Financial shocks and inflation dynamics*

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Abstract

We assess the effects of financial shocks on inflation, and to what extent financial shocks can account for the “missing disinflation” during the Great Recession. We apply a vector autoregressive model to US data and identify financial shocks through sign restrictions. Our main finding is that expansionary financial shocks tend to temporarily lower inflation. This result withstands a large battery of robustness checks. Therefore, negative financial shocks help to explain why inflation did not drop more sharply during the financial crisis. We also show that our results are consistent with the cost channel. A policy implication is that financial shocks that move output and inflation in opposite directions may worsen the trade-off for a central bank with a dual mandate.

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1 Introduction

Despite a massive fall in demand during the Global Financial Crisis (GFC), the US economy experienced only a modest disinflation. Two prominent explanations for this “missing disinflation puzzle” have been proposed. First, inflation expectations were well anchored (Bernanke 2010, Yellen 2013), while the rise in energy prices prevented a fall in long-run inflation expectations (Coibon and Gorodnichenko 2015). Second, the short-term unemployment rate is a more relevant measure of economic slack, and it increased by less and recovered more quickly than long-run unemployment (Gordon 2013, Krueger et al. 2014). Recently, financial market frictions have been suggested as an alternative explanation for the missing disinflation. For instance, Gilchrist et al. (2017) show that during the GFC financially constrained firms increased prices, while financially unconstrained firms lowered them. To explain this empirical finding, they build a theoretical model where firms price goods above marginal costs in order to hedge against the risk of relying on costly external finance. Financial shocks that increase the cost of external finance may prevent inflation from falling even if output drops considerably.

Macroeconomic models featuring financial frictions are compatible with both an increase and a decrease of inflation after financial shocks. Expansionary financial shocks can lead to an increase in inflation if aggregate demand effects dominate in the transmission mechanism. In general, financial shocks raise asset prices, generating wealth effects that lead to an increase in consumption and, through that, to an increase in inflation. In Curdia and Woodford (2010), a sudden drop in the fraction of non-performing loans reduces the credit spread. Cheaper borrowing induces borrowers to increase consumption, which in turn increases demand and inflation. Another example is Gertler and Karadi (2011), where financial shocks relax banking constraints and allow firms to rent more capital and hire more workers. The higher labor demand increases wages, thereby putting an upward pressure on prices. On the other hand, expansionary financial shocks can have disinflationary effects if aggregate supply channels dominate. Besides the mechanism in Gilchrist et al. (2017) described above, this is the case in models with a cost channel, where firms borrow in advance to finance the wage bill, such as in De Fiore and Tris-

\[\text{\textsuperscript{1}}\text{See Antoun de Almeida (2015) for evidence on the euro area, and Balleer et al. (2015) on Germany.}\]

\[\text{\textsuperscript{2}}\text{See also Christiano et al. (2015) and Del Negro et al. (2015) for alternative theories in which financial frictions play a key role.}\]
Another mechanism through which financial shocks can lead to a decline in inflation is described in Meh and Moran (2010). In this model banks can charge a lower deposit rate after a financial shock. This prompts a decline in consumption and an increase in labor supply, which in turn causes a fall in real wages, marginal costs and inflation. Table 1 summarizes the implications of these models for the behavior of inflation after financial shocks. Overall, financial shocks propagate through the economy through various aggregate supply- and demand-type channels, and their impact on inflation depends on which channels dominate. Hence, whether financial shocks raise or lower aggregate inflation is ultimately an empirical question.

We apply a vector autoregressive model (VAR) to a set of US macroeconomic and financial data. We identify financial shocks by employing short-run sign restrictions on impulse response functions. Financial shocks in our model increase credit growth, lower funding costs and raise stock prices, thereby matching the characterization of financial shocks in standard macroeconomic models (see Table 1). Most importantly, our identification strategy is fully agnostic about the response of inflation after financial shocks, while still disentangling financial from other structural shocks.

Our first key result is that financial shocks that increase output and credit growth tend to reduce inflation. The effect arises on impact and is significant over about two to three quarters. Based on a historical decomposition, we show that financial shocks contributed to the pre-crisis credit boom by lowering risk premia and increasing credit growth. Moreover, we find that contractionary financial shocks contributed positively to inflation during the GFC. Hence, negative financial shocks - to some extent - compensated deflationary pressures from other developments (but other drivers not studied in this paper also mattered).

We then explore the transmission channels that can account for the response of inflation after financial shocks. We find that expansionary financial shocks reduce credit spreads, implying lower borrowing costs. The drop in borrowing costs lowers overall marginal costs, ceteris paribus, which may partly explain the negative inflation response. Our result that expansionary financial shocks reduce inflation is therefore consistent with theories in which aggregate supply effects dominate.

\footnote{A cost channel is also present in Gilchrist et al. (2017), though the authors argue that is not quantitatively significant for the transmission mechanism of financial shocks.}

\footnote{The models discussed here do not allow to associate specific characteristics of financial shocks to a specific inflation response. For example, both Gerali et al. (2010) and Gertler and Karadi (2011) consider shocks to bank capital, but inflation responses differ (see Table 1).}
the transmission mechanism of financial shocks (e.g. De Fiore and Tristani 2013 or Gilchrist et al. 2017).

Our main finding is robust against a battery of robustness checks. Most importantly, we show that our financial shock is not contaminated by other shocks like technology and technology news shocks, oil shocks or housing shocks. Further, we employ the alternative financial shock identification scheme of Caldara et al. (2016) which does not rely on sign restrictions. We also experiment with alternative measures of interest rates, inflation and credit. Our main result is unaffected by all of these changes to the model setup. Moreover we change the sample period, i.e. we exclude the GFC and post-GFC/Zero Lower Bound period. Our key finding does not change and, hence, is not driven by the fact that monetary policy was unable to reduce the interest rate in response to negative financial shocks over the last years of our sample period. Finally, we also show that the financial shocks affect banking variables and survey measures of credit supply in the expected way.

Relative to the existing literature, our approach offers two distinct contributions.

