about the estimated trend in credit, we also use growth in the credit-to-GDP ratio as an alternative to the credit-to-GDP gap. In particular, we focus on credit-to-GDP growth for eight years (32 quarters), log (credit-to-GDP$_t$) – log (credit-to-GDP$_{t-32}$) relative to its mean, roughly the maximum length of the average business cycle. Relative to differences over shorter periods, differences over longer periods capture sustained credit growth, which is a better signal of the buildup of excess credit. This measure also is closer in spirit to Schularick and Taylor (2012) and Jordà, Schularick, and Taylor (2013), which look at growth in the ratio of bank loans to the nonfinancial sector to GDP, from trough to peak, relative to its mean.

2.2 Measures of Financial Conditions

Financial conditions indexes are summary measures of the ease with which borrowers can access credit. They have been found to help

[3]These increases are due to a combination of public policies, including the tax advantage of mortgage debt and the funding advantage enjoyed by the housing-related government-sponsored enterprises (GSEs), Fannie Mae and Freddie Mac. The share of mortgage credit funded by Fannie and Freddie grew from 12 percent in 1975 to roughly 60 percent in 2014 (Financial Accounts of the United States, table L.218.) The GSEs faced lower capital charges for funding residential mortgages than did banks, and benefited as well from an implicit backstop by the U.S. government. For a discussion of the capital advantages enjoyed by the GSEs, see Hancock et al. (2006).

to predict future economic growth. English, Tsatsaronis, and Zoli (2005) show that looser financial conditions lead to lower output gaps (stronger economic conditions) four and eight quarters ahead.

FCIs typically incorporate both price and nonprice measures. Higher asset valuations relative to historical averages may reflect lower risk premiums and greater risk-taking behavior. Rapidly rising real estate prices relative to rents are viewed by many economists as key sources of financial fragility (see, for instance, Iacoviello 2005, Cecchetti 2008, and Jordà, Schularick, and Taylor 2015). Dell'Ariccia, Igan, and Laeven (2008) show that lending standards (denial rates and loan-to-income ratios) deteriorated more when credit growth was strong in 2000 to 2006. Others have emphasized the information in bond risk premiums and nonprice measures, such as the share of nonfinancial corporate bond issuance that is speculative grade (Stein 2013b and López-Salido, Stein, and Zakrajsek 2015). According to this view, when risk premiums are unusually low there is a greater probability of a subsequent rapid reversal, which may be associated with significant adverse economic effects. Brunnermeier and Sannikov (2014), among others, have argued that high asset prices and low volatility may spur risk-taking, with the potential for a destabilizing unraveling when prices eventually reverse.

Our FCI captures borrowing conditions for both businesses and households, and is based on a consistent set of variables for the estimation period starting in 1975. In contrast, many do not start until the 1990s (see Aramonte, Rosen, and Schindler 2017). It is constructed by taking the weighted sum of normalized time series related to asset valuations and lending standards for different sources of business and household credit. The overall index is then a weighted average of the standardized index for the two sectors—this is in the spirit of the methodology in Aikman et al. (2017). The components of each sector are as follows:

- Business Sector: the S&P 500 price-to-earnings ratio to measure corporate-sector valuations; the BBB-rated corporate bond yield to Treasury yield; the share of nonfinancial corporate bond issuance that is speculative grade, used to represent investor willingness to take risk (Stein 2013a, López-Salido, Stein, and Zakrajsek 2015); the index of credit availability from the National Federation of Independent Business survey of small businesses to capture credit conditions for such borrowers; and growth in real commercial real estate prices to represent commercial real estate valuations.

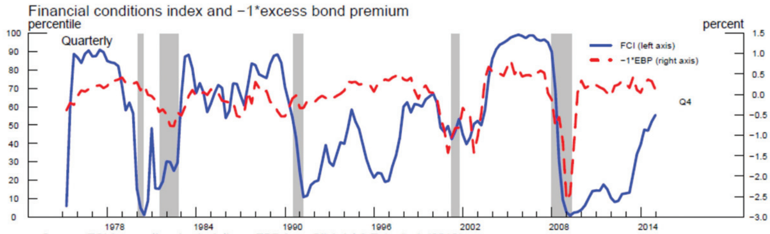
- Household Sector: the residential house price-to-rent ratio to represent house price valuations, and lending standards for consumer installment loans from the Senior Loan Officer Opinion Survey to represent banks' willingness to provide loans to households (Dell'Ariccia, Igan, and Laeven 2008).

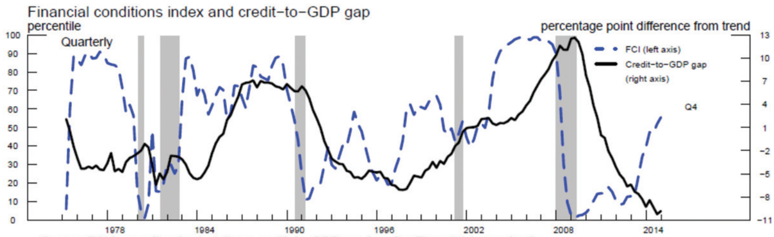
To link to the existing literature, we compare our FCI to the EBP, which is based on corporate bond prices. A higher FCI value represents looser financial conditions, representing greater willingness to accept risk. Both the FCI and the negative of EBP (the top panel of figure 2) fall with each recession, but fluctuations in the EBP are smaller than for our FCI because the EBP reflects large nonfinancial corporations, while the FCI also reflects credit conditions for small businesses and conditions for the household sector, which have cycles distinct from corporate asset markets.[4]

The contemporaneous correlation of the FCI and the credit-to-GDP gap is low, but the data show that the FCI tends to lead the credit-to-GDP gap (figure 2, middle panel). This lead structure suggests that looser financial conditions tend to create the conditions for a period of a high credit gap. To illustrate the leading properties of the FCI for the credit-to-GDP gap, we conduct an out-of-sample forecast exercise. In this exercise, we compare the accuracy of the credit-to-GDP gap forecasts obtained through a bivariate VAR for the credit-to-GDP gap and the FCI with the accuracy of the forecast obtained with two alternative AR models. The bivariate VAR is estimated with nine lags, in order to capture the maximum correlation between the FCI and credit-to-GDP gap at nine quarters. The alternative AR models for the credit-to-GDP gap are estimated with one lag, to control for parameters' proliferation that may affect forecast accuracy, and with nine lags to be comparable to the bivariate VAR. The forecasts are obtained estimating the models' parameters recursively. The first estimation sample is 1975:Q1 to 1982:Q1

[4]The correlation of our FCI and (negative) EBP is .32. The correlation of the business component of our FCI and (negative) EBP is .41.