First, we suggest an identification scheme for financial shocks which leaves the inflation response unrestricted. Previous work based on sign restrictions - which focuses on the effects of financial shocks on real economic activity - imposes either a positive comovement between output and inflation, or a positive comovement between output and the policy rate after financial shocks (Busch et al. 2010, Conti et al. 2015, De Santis and Darracq-Paries 2015, Furlanetto et al. 2017, Gambetti and Musso 2017, Hristov et al. 2012). Other work restricts the impact effects on inflation and output to zero, but leaves the signs of their impulse responses beyond impact unrestricted (Gilchrist and Zakrajsek 2012, Peersman 2012). The evidence on the effects of financial shocks on inflation dynamics from these papers is mixed: in Peersman (2012), expansionary financial shocks increase inflation, while in Gilchrist and Zakrajsek (2012) inflation does not react significantly to financial shocks.

Second, we explore various transmission channels of financial shocks and their implications for inflation in an aggregate time series setup. Previous work by Antoun de Almeida (2015), Balleer et al. (2015) and Gilchrist et al. (2017) relies on data at the product or firm level. These studies focus on the price setting behavior of financially constrained relative to unconstrained firms, and show that borrowing constraints are an important determinant for the price setting behavior of firms. While these studies are well suited to cleanly identify the effect of borrowing
constraints on the price setting behavior of firms, they lack clear cut implications for the behavior of aggregate inflation after financial shocks. Our study fills this gap by showing that financial shocks that increase borrowing costs might reduce aggregate inflation.

The results from our analysis have two policy implications. First, financial shocks which raise output and lower inflation may worsen the trade-off faced by a central bank which seeks to stabilize both output and inflation. Second, a monetary policy designed to strengthen credit supply may have unintended disinflationary effects (e.g. through the cost channel). Clearly, this would not be desirable in an environment where inflation is already low.

The rest of the paper is structured as follows. In Section 2 we provide details on the data, the methodology, and the financial shock identification strategy. We present the results from the baseline model and investigate the transmission channels of financial shocks in Section 3. In Section 4 we provide several robustness checks, explore the reaction of banking variables and survey measures to the financial shocks. Section 5 concludes.

2 Data and modeling approach

2.1 Data

Our baseline analysis departs from an \( n \)-dimensional vector \( X_t \) of seasonally adjusted quarterly series: real GDP, core inflation, a policy interest rate, credit growth, the excess bond premium (EBP), house prices, and stock prices. These are standard variables in empirical macro-financial studies.

We use the core PCE deflator, excluding energy and food, to measure inflation. We choose core, instead of headline inflation, in order to disentangle financial shocks from commodity price shocks, such as oil shocks. We further investigate this issue in Section 4 by including the oil price in our baseline VAR model. The EBP is a risk premium that reflects systematic deviations in the pricing of US corporate bonds relative to the issuers’ expected default risk.\(^5\) It thus constitutes a proxy for the effective risk-bearing capacity of the financial sector, and is a direct price measure of credit supply. We measure credit growth using total credit to the private nonfinancial sector. The credit series is taken from the Financial Accounts of the United States. In the robustness analysis we also consider alternative credit

\(^5\)Retrieved from Simon Gilchrist’s website: http://people.bu.edu/sgilchri/Data/data.htm
measures. Nominal house and stock prices are taken from Robert Shiller’s website.\footnote{http://www.econ.yale.edu/~shiller/data.htm} We deflate the credit and asset price series by the PCE deflator. Finally, we use the federal funds rate as the main policy interest rate. From 2008Q4 onwards, we replace the federal funds rate with the shadow short rate (SSR) from Krippner (2015).\footnote{https://www.rbnz.govt.nz/research-and-publications/research-programme/additional-research/measures-of-the-stance-of-united-states-monetary-policy} Using the SSR allows to account for unconventional monetary policy: quantitative easing and forward guidance may primarily affect interest rates at longer maturities (Gertler and Karadi 2015, Krippner 2015). As the SSR reflects changes in the term structure of interest rates, it captures the effects of unconventional monetary policy.

GDP and asset prices enter in logarithms, the policy rate and the EBP in levels, the PCE deflator in year-on-year differences of logarithms.\footnote{See Canova et al. (2007), Bjoernland and Leitemo (2009), Primiceri (2005), Ang and Piazzesi (2003) for similar transformations of key variables in VAR models.} We filter outstanding credit using log year-on-year differences. Financial variables are subject to secular trends due to changes in the structure of the financial system and regulatory changes. Following Adrian et al. (2013), we deal with this issue by using detrended credit. The year-on-year change is a convenient way of detrending credit, but we show below that our results are not affected when using a one-sided HP filter applied to outstanding credit.\footnote{See Edge and Meisenzahl (2011), for a discussion on the consequences of different detrending methods for credit gap measures.} If not stated otherwise, we take the series from the FRED database of the Federal Reserve Bank of St. Louis.

The sample period ranges from 1988Q1 to 2015Q2. By choosing 1988Q1 as a starting point we exclude any monetary regime prior to the Greenspan one. Moreover, the period since the mid-1980s until the beginning of the GFC is associated with the Great Moderation. Hence, our sample period excludes the Great Inflation period. We check to what extent parameters have changed with the GFC in Section 4.

Figure 1 shows the series, as they enter the VAR model.

2.2 Vector autoregression

We assume that the dynamics of \( X_t \) follow a VAR model of order \( p \):

\[
X_t = c + B_1 X_{t-1} + \ldots + B_p X_{t-p} + w_t, \quad E(w_t) = 0, \quad E(w_{t}w_{t}') = W. \tag{1}
\]
$B_j$ are $n \times n$ coefficient matrices for $j = 1 \ldots p$, where $p$ is the lag length and set to 2. $p = 2$ seems a reasonable compromise and corresponds to what most quarterly VAR studies use (e.g. Gilchrist and Zakrajsek (2012)). We also experimented with 4 lags, but results were almost identical. We include a constant represented by the $n \times 1$ vector $c$. The $n \times 1$ vector $w_t$ represents the reduced-form innovations which are assumed to be Gaussian with mean zero and positive definite covariance matrix $W = E(w_tw_t')$.

### 2.3 Identifying financial shocks

We identify financial shocks by employing short-run sign restrictions on impulse response functions. We require the EBP not to rise, and credit growth and the stock price not to fall after expansionary financial shocks. The restriction on the stock price ensures that we disentangle financial shocks from investment-specific demand shocks. According to Furlanetto et al. (2017), investment-specific demand shocks lead to a decline in the stock price.\(^{10}\) We restrict both credit and GDP to increase. We impose the additional restriction that credit increases by more than GDP. This restriction on the behavior of credit relative to GDP disentangles the financial from other aggregate macroeconomic shocks: typical aggregate demand or supply shocks would change GDP by more than credit (see also Eickmeier and Ng 2015).\(^{11}\)

Previous empirical work - which focuses on the real effects of financial shocks - restricts either inflation to be positive, not to react on impact, or it restricts the policy rate to increase after expansionary financial shocks, which might also bias the inflation response (Conti et al. 2015, De Santis and Darracq-Paries 2015, Fornari and Stracca 2012, Furlanetto et al. 2017, Gambetti and Musso 2017, Gilchrist and Zakrajsek 2012, Hristov et al. 2012, Peersmann 2010). Given our focus on inflation, and that theory is ambiguous on the effects of financial shocks on inflation and the policy interest rate (see Table 1), we instead adopt an identification scheme that leaves the responses of both inflation and the policy rate unrestricted.

\(^{10}\)Furlanetto et al. (2017) argue as follows. “Investment shocks are shocks to the supply of capital and, therefore, imply a negative co-movement between the stock of capital (together with investment and output) and the price of capital. The price of capital is seen as a proxy of the stock market value for the firm and as a main driver of the firm’s net worth. Financial shocks, instead, are shocks to the demand for capital and imply a positive co-movement between output and the price of capital (together with the stock market).”

\(^{11}\)Replacing the credit versus GDP restriction with the restriction that GDP does not move on impact but rises in the subsequent year does not change our results.
Specifically, we impose the restrictions described above on credit growth, the stock price, the EBP and GDP. The house price is left unrestricted. We then check the inflation response for each model which yields financial shocks satisfying the restrictions. If inflation rises on impact, the response of a central bank following a Taylor rule is unambiguously positive. In this case, we restrict the policy rate to increase on impact. If inflation falls, we do not restrict the policy rate. In this way, we disentangle financial from monetary policy shocks. In standard New Keynesian and structural VAR models, monetary policy shocks move the interest rate in one direction, and the price level and output in the other direction (e.g. Peersman 2004). A more detailed discussion on the relationship between financial and monetary policy shocks is provided in Section 4. Finally, we restrict the remaining \( n - 1 = 6 \) shocks not to have the same characteristics as the financial shocks. Hence, the identified financial shocks are the only shocks that satisfy the restrictions.

We impose all sign restrictions (except for the one on the policy rate) on impact and over the first four quarters following the shocks. This allows us to focus on relatively persistent shocks similar to those we have observed around the GFC. In the robustness section we also experiment fewer and more restricted periods. In Table 2 we summarize the sign restrictions, which are all implemented as \( \geq / \leq 0 \).

Note that our sign restrictions are consistent with a range of structural models with a financial sector (see Table 1). Similar restrictions have been used in previous empirical work. However, as noted above, most of the existing empirical work also restricts the reaction of inflation or of the interest rate. The novelty of our identification scheme is that it disentangles financial shocks from other structural shocks, while being agnostic on the response of inflation and of the policy rate. We explore below the robustness of our key results against alternative identification schemes. Most importantly, while our baseline model and identification scheme allows us to disentangle financial from standard (macro and conventional monetary policy) shocks, we extend the model below to explicitly separate financial from other shocks such as technology news shocks and oil shocks.

12 Relaxing the conditional restriction on the policy rate produces the same qualitative results, but increases the model uncertainty associated with the sign restrictions. This might be because the financial shock is not appropriately separated from a monetary policy shock without the restriction on the interest rate.

To implement the sign restrictions, we follow the approach suggested by Rubio-Ramirez et al. (2010). Let $W = P P'$ be the Cholesky decomposition of the reduced form variance-covariance matrix of the VAR. Further, let $\Omega$ be a $n \times n$ random matrix drawn from an independent standard normal distribution. The $QR$ decomposition of $\Omega$ delivers $\Omega = QR$. The impact matrix of the structural shocks $\tilde{A}_0$ is then computed by multiplying $P$ (i.e. the orthogonalized residuals) with $Q'$. If the impulse responses generated by the impact matrix $\tilde{A}_0$ satisfy the sign restrictions, we keep the matrix, otherwise we discard it. We keep drawing from $\Omega$ until we obtain 250 impact matrices which satisfy all restrictions simultaneously. The financial shocks are given by the corresponding element of $\eta_t = (P \times Q')w_t$.

Sign restrictions do not achieve unique identification of shocks (Fry and Pagan 2011 refer to this issue as the “multiple models problem”). Following Fry and Pagan (2007)’s “Median Target” approach, we select among the 250 qualifying models the one whose impulse responses are closest to the median responses across models and horizons. This single model reflects the “central tendency” across all models. Once we have picked a single rotation matrix, we construct confidence bands with 500 bootstrap replications. To correct for a possible small sample bias, we apply the bootstrap-after-bootstrap methodology proposed by Kilian (1998).

We conduct inference on the structural impulse response functions using a wild bootstrap. That is, we generate bootstrap residuals as $w^b_t = w_t \omega_t$, where $\omega_t$ is a scalar drawn from the Rademacher two-point distribution: $P(\omega_t = 1) = P(\omega_t = -1) = 1/2$. Based on the point estimates of the VAR parameters and $w^b_t$ we simulate the endogenous variables and re-estimate the VAR model. We then identify the financial shocks as described above. The confidence bands are then constructed as the percentile intervals of the resulting bootstrap distribution of the impulse response functions.

3 Results

3.1 Results from the baseline model

Impulse responses analysis In Figure 2, we present impulse responses to a financial shock. The solid red lines are median impulse responses, while the shaded areas are the 1 standard deviation confidence bands. As imposed by the sign restrictions, the EBP declines, and credit growth and the stock price increase. The positive effects on credit growth, the stock price and also on GDP are very persistent, with the peak effect occurring after around one year following the
shock. The policy rate increases, following the GDP response. House prices also rise persistently, but the reaction is significant only around 1 year after the shock.