Figure 2. Financial Conditions Index, Excess Bond Premium, and Credit-to-GDP Gap





Ratio of Root Mean Squared Forecast Errors of Bivariate VAR to AR Models for Credit-to-GDP Gap, by Forecast Horizon

	1 Quarter	4 Quarters	8 Quarters	12 Quarters
AR (9)	0.93**	0.83**	0.81*	0.85*
AR (1)	0.76***	0.71**	0.72**	0.76**

Note: The symbols *, **, and *** indicate that we can reject the hypothesis of equality between the alternative forecasts with 10 percent, 5 percent, and 1 percent significance level, respectively.

Notes: The top panel shows the FCI and EBP at a quarterly frequency, with NBER recessions shaded. The middle panel shows the the FCI and the solid line the credit-to-GDP gap. The numbers in the table (lower panel) represent the ratio of root mean squared forecast errors for a bivariate vector autoregressive model with nine lags, related to an autoregressive model with one lag and an autoregressive model with nine lags for forecast horizons of 1, 4, 8, and 12 quarters.

in order to obtain the 12-quarter-ahead forecast for 1985:Q1. The last estimation sample is 1975:Q1 to 2014:Q3 in order to obtain the one-quarter-ahead forecast for 2014:Q4. The forecast accuracy is therefore evaluated on the sample 1985:Q1 to 2014:Q4.

The table in the bottom panel of figure 2 reports the ratio of the root mean squared forecast errors (RMSFEs) of the VAR(9) to

Table 1. Sample Statistics by Credit-to-GDP Gap (CY) and Financial Conditions (FCI)

	No. of Obs.	Unemployment Rate		GDP Growth[b]	Deflator Growth	Federal Funds Effective	
		Level	Change[a]			Level	Change[a]
CY Low	94	6.71	−8.72	3.28	3.65	6.56	1.88
CY High	66	6.25	8.00	2.18	2.52	4.66	−10.49
FCI Low	78	7.14	8.44	1.80	2.98	5.20	−10.49
FCI High	82	5.93	−11.59	3.80	3.38	6.32	3.35

Note: Unemployment rate level, deflator growth, and effective federal funds level are in percent.
[a]Change in basis points.
[b]400x quarterly change in log level.

the RMSFEs of the AR(1) and the AR(9) for 1, 4, 8, and 12 quarters ahead. Values below one indicate that the VAR performs better than the competing model. We test the equality of forecast accuracy with the Diebold and Mariano (1995) test. As shown, values are significantly below one in all comparisons, indicating that the VAR outperforms the competing models at each horizon. These results highlight the forecasting power of the FCI for the credit-to-GDP gap in future quarters.

2.3 Sample Statistics

Table 1 gives sample statistics for the variables in our system. The table reports statistics for periods when the credit-to-GDP gap and FCI are above or below their means. For each measure, in periods when it is high or low, the table gives the level and quarterly change in the unemployment rate, real GDP growth, inflation, and the level and quarterly change in the average effective federal funds rate.

When the credit-to-GDP gap is low, real GDP growth and the inflation rate are higher than in periods when it is high. Further, in these low periods, the unemployment rate is falling and the federal funds rate is increasing, suggesting that such low periods occur near business cycle peaks. In contrast, periods when the gap is high are

Table 2. Monetary Policy Changes by Credit-to-GDP Gap (CY) and Financial Conditions (FCI)

Number of Periods in Which ...	Federal Funds Decreased	Federal Funds Unchanged	Federal Funds Increased
CY Low	30	31	33
CY High	20	26	20
FCI Low	23	37	18
FCI High	37	20	35

Notes: Columns labeled decreased (increased) refer to quarters in which the effective funds rate decreased (increased) 25 basis points or more; quarters in which the effective federal funds rate changed less than 25 basis points in absolute value are labeled unchanged.

associated with lower economic growth, low but rising unemployment, and loosening monetary policy, suggesting that they occur near business cycle troughs.

This pattern is in contrast with that for the FCI. Periods when the FCI is low (indicating that financial conditions are tighter than average) are associated with worse overall economic performance: the unemployment rate is higher and rising, and real GDP growth is significantly lower. Monetary policy appears to be easing in these periods, with the effective funds rate falling, on average, in such quarters. Put another way, periods of high FCI are associated with good economic performance—higher real GDP growth and falling unemployment.

Given our focus on the interaction of the effectiveness of monetary policy with our vulnerability measures, we report in table 2 the number of quarters in which the effective federal funds rate rose or fell by 25 basis points or more, conditional on whether the credit-to-GDP gap or the FCI is high or low. One concern would be if the subsample in a high or low value of a measure contained too few easing or tightening episodes. Overall, for both the credit-to-GDP gap and the FCI, there are a reasonable number of quarters in each of the categories of easing, tightening, or unchanged.[5] For example, when the credit-to-GDP gap is either high or low, the distributions

[5] For the entire sample, the effective funds rate fell 25 basis points or more in 41 quarters, changed less than 25 basis points in absolute value in 70 quarters, and rose 25 basis points or more in 46 quarters.

of changes in the federal funds rate across decreased, unchanged, and increased is roughly equal.

2.4 Specification

Our primary goal is to characterize the effect of shocks to the FCI and federal funds rate and its effects on credit and economic performance, and to evaluate whether these effects differ depending on whether the credit-to-GDP gap is high or low, or whether credit-to-GDP growth is above or below average.

We characterize these effects using threshold vector autoregressions estimated on quarterly U.S. macro data starting in 1975:Q1. We estimate the TVARs using Bayesian techniques, following the estimation strategy proposed by Giannone, Lenza, and Primiceri (2015) that is based on the so-called Minnesota prior, first introduced in Litterman (1979, 1980). This prior is centered on the assumption that each variable follows a random walk, possibly with a drift (if the variables are not stationary); this reduces estimation uncertainty and leads to more stable inference and more accurate out-of-sample forecasts. As is standard in this literature, we report the 16th and 84th percentiles of the distribution of the impulse response functions (Uhlig 2005, Giannone, Lenza, and Primiceri 2015).

Our baseline specifications contain the following variables:

- 100 $\times$ logarithm of real gross domestic product (Real GDP);
- 100 $\times$ logarithm of the GDP deflator (GDP Deflator);
- Unemployment rate (Unemployment);
- Private nonfinancial credit-to-GDP gap (Credit/GDP Gap);
- Financial conditions (FCI) defined so that higher values indicate looser financial conditions; and
- Federal funds rate, effective, per annum (FFR).

Following Giannone, Lenza, and Primiceri (2015), real GDP and the GDP deflator enter the models in annualized log levels (i.e., we take logs and multiply by 4), while the other variables enter in levels.[6] In

[6]The impulse response functions are instead displayed in basis points; therefore, Real GDP and GDP deflator are divided by 4 and multiplied by 100, while the other variables are simply multiplied by 100.

all instances we use nine lags of the vector of dependent variables, which allows us to capture the lead–lag relationship between the FCI and the credit-to-GDP gap, which has a maximum correlation at nine quarters.