Most importantly, inflation falls on impact by 0.08 percentage points and remains negative for around two to three quarters after the shock. We re-emphasize here that we are agnostic about the response of inflation after the financial shock, leaving its sign unrestricted. Hence, our results suggest that after financial shocks aggregate supply effects dominate demand effects. As discussed above, we focus on the “Median Target” model, but neglect model uncertainty. Model uncertainty is, however, limited, as 96% of the models suggest a negative inflation response on impact after expansionary financial shocks.

Variance and historical decomposition In Table 3, we provide results from the forecast error variance decomposition at the four-year horizon. The financial shock accounts for almost half of the forecast error variance of credit growth and the EBP. Moreover, financial shocks explain 23% of the fluctuation in GDP and 18% of the fluctuation in inflation. Hence, on average over the sample period, financial shocks made notable, although not very large contributions to inflation dynamics.

In Figure 3, we present the historical decomposition of the EBP, credit growth, inflation and GDP over the period 1999-2015. The financial shock contributed to the pre-crisis credit boom by holding the EBP down over most of this period and pushing credit growth up. Negative financial shocks over the GFC accounted for large parts of the drop in credit growth and the rise in the EBP. Most importantly, around and after the GFC financial shocks made positive contributions to inflation. Between 2008 and 2009 negative financial shocks increased core inflation around 0.2 percentage points. Put differently, core inflation, as deviation from its deterministic component, would have been roughly 50% lower in the absence of financial shocks. Hence, there have been other important drivers (not studied in this paper) which helped preventing a deflation. The financial shock also explains a substantial fraction of the GDP decline after the 2007-09 recession. Our results for the GFC corroborate the results in Del Negro et al. (2015). They show that a DSGE model needs to be augmented with financial frictions and a credit spread to successfully predict the moderate decline in inflation and the strong decline in

\[14\] This share for GDP is roughly in line with the empirical VAR literature which finds contributions of credit supply or financial shocks to the forecast error variance of GDP between 10% and 30%. See for example Bean et al. (2010), Busch et al. (2010), De Nicolò and Lucchetta (2011), Eickmeier and Ng (2015), Helbling et al. (2011), Hristov et al. (2012), Meeks (2012) and Peersman (2012).
output during the GFC. We finally note that the financial shock also accounts for the financial headwinds in the late 1980s/early-1990s, and kept inflation up over that period as well (not shown).

Transmission channels of financial shocks relevant for inflation Why does inflation decline after expansionary financial shocks? In Figure 4 we present impulse responses to the financial shock of variables that capture the key transmission channels implied by the models summarized in Table 1, as well as other relevant variables. We include these variables one by one in the baseline VAR. We treat the endogenous variables from our baseline model as block exogenous for the added variable and restrict the residual covariance matrix, so that shocks to those additional variables do not affect the endogenous variables nor the financial shock estimates.

The first row of Figure 4 shows that the financial shock leads to a strong and hump-shaped increase in real private investment, consumption and employment. The increase in consumption is potentially the result of wealth effects due to the increase in asset prices after the financial shock. Investment increases by more than consumption, which is consistent with the restriction imposed by Furlanetto et al. (2017) to identify financial shocks. The gradual increase in demand is likely to be the reason behind the recovery of inflation over the first year after the shock. Real wages increase in a marginally significant way shortly after the shock, but turn insignificant after two quarters. The responses of investment, consumption, employment and wages after the financial shock are in line with the mechanism in Gertler and Karadi (2011). In their model, a financial shock leads to an investment boom because firms can rent more capital. Because of the complementarity between capital and labor, firms increase labor demand putting an upward pressure on real wages and, through that, on firms’ marginal costs and inflation. Our baseline result, by contrast, suggests that financial shocks lead to a short-run reduction in inflation. The mechanism in place in models such as in Gertler and Karadi (2011) is therefore not able to explain the disinflationary effects of financial shocks in the data.

The key determinant of the pricing decision of firms are current and expected future marginal costs. We therefore explore their behavior after financial shocks, by looking at the response of the labor income share, a proxy for marginal costs used for instance in Nekarda and Ramey (2013). Figure 4 shows that the labor share declines after around two quarters and then returns to baseline. The response of the labor share after the financial shock suggests a shift from labor to capital
as production inputs. Hence, marginal production costs decrease slightly after expansionary financial shocks. This does not however explain the instantaneous drop in inflation.

If firms have to borrow in advance to finance part of the wage bill, the relevant marginal costs are also determined by borrowing rates. Models featuring a cost channel, such as Christiano et al. (2010) and De Fiore and Tristani (2013), stress the importance of taking into account financing costs for the pricing decision of firms. Accordingly, we assess the responses of different borrowing spreads after the financial shock. We show impulse responses of the Baa spread, the commercial paper spread, the C&I loan spread and the mortgage spread. The spreads are defined as the Baa corporate bond yield over the 10-year government bond yield; the 3-month commercial paper rate over the 3-month T-bill rate; the C&I loan rate over the 2-year government bond yield; the 30-year mortgage rate over the 10-year government bond yield. All spreads decline significantly on impact, and the shapes roughly match the inflation response. Hence, if a cost channel is active, then the reduction in borrowing costs should decrease overall marginal costs.

To summarize, the results from our analysis suggest that a mechanism related to the cost channel might in part be able to explain the reduction in inflation after the expansionary financial shock. Expansionary financial shocks reduce borrowing costs significantly on impact. Also, we observe a decline in the labor income share, reflecting a shift from labor to capital as production input, which may have subdued demand and, hence, inflationary effects after financial shocks. This causes an overall decline in firms’ marginal costs which may contribute to the drop in inflation. Other supply-type mechanisms, such as the one emphasized in Gilchrist et al. (2017), may have played a role as well.

15 The US has non-negligible mortgage pre-payment activity. The conventional estimate for the duration of mortgages in the US is 7-8 years. Hence, rather than computing the mortgage spread relative to the 30-year government bond rate, we calculate the spread relative to the 10-year government bond rate. See also Walentin (2014) for a similar discussion.

16 For the derivation of price markups with a cost channel we refer to Ravenna and Walsh (2006), and Lewis and Poilly (2012).
4 Validation and robustness

4.1 Responses of credit supply and banking variables to the financial shock

To better understand the characteristics of our financial shock, and to validate that we are indeed identifying a financial shock, we explore the behavior of credit supply measures and banking variables. The series are again inserted one by one as exogenous variables into the VAR, and we restrict shocks to them not to affect the baseline model’s variables nor its shock estimates. We present the results in Figure 5.

First, we add survey measures of credit supply in order to verify whether our identified shocks are consistent with the answers of survey participants from the banking sector. We use data from the Senior Loan Officer Opinion Survey on Bank Lending Practices: the net percentage of domestic respondents tightening standards for C&I loans (“tightening standards”) and the net percentage of domestic respondents reporting increased willingness to make consumer installment loans (“willingness to lend to consumers”). Bank’s willingness to lend to consumers increases on impact and remains positive for one year. Similarly, banks loosen their credit standards strongly on impact, and keep them below baseline for more than one year after the financial shock. Hence, both survey measures move in the expected direction.

Second, we include data on the return on assets of commercial banks, the ratio of non-performing loans to total loans, the ratio of bank capital to total assets and the volatility of bank stock prices. Bank return on assets - a measure of bank profitability - increases significantly and remains positive for about a year. This increase is reflected in the response of the bank capital ratio, which also rises significantly on impact and remains positive for about a year. The higher profitability allows banks to increase retained earnings, which in turn increases net worth, e.g. bank capital, thus generating a stronger capital position. Finally, the share of problem loans on the balance sheet of banks - represented by the ratio of non-performing loans in total loans - drops significantly. The response is hump shaped, reaching its minimum after around one year. The behavior of the non-performing loans ratio follows closely the movement of GDP. The increase

\[17\] We construct the “tightening standards” series as the arithmetic mean of the series for large, medium and small firms. Since the individual “tightening standards” series start in 1990Q2, we estimate the model over 1990Q2-2015Q4. The “willingness to lend to consumers” series is instead available over the entire sample period.
in economic activity after the financial shock improves the balance sheets of entrepreneurs and households, which in turn decreases the frequency of default. In addition, the volatility of bank stock prices drops significantly.

All in all, this exercise delivers responses of credit supply and banking variables consistent with a financial shock.

4.2 Financial shocks versus other shocks not explicitly accounted for in the baseline model

While we opted for a relatively small baseline VAR model, which allowed us to disentangle financial from other, standard (macro and conventional monetary policy) shocks, we will in this subsection extend the model and discuss to what extent our financial shocks are disentangled from other shocks, not explicitly accounted for in our baseline model. The figures in the Appendix shows impulse responses of inflation. For comparability, we standardize the financial shocks to have the same minimum effect on the EBP as in the baseline model. We plot median impulse responses from the alternative models against median impulse responses and confidence bands from the baseline model.

**Technology and news shocks** Our identified financial shock has features of typical aggregate technology or technology news shock. In the baseline identification scheme, the relative restriction that credit growth increases by more than GDP should ensure that we separate the financial shock from technology and technology news shocks. In this section, we nevertheless explicitly identify a surprise technology and a technology news shock simultaneously alongside the financial shock.

In order to identify surprise and news technology shocks alongside the financial shocks we add to the baseline VAR the total factor productivity series (TFP) of Fernald (2012) which is adjusted for unobserved factor utilization. The TFP series enters the VAR first. As in Barsky and Sims (2011), we identify a technology shock based on the assumption that only surprise technology shocks have a contemporaneous effect on TFP. That is, we identify the technology shock as the reduced-form shock to the TFP series. Again following Barsky and Sims (2011), we identify the news shock as the shock that has no contemporaneous impact on TFP and explains the maximum of the forecast error variance of the TFP series. We then identify the financial shocks using the same set of sign restrictions as in the baseline, and additionally impose the restriction that the financial shock
has no contemporaneous effect on TFP. This procedure ensures that the financial shock is formally disentangled from technology and news shocks.

The result from this exercise is shown in Table A1. Inflation declines by a bit less when we explicitly identify a technology shock and a technology news shock alongside the financial shock. However, the median impulse response still lies in the confidence bands of the baseline model. We note that TFP does not react significantly to financial shocks over the first two years. This finding is not at odds with theory, which is ambiguous on the effects of financial shocks on productivity (Khan and Thomas (2013), Petrosky-Nadeau (2013)).18

**Housing shocks** Next, we consider a narrower financial (credit supply) shock, which we disentangle explicitly from a housing shock. Following Furlanetto et al. (2017), we add housing stock to credit (taken from the Financial Accounts) to our model and restrict the ratio to decline on impact (i.e. credit rises by more than the housing stock after financial shocks). Inflation declines by more after financial shocks than in the baseline model (Figure A1). The reason is that house prices now do not rise as before. Hence, the increase in house prices and the corresponding increase in housing wealth following the financial shock in the baseline prevented an even stronger decline in inflation.

**Oil shocks** Oil price inflation is defined as the log year-on-year change in the West Texas Intermediate (WTI) price of crude oil (following the transformation of the PCE deflator).19 In order to disentangle financial from oil shocks, we restrict the oil price not to move on impact after financial shocks. The zero restriction on the oil price implies that oil supply and oil demand, which should move the oil price on impact, react only with a delay to financial shocks. The inflation response is basically identical (Figure A1).

**Uncertainty shocks** To disentangle our financial from uncertainty shocks, we add the uncertainty measures constructed by Jurado et al. (2015) and restrict the EBP to decline by more than uncertainty on impact (see Furlanetto et al. (2017)).

18 These papers consider the effects of financial shocks on productivity in real models and can therefore not derive implications for inflation.

19 Alquist et al. (2013) argue that while the WTI oil price has been regulated before the mid-1980s, it is a reasonable oil price measure since the mid-1980s, which overlaps with our sample period.
The resulting inflation reaction after the financial shock is very similar to the baseline response (Figure A1). We also note that macroeconomic uncertainty declines modestly on impact and has a humped-shaped behavior after the financial shock. How a reduction in uncertainty affects inflation and, hence, whether uncertainty represents an additional channel through which financial shocks affect inflation is theoretically unclear. On the one hand, a decline in uncertainty can increase inflation through standard aggregate demand effects associated with nominal rigidities (Leduc and Liu 2016). On the other hand, a decline in uncertainty can reduce inflation in models with concave profit functions and price adjustment costs (Fernandez-Villaverde et al. 2015 and Muntaz and Theodoridis (2016)).