In computing impulse response functions, we identify shocks using a Cholesky decomposition. When identifying monetary policy shocks, monetary policy is assumed to be able to react to risk appetite shocks in the same quarter, as in Gilchrist and Zakrajsek (2012).

The TVARs are estimated over disjoint subsamples with the thresholds determined by the credit-to-GDP gap. We compute responses when the gap is high (above its trend) and when the gap is low (below its trend). This permits us to test for nonlinear dynamics; that is, whether a shock to the FCI or monetary policy has a different effect in times of high versus low excess credit. Thus, our baseline specification is a TVAR based on the level of a measure X_t (usually the credit-to-GDP gap), which has a sample mean of μ_X:

$$y_t = c^{(j)} + A(L)^{(j)} y_{t-1} + \varepsilon_t^{(j)} \begin{cases} j = \text{high}, & \text{if } X_t > \mu_X \\ j = \text{low}, & \text{if } X_t \leq \mu_X \end{cases}, \qquad (1)$$

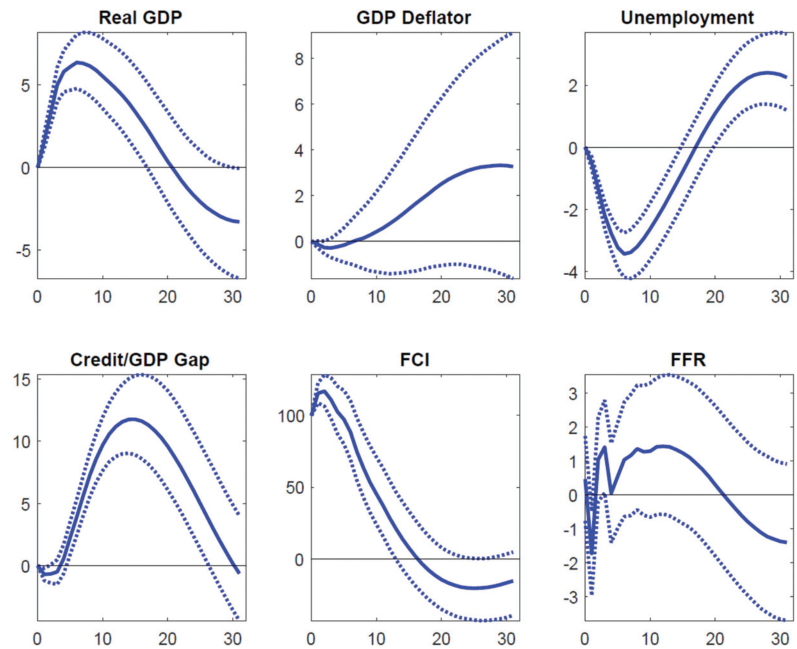
where y_t is the vector of endogenous variables described above and we define $\mu_X = 0$.

3. Baseline Results

3.1 Financial Conditions and Credit

Figure 3 shows the impulse response functions (IRFs) with respect to shocks to the FCI in a six-variable linear system that includes both the FCI and the credit-to-GDP gap. We identify shocks to the FCI using a Cholesky decomposition in which monetary policy is permitted to react within the same quarter as the shock to FCI (a strategy used by Gilchrist and Zakrajsek 2012). FCI is defined where higher values indicate looser financial conditions. Real GDP rises and the unemployment rate falls in response to a positive impulse to the FCI, with the responses peaking about eight quarters after the shock. The credit-to-GDP gap rises, responding more slowly than GDP and unemployment, peaking about 16 quarters after the

Figure 3. Financial Conditions Index (FCI) Shock, Linear

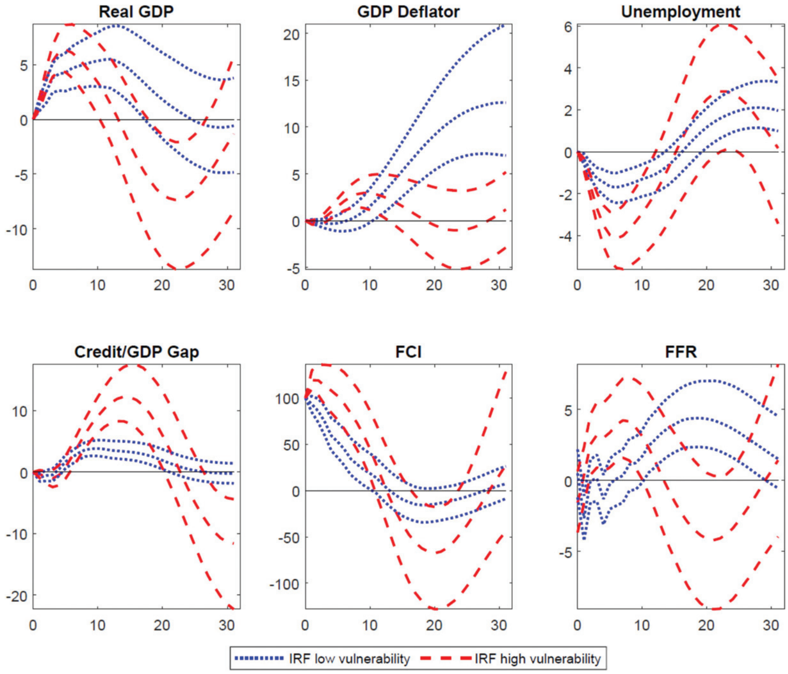


Notes: The solid line reports the median impulse response to a shock to financial conditions (FCI). The dotted lines report one-standard-deviation confidence intervals for each impulse response. Variables are defined in section 2.4.

shock. Further out, 20 quarters from the shock, the economy deteriorates, with GDP contracting and unemployment rising. Including both financial variables in the system helps to clarify the dynamics: a positive impulse to financial conditions stimulates economic activity but also leads to a buildup in credit and, subsequently, subpar growth. English, Tsatsaronis, and Zoli (2005) showed a stimulative effect on GDP from looser financial conditions, but they did not include the credit-to-GDP gap and effects beyond eight quarters.

We next examine whether the response of the economy to an FCI shock varies depending on the level of the credit-to-GDP gap. This question is motivated by the post-crisis literature's focus on the proposition that high levels of imbalances leave the economy more vulnerable to negative shocks. To do so, we estimate the model after

Figure 4. Financial Conditions Index (FCI) Shock, Nonlinear with Credit-to-GDP Gap Threshold



Notes: The dotted blue lines report the median impulse response to a shock to financial conditions (FCI) when the credit-to-GDP gap ratio is below zero, with one-standard-deviation confidence intervals. The dashed red lines report the median impulse response to a shock to FCI when the credit-to-GDP gap ratio is above zero, with one-standard-deviation confidence intervals. Variables are defined in section 2.4.

dividing the sample into two parts—when the credit-to-GDP gap is above and below zero. This specification permits nonlinear dynamics to emerge. The results are shown in figure 4. (For color versions of the figures, see the IJCB website at http://www.ijcb.org.)