(Unconventional) monetary policy shocks In Section 2.3 we have argued that we disentangle financial shocks from monetary policy shocks as usually identified in the literature. Recall that monetary policy shocks move interest rates in one direction, and prices and output in the opposite direction. By contrast, our financial shocks either move output, prices and the policy rate in the same direction or move output and prices in opposite directions. However, the aggregate supply-type transmission channels discussed above may not only be effective after financial, but also after monetary policy shocks. The cost channel of monetary policy is one specific example for a transmission channel which can lead to a drop in inflation after monetary policy shocks. The cost channel of monetary policy has been brought forward as one explanation of the “price puzzle” (e.g. Castelnuovo 2012, Gaiotti and Secchi 2006, Ravenna and Walsh 2006 and discussions therein). If the cost channel of monetary policy is a relevant transmission mechanism, it is not fully clear whether our financial shock is disentangled from monetary policy shocks. Put differently, a monetary policy shock affects funding costs and is therefore for a specific type of financial shock. This concern should be even more valid for unconventional monetary policy, which is - in part - designed to explicitly stimulate credit supply and lower funding costs and, through these channels, stimulate economic activity and inflation.21

Existing work already emphasizes the link between unconventional monetary policy and credit supply or financial shocks. De Santis and Darracq-Paries (2015)
explicitly identify unconventional monetary policy shocks in the euro area in a VAR model as shocks that increase credit supply. Moreover, in a time-varying parameter VAR for the US, Prieto et al. (2016) find no evidence for federal funds rate shocks to have affected GDP growth from 2010 onwards. Instead, credit spread shocks have positively contributed to growth. They argue that those credit spread shocks probably capture unconventional monetary policy actions.

We investigate in this section to what extent monetary policy actions lie behind our financial shocks. For that purpose we plot in Figure 6 the financial shock estimates (solid line) against the monetary policy shock measure taken from Nakamura and Steinsson (2017) (dashed line) over 1999-2015. This “policy news shock” is constructed based on high-frequency responses of current and expected future interest rates in a 30-minute window surrounding scheduled Federal Reserve announcements, and captures the effects of forward guidance. For comparability with our financial shock estimate, we normalize the Nakamura and Steinsson (2017) shock in the figure such that positive values represent a monetary policy easing (which can be expected to raise credit growth and lower funding costs), and that the standard deviation is one over the period over which we plot the shocks.

Figure 6 reveals that the correlation between the two shocks is very low over the entire sample (correlation coefficient: -0.02). Financial shocks seem, however, more highly correlated with the monetary policy shocks around the 2001 recession and the GFC. In both episodes, the Federal Reserve strongly lowered the federal funds rate and provided liquidity to financial institutions with the intention to stabilize the financial system. In addition, in the course of the GFC the Federal Reserve lent directly to borrowers and investors in credit markets, and purchased longer-term securities. This finding is consistent with Eickmeier et al. (2016) who find a price puzzle after an expansionary monetary policy shock in high, but not in low financial volatility periods. Similarly, Fry-McKibbin and Zhen (2016) find that prices rise after expansionary monetary policy shocks in financial stress periods, but not in low stress periods. They argue that this is consistent with cost channel effects during financial stress periods.

As a further check, we also include the Nakamura and Steinsson (2017) monetary policy shock measure as an explanatory variable in the VAR, and re-run the

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22 For further details we refer to Nakamura and Steinsson (2017).

23 The Federal Reserve acted as a provider of liquidity to encounter the disruption of normal channels of borrowing and payments after September 11, 2001 (Meyer 2001). See Bernanke (2009) and Kohn (2010) for details on the liquidity provision to financial institutions during the GFC by the Federal Reserve.
estimation and shock identification. The idea is that the monetary policy shock should capture all remaining uncontrolled confounding effects of monetary policy shocks. The identified financial shocks remain disinflationary and the magnitude of the inflation response is also similar to the baseline model (Figure A2).

To sum up, the discussion herein suggests that our financial shock is barely contaminated by monetary policy shocks, and that financial shocks cleaned from monetary policy shocks still produce negative effects on inflation. We find, if anything, some correlation between financial and monetary policy shocks in financial stress periods. One implication is that a monetary policy which targets credit supply and borrowing costs may exert downward pressure on inflation through the mechanisms discussed above. This would not be desirable in an environment of already low inflation. However, we would like to emphasize that our results do not imply that the overall effects of monetary policy actions on inflation are negative. Although monetary policy might put a downward pressure on inflation through credit supply effects, other channels might predominate which increase inflation through demand effects. Analyzing those would go beyond the scope of this paper.

4.3 Other changes to the identification scheme

We employ the identification scheme for financial shocks suggested by Caldara et al. (2016). This scheme relies on the assumption that financial shocks maximize the response of the EBP after two quarters following the shock. We do not impose any of the previous restrictions. We obtain a slightly weaker negative inflation response as in our baseline model (Figure A2).

Paustian (2007) shows that one can sharpen the shock identification by identifying additional shocks. We therefore identify, as a further robustness check, a monetary policy shock simultaneously alongside the financial shock. We leave the identifying restrictions for the financial shock unchanged and identify a monetary policy shock with the usual properties: we restrict the policy rate and the EBP to decline and inflation to increase on impact and over the coming year, and output to increase over the first year after the monetary policy shock. The financial shock continues to have disinflationary effects (Figure A2).

\footnote{For that purpose we lengthen the Nakamura and Steinsson (2017) shocks, which are available from 1995 onwards, with the monetary policy shocks constructed by Romer and Romer (2004). We order the Nakamura and Steinsson (2017) shocks first in the VAR and rotate the remaining shocks to identify our financial shocks.}
4.4 Further robustness

Changing the number of restricted periods  In the baseline model we imposed the sign restrictions on impact and over the first four quarters following the shocks in order to focus on relatively persistent shocks similar to those we have observed around the GFC. To better understand to what extent this choice affects our results, we now restrict 0-2 quarters and, alternatively, 0-6 quarters after the shocks (Figure A3). We find that our key result does not hinge on the number of restricted horizons. Moreover, 80% (0-2 quarters restricted) and 100% (0-6 quarters restricted) of the impact effects on inflation are negative (compared to 96% of valid models yielding a negative impact inflation effect in our baseline model). To summarize, our key finding, that inflation drops after financial shocks is generally supported by these checks. It is confirmed by almost all models satisfying the sign restrictions, and holds, the more persistent financial shocks are.