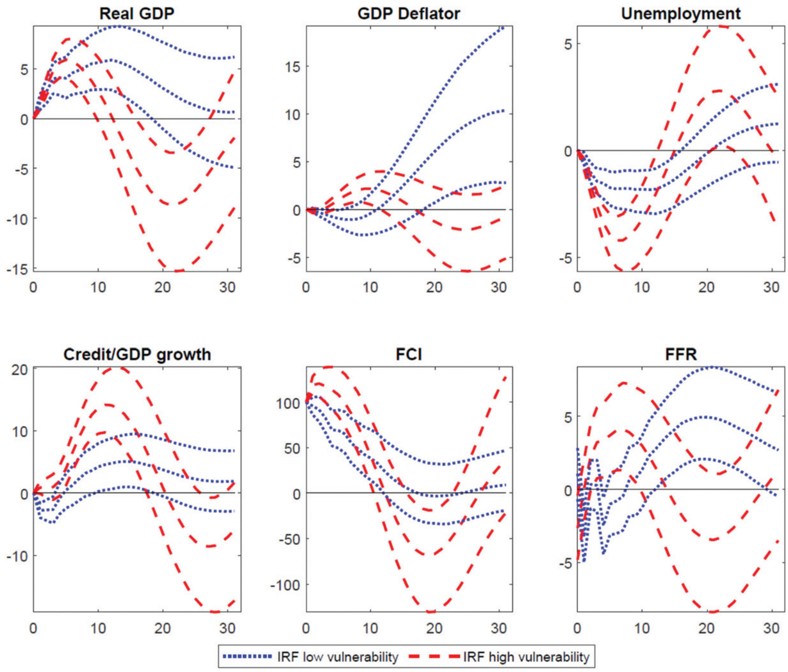
When the credit gap is low (dotted blue lines), shocks to the FCI lead to an increase in output, inflation, and a decline in unemployment; moreover, the credit-to-GDP gap increases modestly. In contrast, shocks to the FCI in a high credit gap environment (dashed red lines) result in a significantly larger increase in the credit-to-GDP gap than in a low credit gap environment. And while there is a boost to economic activity in the short term, GDP contracts and unemployment increases after about 12 quarters. These results suggest that a positive shock to financial conditions that occurs in a high credit gap environment generates an intertemporal tradeoff: activity expands in the near term, but an increase in indebtedness that results from the expansion may sow the seeds for weaker economic performance in subsequent periods. In contrast, a shock to financial conditions in a low credit gap period does not suggest the same costs and intertemporal tradeoff for economic activity. These results suggest that a positive credit gap is an indicator of macroeconomic vulnerability, which leaves the economy more prone to a recession.[7]

The IRFs for a shock to financial conditions when credit is measured by growth in the credit-to-GDP ratio are shown in figure 5. The results are similar to those based on the credit-to-GDP gap, indicating that the results are robust to alternative measures of high and low credit periods. The nonlinear effects are consistent with Bauer and Grazienga (2016), who find that the effect of the credit gap on the probability of a crisis 8 to 12 quarters ahead for a sample of 18 countries depends on the initial level of the credit gap. Their paper, however, does not explore the direct role of financial conditions on the credit gap.

We offer several alternative structural interpretations of our financial conditions shock. First, following He and Krishnamurthy (2012, 2013), this shock could reflect shifts in financial intermediaries' equity, with knock-on consequences for the risk-bearing capacity of the marginal investor and hence risk premiums. Second, following Brunnermeier and Pedersen (2009), Adrian and Shin (2014), and Brunnermeier and Sannikov (2014), it could reflect the endogenous reactions of financial intermediaries via value-at-risk (VaR) constraints to episodes of low volatility. Third, following

[7]When the credit-to-GDP gap is low, the unemployment rate rises in later quarters after falling in the near term from a positive (looser) shock to FCI. The rise in later quarters appears to be due to a tightening response of monetary policy following the initial positive FCI shock, and subsequent increases in real GDP and the GDP deflator. That is, when we shut off the monetary policy reaction (prevent monetary policy from tightening in response), the IRFs no longer show a rise in the unemployment rate in later quarters. We thank a referee for pointing this out.

Figure 5. Financial Conditions Index (FCI) Shock, Nonlinear with Credit-to-GDP Growth Threshold



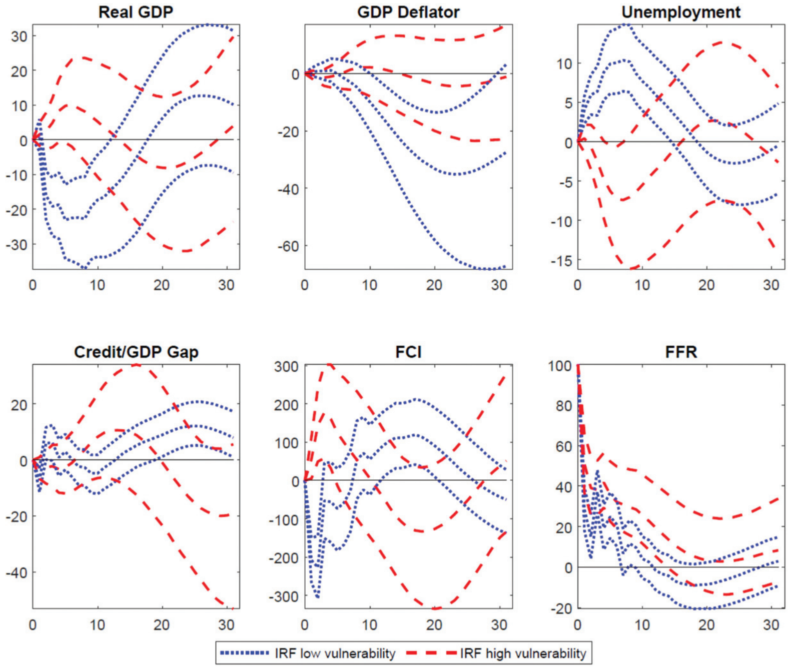
Notes: The dotted blue lines report the median impulse response to a shock to financial conditions (FCI) when the credit-to-GDP growth is below zero, with one-standard-deviation confidence intervals. The dashed red lines report the median impulse response to a shock to FCI when the credit-to-GDP growth is above zero, with one-standard-deviation confidence intervals. Variables are defined in section 2.4.

Christiano, Motto, and Rostagno (2014), it could reflect episodes in which the cross-sectional, idiosyncratic dispersion in investment project outcomes is perceived to have changed. In each of these models, increases in financial conditions (looser financial conditions) lead to economic expansions.

3.2 Monetary Policy

We next turn to the role of monetary policy and, in particular, its interactions with the credit gap. Figure 6 shows the responses of the economy to a shock to monetary policy (identified using a Cholesky

Figure 6. Monetary Policy (FFR) Shock, Nonlinear with Credit-to-GDP Gap Threshold



Notes: The dotted blue lines report the median impulse response to the federal funds rate (FFR) when the credit-to-GDP gap is below zero, with one-standard-deviation confidence intervals. The dashed red lines report the median impulse response to the FFR when the credit-to-GDP gap is above zero. Variables are defined in section 2.4.

decomposition) in our nonlinear specification with the threshold based on the credit-to-GDP gap. As before, the dotted blue lines show the IRFs from the system estimated in low credit-to-GDP gap periods, and the dashed red lines show the IRFs in high credit gap periods. There are important differences in the dynamics of the system in response to a monetary policy shock between high and low credit-to-GDP gap periods. When the credit gap is low, the system reacts as expected: GDP and prices fall and the unemployment rate rises. However, when the credit gap is high, monetary policy appears ineffective, as real GDP, prices, and the unemployment rate do not react significantly to the shock.

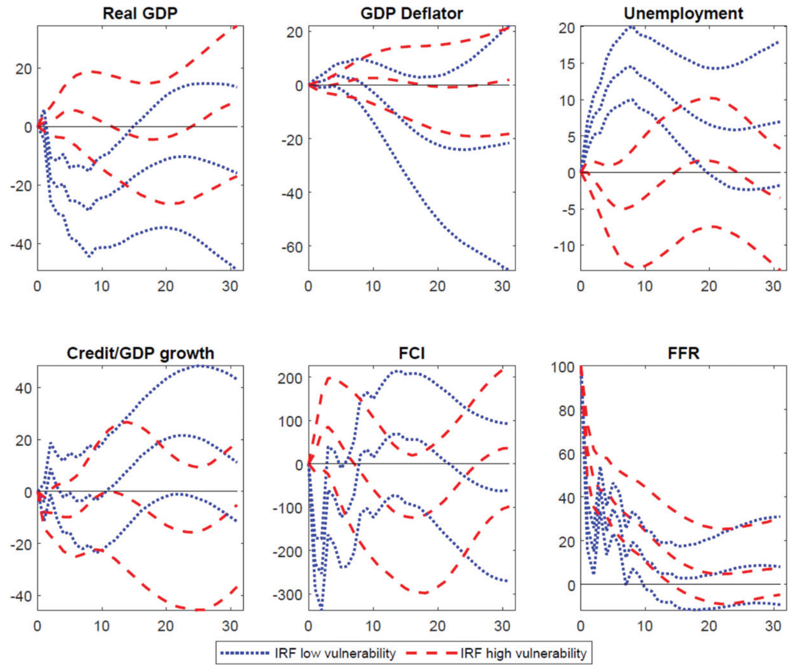
A proximate explanation for these different effects of monetary policy shocks appears to be related to the behavior of financial conditions. In particular, when the credit gap is low, the FCI falls (that is, tightens) following a contractionary monetary policy shock, reinforcing the tightening of monetary policy. In contrast, when the credit gap is high, the FCI actually increases (that is, loosens) following the monetary policy shock, acting as an offset to a contractionary effect of tighter monetary policy. We show later (in section 5.1) that the EBP behaves similarly to the FCI following a monetary policy shock, indicating that this effect is not unique to our FCI measure.

Results for a threshold based on growth in credit-to-GDP are similar to those based on the credit gap (figure 7). Both sets of results suggest that the transmission of monetary policy to the real economy depends significantly on credit, through its effects on financial conditions, and that the effects are nonlinear.

Our finding that the strength of the monetary policy transmission mechanism varies over the financial cycle is consistent with predictions from the large literature analyzing the role of financial frictions in the monetary transmission mechanism (see Bernanke, Gertler, and Gilchrist 1999). Asymmetric information between borrowers and lenders gives rise to a credit spread, a premium in the interest rate paid by the borrower over and above the risk-free rate, which depends inversely on borrowers' net worth. A tightening in monetary policy reduces profits and asset values, depressing borrowers' net worth. This leads to an increase in the credit spread, which magnifies the decline in real activity and increases the persistence of the economy's response to the shock (see Gertler and Karadi 2015 for empirical evidence). It is plausible to expect the strength of this "financial accelerator" to vary over the cycle: It will be weak in "good" times—states of the world when credit is freely available for households and firms and we expect the credit-to-GDP ratio to be high and rising—and strong in "bad" times—states of the world when borrowing constraints are binding and we expect credit-to-GDP to be low and falling.

This asymmetry also is a common finding in models where a credit channel is present, including those that emphasize frictions in the financial intermediary sector. For instance, in Gertler and Karadi's (2011) model, an agency problem between intermediaries and depositors generates an endogenous "market-determined"

Figure 7. Monetary Policy (FFR) Shock, Nonlinear with Credit-to-GDP Growth Threshold



Notes: The dotted blue lines report the median impulse response to the federal funds rate (FFR) when credit-to-GDP growth is below zero, with one-standard-deviation confidence intervals. The dashed red lines report the median impulse response to the FFR when credit-to-GDP growth is above zero. Variables are defined in section 2.4.

constraint on intermediary leverage. When this constraint binds, the impact of a tightening in monetary policy is amplified by its impact on intermediary equity and hence credit supply. This is also the case in Van den Heuvel's (2002) model, in which dynamically optimizing banks engage in maturity transformation, a consequence of which is that their profits and hence equity falls in response to a tightening in monetary policy. If risk-based capital requirements are binding, then unless banks are able to issue fresh equity or reduce dividends, they will be forced to restrict lending. These financial accelerator mechanisms are more likely to act powerfully in bad times, when bank equity is scarce, than in good times, when banks tend to be highly profitable.

4. Nonlinear Monetary Policy Transmission

We investigate further why monetary policy shocks appear to have little effect when the credit gap is high, using an alternative identification strategy and with a different outcome variable. In particular, we analyze the effect of a monetary policy shock on government bond forward rates, following the approach of Hanson and Stein (2015) (henceforth referred to as "HS"). We use high-frequency data and test whether the response of distant forward rates to shocks to shorter-maturity rates differs between high credit gap and low credit gap states. HS find that, based on data from 1999 to 2012, forward rates respond significantly to changes in short-term nominal rates on Federal Open Market Committee (FOMC) days; they further find that most of the response is driven by movements in forward real rates rather than in inflation. HS attribute the movements to changes in term premiums rather than to changes in the path of short rates at distant horizons, consistent with "reach-for-yield" behavior by investors who prefer current income to a holding-period return. When monetary policy changes, investors adjust to mitigate the change in current yields; for example, if policy loosens, these investors rebalance to longer-term bonds to gain yield, which (in equilibrium) reduces term premiums. Conversely, if policy tightens, investors sell longer-term bonds and term premiums rise.