Is the Great Recession period different?  One potentially critical point is that the Great Recession period might be different from more “normal” times; for example because financial frictions are larger in crisis times. We re-estimate the model excluding the GFC and the post-GFC period, i.e. over the period 1988Q1 to 2007Q2. Although the negative inflation response is slightly stronger on impact, there is also a very pronounced overshooting of inflation after the financial shock (Figure A3). This might suggest that financial shocks were more disinflationary during the GFC than before. However, our main finding that expansionary financial shocks lower inflation also holds for less extreme times. It is also interesting to note that this key finding cannot be explained by the Zero Lower Bound and monetary policy not being able to response to negative financial shocks by lowering the interest rate.

Alternative measures of inflation and controlling for inflation expectations  As a set of alternative checks, we replace core PCE deflator inflation with either core CPI inflation or core PPI inflation. In all alternative models financial shocks produce a disinflationary effect (Figure A4). It is worthwhile mentioning that core PPI inflation declines by much more than core CPI inflation or core PCE deflator inflation. A possible reason could be that PPI inflation is a more direct measure of the price-setting behavior of producers, and that the emphasized supply channels are especially relevant for the manufacturing industry.
We also control for inflation expectations as an omitted variable. Inflation expectations are measured as 1-year ahead forecasts of (year-on-year) GDP deflator inflation from the Survey of Professional Forecasters (SPF). This follows Castelnuovo and Surico (2010), who argue that inflation expectations should be included in monetary VARs as they help to identify structural shocks. Though the authors focus on monetary policy shocks, this problem might affect other shocks in the system as well. We do not impose any restriction on inflation expectations. The financial shock still produces a disinflationary effect (Figure A4). Moreover, inflation expectations also drop after after financial shocks (not shown).

Alternative measures of the short term interest rate We also check the sensitivity of our main results to changes in the short term interest rate. First, we replace the linked federal funds rate-SSR variable the original federal funds rate. Second, following Gertler and Karadi 2015 we use the 2-year T-bill rate as the monetary policy indicator. Third, we link the federal funds rate with the SSR proposed by Wu and Xia (2016). Inflation drops after the financial shocks regardless of the exact measure of the short term interest rate (Figure A5).

Alternative credit and spread measures We experiment with alternative measures of credit growth and credit spreads to check whether our findings are driven by the baseline credit measure and the EBP. We first replace our measure of total credit with either business credit, total bank credit, or commercial and industrial bank loans. Moreover, we use a different detrending method for credit. Rather than using year-on-year changes we employ a one-sided HP filter applied to the log of outstanding credit.

Furthermore, we replace the EBP with a composite business lending spread, computed as the weighted average of the commercial paper spread, the Baa spread and the C&I loan spread. As for the EBP, we restrict the composite lending spread to decrease after the financial shock. This helps us to separate more for-

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25Recently, the SPF also publishes PCE deflator inflation expectations. However, those data are not available over most of our sample period. Hence, we rely on GDP deflator inflation expectations.

26They use 1-quarter ahead GDP deflator inflation expectations from the SPF. In line with the year-on-year inflation variable in our model, we make use of the 1-year ahead inflation expectations.

27The weights are one half of the share of credit market instruments in total business credit, for the commercial paper rate and the Baa spread, respectively, and the share of commercial and industrial loans in total business credit for the C&I loan spread.
mally credit supply from credit demand shocks, which would instead trigger an increase in both credit growth and the credit spread.

All identified financial shocks from these modified models turn out to be disinflationary (Figure A6). The effects are slightly weaker when HP-filtered credit and bank credit are included in the model.

5 Conclusion

While there exists a large literature on the relationship between financial shocks and the real economy, the literature on the link between financial shocks and inflation dynamics is still in its infancy. However, understanding the link between financial and price stability is of key importance to monetary policy makers.

In this paper, we use a VAR analysis and propose a novel identification scheme for financial shocks which remains fully agnostic about the effects of financial shocks on inflation. Our main finding is that expansionary financial shocks tend to have temporarily disinflationary effects. We also show that the inflationary effect of negative financial shocks contributed to preventing a stronger disinflation during the financial crisis. Hence, our results suggest that financial shocks might be an additional explanation for the “missing deflation puzzle” during the financial crisis. A key implication of our findings is that financial shocks which raise output and, at the same time, lower inflation might worsen the policy trade-off for a central bank which stabilizes output and prices.

We also explore different transmission channels of financial shocks embedded in standard macroeconomic models, and their implications for inflation dynamics after financial shocks. We find that a mechanism related to the cost channel might be a promising explanation for the disinflationary effects of financial shocks. Also, there seems to be a shift from labor to capital after expansionary financial shocks, which may have dampened demand and, hence, inflationary effects.

Our key result that financial shocks have disinflationary effects is robust against a battery of robustness checks, such as the use of alternative or additional variables, alternative shock identification schemes and variations of the sample period. Moreover, the identified financial shocks affect banking variables and survey measures of credit supply in the expected way.

Finally, although our identified financial shock series is basically uncorrelated with the Nakamura and Steinsson (2017) monetary policy shock measure over the entire sample period, we detect some mild correlation between our financial shocks
and monetary policy shocks in times of financial stress. One implication is that a monetary policy which aims at stimulating credit supply and lowering funding costs risks pushing inflation down, something that should be avoided in a low inflation environment.

We note that we focus here on a broad financial (credit supply) shock. One promising future avenue could be to assess the effects of specific types of financial shocks, such as those emphasized in Table 1.


References

Adrian, T., E. Moench, and H. Shin (2013). Dynamic leverage asset pricing. Staff Reports 625.


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Table 1: **Theoretical responses implied by different models:**
The variables are output \( y \), consumption \( c \), real wages \( w \), the risk-free rate \( R \) and inflation \( \pi \). An increase (decrease) is denoted with a + (-) sign. A space is left if the transmission mechanism does not involve a certain variable. GK refers to Gertler and Karadi (2011); GNSS refers to Gerali et al. (2010); FT refers to De Fiore and Tristani (2013); GSSZ refers to Gilchrist et al. (2017); MM refers to Meh and Moran (2010).