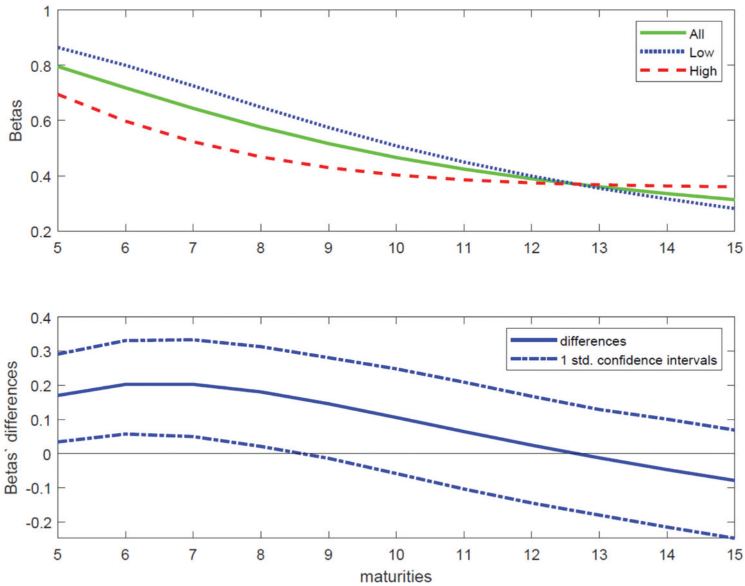
In contrast to HS, we are interested in determining whether the response of longer-maturity yields to monetary policy surprises is attenuated in high credit gap periods, thus providing a mechanism for our result that monetary policy shocks do not affect GDP growth when the credit gap is high. We replicate the HS analysis using nominal government rates for 1975 to 2014, and estimate regressions separately for high and low credit-to-GDP gap periods.

We estimate the following regression:

$$\Delta f_t^{X(n)} = \alpha_{X(n)} + \beta_{X(n)} \Delta y_t + \Delta \varepsilon_t^{X(n)}, \tag{2}$$

where f indicates the forward, n the maturity, and X indicates if the forward is of a nominal bond ($X = \$$) or a real bond ($X = TIPS$). Here, Δy_t is the one-day change in the two-year maturity

Figure 8. Estimated Betas for Distant Forward Nominal Rates by Credit-to-GDP Gap, 1975 to 2014



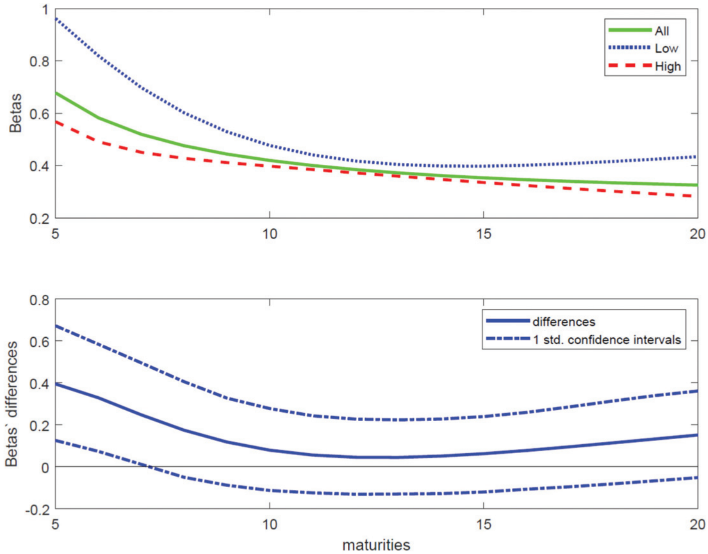
Notes: The lines in the upper panel report the estimated betas from regressions of the daily change in nominal government bond forward rates, for maturities from 5 to 15 years, from a monetary policy shock measured as the daily change in the 2-year bond yield. The dotted blue line shows the estimated betas when the credit-to-GDP gap is below zero, the dashed red line shows the estimated betas when the credit-to-GDP gap is above zero, and the solid green line reports the estimated betas for the full sample. In the lower panel, the solid blue line reports the difference in the estimated betas when the credit-to-GDP gap is high versus when it is low. The dashed lines report one-standard-deviation confidence intervals (obtained through block bootstrapping with blocks of dimension equal to 8).

Treasury bond yield on the day of an FOMC announcement, a proxy for surprises to monetary policy over the relevant horizon.[8]

The estimated betas for the regressions are shown in the top panel of figure 8 for nominal yields and figure 9 for real yields (the

[8]The general strategy of measuring monetary policy surprises by the change in a short-term Treasury security over a narrow time window is commonly used—see, for example, Gürkaynak, Sack, and Swanson (2005) and Gilchrist, López-Salido, and Zakrajsek (2015). This identification strategy is popular because it minimizes confounding effects—the FOMC decision is the main news on such days.

Figure 9. Estimated Betas for Distant Forward Real Rates by Credit-to-GDP Gap, 1999 to 2014



Notes: The lines in the upper panel report the estimated betas from regressions of the daily change in real government bond forward rates, for maturities from 5 to 20 years, on a monetary policy shock measured as the daily change in the 2-year bond yield. The dotted blue line shows the estimated betas when the credit-to-GDP gap is below zero, the dashed red line shows the estimated betas when the credit-to-GDP gap is above zero, and the solid green line shows the estimated betas for the full sample. In the lower panel, the solid blue line reports the difference in the estimated betas for when the credit-to-GDP gap is high versus when it is low. The dashed lines report one-standard-deviation confidence intervals (obtained through block bootstrapping with blocks of dimension equal to 8).

"All" line in figure 9 exactly replicates HS). For parallelism with our other results, we use an estimation period back to 1975 for nominal Treasury yields for maturities of 5 to 15 years (nominal Treasury securities with maturities beyond 15 years were not available back to 1975). The estimated betas for nominal forward rates are higher in the low credit-to-GDP gap state than in the high credit gap state, and differences are statistically different out to eight years.[9] Figure 9,

[9]Differences between the betas for the high and low credit gap periods for the sample back to 1975 rather than back to 1999 are smaller in magnitude at closer horizons, but betas for both samples converge to about .4 at far distant horizons.

for real yields for maturities of 5 to 20 years, estimated from 1999 to 2014 (TIPS yields are not available before 1999), also shows significant differences in betas between low and high credit gap periods for forward rates out to roughly 7 years ahead. One possible reason for why the betas in high credit gap periods are lower is that investors who want to rebalance their portfolios to gain yield when short-term rates fall have more opportunities to increase credit risk for the additional yield in high credit gap versus low credit gap periods, and thus do not have to extend their duration risk by as much.

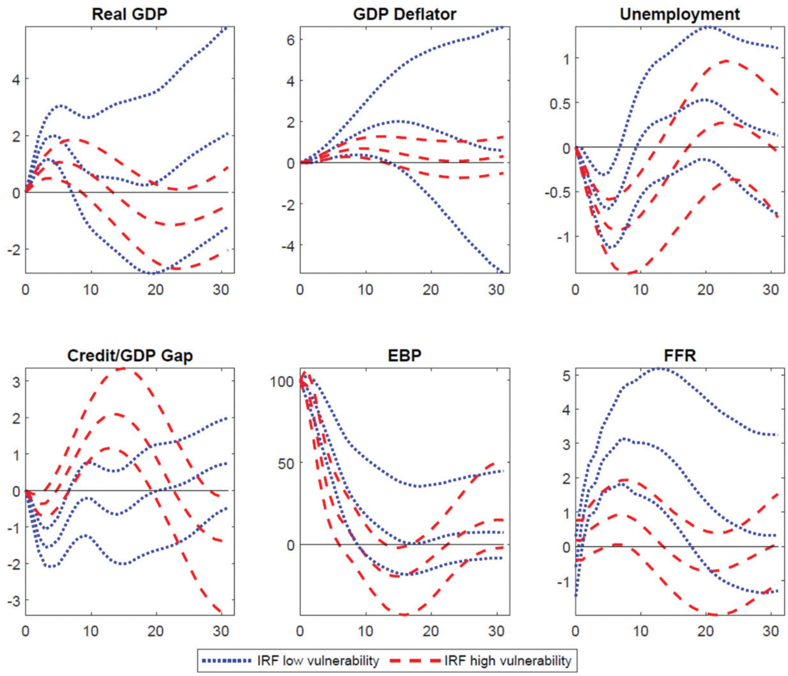
5. Robustness Tests and Extensions

We describe a large number of robustness tests, including using EBP rather than FCI as a financial conditions indicator, alternative measures of credit, and alternative sources of uncertainty. Overall, the robustness results support our interpretation that the effects of financial conditions and monetary policy on economic growth depend nonlinearly on credit.

5.1 Using EBP instead of FCI

First, as an alternative to our FCI, we use the EBP in the nonlinear system with the sample divided by the credit-to-GDP gap. Because higher values of FCI correspond to greater risk appetite while higher values of the EBP correspond to lower risk appetite, we use the negative of the EBP in our estimation. IRFs with respect to shocks to EBP and to monetary policy are shown in figures 10 and 11. Similar to a shock to FCI, a shock to EBP in a high credit gap state stimulates a large enough credit boom to ultimately lead to a recession, although the magnitudes of effects on GDP, unemployment, and the credit gap are smaller. In addition, monetary policy is ineffective in high credit gap states even in the system estimated using EBP instead of FCI. As with the FCI, the (negative) EBP loosens following a contractionary impulse to monetary policy, suggesting our earlier results that our results are not related to the construction of our FCI. Overall, our results are robust to the use of EBP, which has been used often to predict economic performance, which supports our conclusion of monetary policy ineffectiveness in high credit gap periods.

Figure 10. Excess Bond Premium Shock, Nonlinear with Credit-to-GDP Gap Threshold



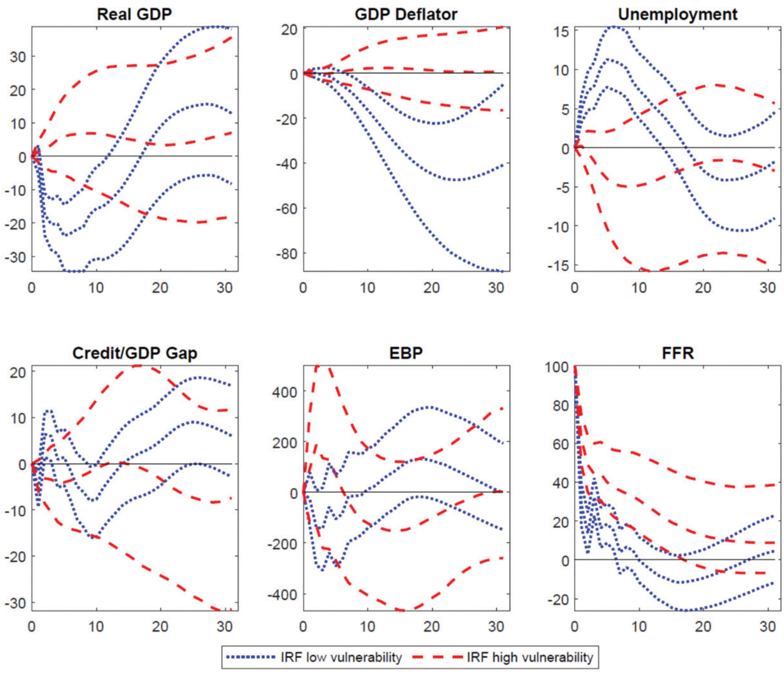
Notes: The dotted blue lines report the median impulse response, and one-standard-deviation confidence intervals, to a shock to the negative of the excess bond premium (EBP) when the credit-to-GDP gap ratio is below zero and the system includes (negative) EBP rather than FCI. The dashed red line reports the median impulse response, and one-standard-deviation confidence intervals, to a shock to the (negative) EBP when the credit-to-GDP gap ratio is above zero and the system includes EBP rather than FCI. Variables are defined in section 2.4.

In addition, we follow Gilchrist and Zakrajsek (2012) in their EBP analysis by placing the FCI before the monetary policy rate in the TVAR. For robustness, we tested the specification with FCI after the policy rate and found results were unchanged.

5.2 Robustness to Alternative Specifications of Credit

The use of the credit-to-GDP gap raises certain questions about the underlying trend, and we have shown already that the

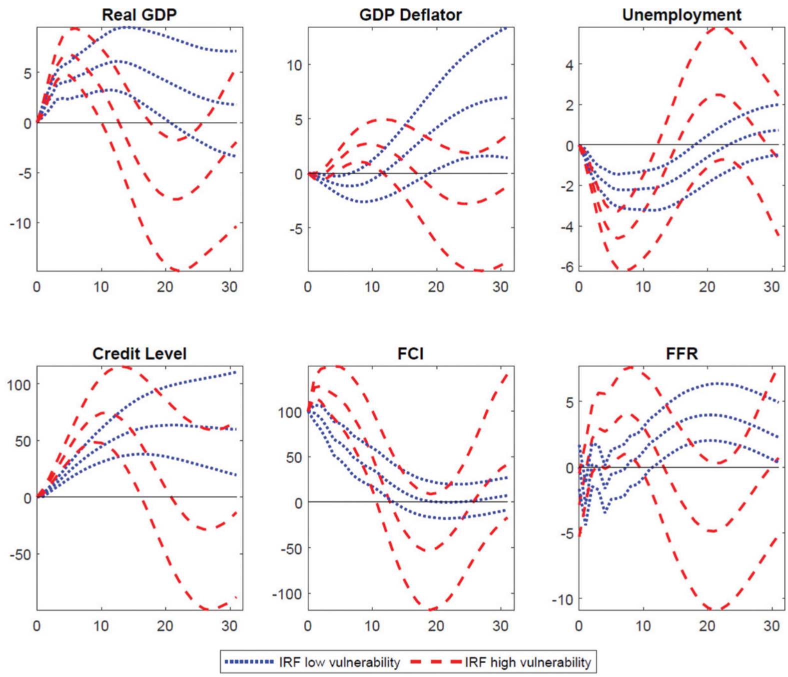
Figure 11. Monetary Policy Shock with Excess Bond Premium, Nonlinear with Credit-to-GDP Gap Threshold