<table>
<thead>
<tr>
<th>MODEL</th>
<th>SHOCK</th>
<th>VARIABLES</th>
<th>y</th>
<th>c</th>
<th>w</th>
<th>R</th>
<th>π</th>
</tr>
</thead>
<tbody>
<tr>
<td>GK</td>
<td>BANK CAPITAL INCREASE</td>
<td></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>GNSS</td>
<td>BANK CAPITAL INCREASE</td>
<td></td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>FT</td>
<td>FIRM NET WORTH INCREASE</td>
<td></td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>GSSZ</td>
<td>DROP IN EXT. FIN. COST</td>
<td></td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>MM</td>
<td>BANK CAPITAL INCREASE</td>
<td></td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 2: **Sign restrictions to identify financial shocks:**
This table shows the restrictions imposed on the signs of the impulse responses of the endogenous variables in the baseline VAR to identify financial shocks.

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>gdp</th>
<th>inflation</th>
<th>credit growth</th>
<th>interest rate</th>
<th>ebp</th>
<th>stock prices</th>
<th>house prices</th>
<th>credit growth to GDP</th>
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<tbody>
<tr>
<td>impact</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>horizon 1 to 4</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
</tr>
</tbody>
</table>

Table 3: **Forecast error variance decomposition:**
This table shows the variance share explained by financial shocks of the endogenous variables in the baseline VAR.

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>gdp</th>
<th>inflation</th>
<th>credit growth</th>
<th>interest rate</th>
<th>ebp</th>
<th>stock prices</th>
<th>house prices</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.23</td>
<td>0.18</td>
<td>0.49</td>
<td>0.36</td>
<td>0.44</td>
<td>0.35</td>
<td>0.14</td>
</tr>
</tbody>
</table>
7 Figures

Figure 1: Time series as they enter the VAR

Figure 2: **Impulse responses to a one-standard deviation expansionary financial shock**: Plot shows median impulse responses (solid lines) and one standard deviation confidence bands (shaded areas). Responses of gdp, inflation, credit growth, stock and house prices are expressed in percentage points, while those of the interest rate and the excess bond premium are in basis points.
Figure 3: **Historical decomposition of key variables**: Plot shows the contribution of all shocks to explaining the deviation of key variables from their deterministic trend (solid lines), and the contribution of the financial shocks (bars).
Figure 4: Transmission channels of financial shocks relevant for inflation: Plot shows median impulse responses (solid lines) and one standard deviation confidence bands (shaded areas). Responses are expressed in percentage points, with the exception of those of the various interest rates and of uncertainty (in basis points). See text for a description of the variables.
Figure 5: Response of credit supply and banking variables to a one-standard deviation expansionary financial shock: Plot shows median impulse responses (solid lines) and one standard deviation confidence bands (shaded areas). Responses are expressed in basis points. See text for a description of the variables.
Figure 6: **Financial shocks and monetary policy**: Identified financial shock (solid line) and Nakamura-Steinsson monetary policy shocks (dashed-dotted lines)
A Additional results and robustness

Figure A1: **Effect of financial shocks on inflation: Robustness checks I** Plot shows median impulse responses (red solid line) and one standard deviation confidence bands (shaded areas) from the baseline model. Dashed and dotted lines show median impulse responses of inflation based on alternative models. identify techn and news shocks: Simultaneous identification of technology shocks, technology news shocks and financial shocks. identify housing shock: Simultaneous identification of housing and financial shocks. add oil price: adding oil prices to the baseline VAR and restricting the oil prices not move on impact. add uncertainty: adding uncertainty measure to the baseline VAR and restricting the EBP to decline by more than uncertainty.
Figure A2: **Effect of financial shocks on inflation: Robustness checks II**: Plot shows median impulse responses (red solid line) and one standard deviation confidence bands (shaded areas) from the baseline model. Dashed and dotted lines show median impulse responses of inflation based on alternative models. 

- **add Nakamura-Steinsson shock**: Adding the monetary policy shocks series of Nakamura and Steinsson (2017) to the baseline VAR.
- **max ebp response**: Identifying financial shocks using the Caldara et al. (2016) approach.
- **identify a mp shock**: Simultaneous identification of monetary policy and financial shocks.
Figure A3: Effect of financial shocks on inflation: Robustness checks III: Plot shows median impulse responses (red solid line) and one standard deviation confidence bands (shaded areas) from the baseline model. Dashed and dotted lines show median impulse responses of inflation based on alternative models. Exclude the GFC: Estimating the model over the period 1988Q1 to 2007Q2. 0–2 quarters restricted: restrict up to 2 quarters. 0–6 quarters restricted: restrict up to 6 quarters.
Figure A4: **Effect of financial shocks on inflation: Robustness checks IV**: Plot shows median impulse responses (red solid line) and one standard deviation confidence bands (shaded areas) from the baseline model. Dashed and dotted lines show median impulse responses of inflation based on alternative models. core cpi: Replacing core pce deflator inflation with core cpi inflation. core ppi inflation: Replacing core pce deflator inflation with core ppi inflation. add infl. exp.: Adding 1-year ahead inflation expectations to the baseline VAR.
Figure A5: Effect of financial shocks on inflation: Robustness checks V: Plot shows median impulse responses (red solid line) and one standard deviation confidence bands (shaded areas) from the baseline model. Dashed and dotted lines show median impulse responses of inflation based on alternative models. federal funds rate: Replacing linked federal funds rate-SSR variable with the original federal funds rate series. 2-year rate: Replacing linked federal funds rate-SSR variable with the 2-year T-Bill rate. Wu-Xia srr: Replace SSR of Krippner (2015) with SSR of Wu and Xia (2016).
Figure A6: **Effect of financial shocks on inflation: Robustness checks VI.** Plot shows median impulse responses (red solid line) and one standard deviation confidence bands (shaded areas) from the baseline model. Dashed and dotted lines show median impulse responses of inflation based on alternative models. *business credit:* Replacing total credit growth with business credit growth. *total bank credit:* Replacing total credit growth with total bank credit growth. *c&i loans:* Replacing total credit growth with commercial and industrial loan growth. *hp-filtered credit:* Replacing total credit growth with hp-filtered credit. *composite lending spread:* Replacing EBP with a composite lending spread.