Notes: The dotted blue lines report the median impulse response, and one-standard-deviation confidence intervals, to the federal funds rate (FFR) when the credit-to-GDP gap is below zero and the system includes the (negative) excess bond premium (EBP) rather than FCI. The dashed red lines report the median impulse response, and one-standard-deviation confidence intervals, to the FFR when the credit-to-GDP gap is above zero and the system includes the (negative) EBP rather than FCI. Variables are defined in section 2.4.

empirical results are robust to using credit-to-GDP growth (see figures 5 and 7). Figure 12 shows the results of an alternative specification in which the credit-to-GDP gap is replaced with the log level of credit outstanding. In order to limit the number of changes in specification, high and low vulnerability periods are defined relative to the credit-to-GDP gap as before. As shown, results using log level of credit are similar to those when using the credit-to-GDP gap: An upward shock to FCI during either high or low vulnerability periods results immediately in real GDP growth and

Figure 12. Financial Conditions Index (FCI) Shock with Credit Level, Nonlinear with Credit-to-GDP Gap Threshold



Notes: The dotted blue lines report the median impulse response, and one-standard-deviation confidence intervals, to a shock to FCI when the credit-to-GDP gap ratio is below zero and the system includes the (log) level of credit rather than the credit-to-GDP gap. The dashed red lines report the median impulse response, and one-standard-deviation confidence intervals, to a shock to FCI when the credit-to-GDP gap ratio is above zero and the system includes the (log) level of credit rather than the credit-to-GDP gap. Variables are defined in section 2.4.

a rise in credit. In addition, the same shock in a high vulnerability period eventually results in weaker economic performance than in a low vulnerability period, consistent with the results with credit-to-GDP gap. Moreover, a shock to monetary policy with the log level of credit yields similar results (not shown) to those reported based on the credit-to-GDP gap.

In addition, we evaluate a shock to FCI when the system contains the credit-to-GDP ratio, but we define stricter thresholds for the credit gap to be high or low. Specifically, a high or low credit gap is defined when the gap is either above 2.5 or below −2.5, roughly half a standard deviation above or below the trend. These alternative thresholds effectively restrict the sample to observations where the credit gap is further away from zero. Our results are not much affected by this alternative threshold.[10]

5.3 Robustness to Other Conditioning Variables

In another set of robustness tests, we evaluate whether credit may reflect other sources of uncertainty. These tests are in the spirit of Barnichon, Matthes, and Ziegenbein (2016), who look at how the effects of a shock to credit supply (as measured by the EBP or similar indicators) vary by the state of the business cycle or the sign of the shock, although they do not have credit-to-GDP measures in their VAR model. We split the sample based on whether financial conditions are high or low (above or below average), and do not find any evidence of nonlinearities from a shock to FCI: A positive impulse to FCI conditioned on either low or high FCI leads to growth in the near term and has little effect on performance in the medium term. These results suggest that the nonlinear effects from conditioning on credit are not simply reflecting differences in financial conditions and that asymmetric transmission is through credit, not asset prices and risk-taking behavior.

To further evaluate our interpretation of credit, we look at when both FCI and the credit gap are high, which effectively splits the sample between credit boom periods versus other periods. Similar to our baseline results based on high versus low credit gap periods, we find nonlinear effects from an impulse to FCI, with significantly higher GDP growth in the near-term quarters and lower growth in the medium term, though the effects in the quarters further out are not significant, given the smaller number of observations. In addition, conditioning on the interaction of high FCI and high credit,

[10]In addition, we measured the credit-to-GDP ratio based on potential rather than real GDP, and found the results were very similar although the standard errors were larger. Robustness results described in this section and not shown are available upon request.

an impulse to monetary policy does not have significant results on growth in credit boom periods, similar to results when conditioning on high credit. In addition, the effects in other periods (low credit and low FCI, and low credit and high FCI) work as expected, with tighter monetary policy able to slow economic growth and prices.[11]

We also estimate the baseline nonlinear system based on credit by the type of borrower, either households or nonfinancial businesses. This division is suggested in part because many studies have focused solely on household credit, but there is higher variability in business debt than household debt in the United States. Impulse responses from shocks to FCI to systems with either household or business credit, with the combined credit-to-GDP gap as the threshold, are similar to results reported above when credit is aggregated, and the results are consistent with higher-frequency cycles for business than household credit. However, when the threshold is only the specific type of credit (ignoring the other), shocks to FCI do not lead to a recession. We conclude that one form of credit is not more likely to lead to subpar performance, and that it is the sum of both household and business which matters most.

6. Conclusion

In this paper, we evaluated the interactions among financial conditions, credit, and monetary policy in a threshold VAR framework that allows for nonlinear dynamics. Indeed, we find that the effects of shocks to financial conditions and monetary policy vary importantly depending on whether the initial credit-to-GDP gap is low or high, or initial multi-year credit-to-GDP growth is above or below average.

When the credit-to-GDP gap or growth is low, positive shocks to financial conditions stimulate economic activity and result in a sustained expansion. By contrast, when the credit-to-GDP gap or growth is high, positive shocks to financial conditions, while stimulating economic activity in the short run, lead to excess borrowing and ultimately economic contractions.

[11] We also split on whether the economy is in a recession or expansion, but the number of periods in which the economy was in a recession is too small a sample to yield significant effects.

With respect to monetary policy, when the credit gap is low, contractionary impulses to monetary policy, as expected, lead to declines in economic activity. However, the effectiveness of policy is significantly reduced when the credit gap is high. In such periods, financial conditions do not tighten at the same time that monetary policy tightens, as it does in low credit periods, indicating again that transmission channels depend on the credit gap. In addition, results based on the reaction of forward rates to monetary policy surprises suggest that the attenuation is significant at horizons up to seven years ahead. These results suggest that monetary policy transmission is hindered in periods of high credit.

Taken together, our results suggest that theory and policy should address the role of credit in the transmission of monetary policy and financial conditions. In particular, economic dynamics of particular relevance to policymakers appear significantly different when credit-to-GDP has grown significantly faster than average for some time. This dynamic bears on the costs and benefits of using monetary policy to lean against the wind and prevent the buildup of credit (Gourio, Kashyap, and Sim 2016; Svensson 2016; Adrian and Liang 2018). Moreover, it points to the benefit from additional research evaluating the potential for macroprudential policies to reduce the vulnerabilities associated with excess credit.

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