THE EFFECTS OF MONETARY POLICY SHOCKS ON BANK LOANS

A Master's Thesis

by

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Ankara
September 2022

To my family.

THE EFFECTS OF MONETARY POLICY SHOCKS ON BANK LOANS

The Graduate School of Economics and Social Sciences
of
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I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Economics.

Refet Soykan Gürkaynak
Advisor

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Economics.

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ABSTRACT

THE EFFECTS OF MONETARY POLICY SHOCKS ON BANK LOANS

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M.A., Department of Economics

Supervisor: Prof. Dr. Refet Soykan Gürkaynak

September 2022

This thesis examines the effects of monetary policy shocks on bank loans. I use a vector autoregression (VAR) model with external instrument identification, which is constructed using high-frequency analysis. Gertler and Karadi (2015) methodology is followed. I also consider the information effects and employ the surprises, which are measured by Miranda-Agrippino and Ricco (2021). I find that contractionary monetary policy shocks have significant negative effects on bank loans. The commercial loans growth statistically significantly drops both immediately after the contractionary monetary policy shock and a year after the shock. On the other hand, the consumer and real estate loans growths modestly decrease but it is not statistically significant. Since some of the findings indicate a statistically insignificant decrease in the growth, I also check the response of the credit stocks. There are significant drops in all the credit stocks at least for some periods. Lastly, I show that the findings are robust to the sample period, adding a new variable and the policy indicator. All the findings are consistent with the theory and literature.

Keywords: Financial Markets and the Macroeconomy; Monetary Policy Shocks; Bank Loans

ÖZET

PARA POLİTİKASI ŞOKLARININ BANKA KREDİLERİNE ETKİSİ

KAAN ÖZÇELİKKALE

Yüksek Lisans, İktisat Bölümü

Tez Danışmanı: Prof. Dr. Refet Soykan Gürkaynak

Eylül 2022

Bu tez, para politikası şoklarının banka kredileri üzerindeki etkilerini incelemektedir. Yüksek frekanslı analiz kullanılarak oluşturulmuş dışsal enstrüman ile vektör otoregresyon (VAR) modeli kullanılmış, Gertler ve Karadi (2015) metodolojisi takip edilmiştir. Ayrıca bilgi etkileri de dikkate alınmış, Miranda-Agrippino ve Ricco (2021) tarafından hesaplanan suprizler kullanılmıştır. Daraltıcı para politikası şoklarının banka kredileri üzerinde anlamlı bir negatif etkisi olduğu bulunmuştur. Ticari kredi büyümesi, hem daraltıcı para politikası şokunun hemen ardından hem de şoktan bir yıl sonra istatistiksel olarak anlamlı ölçüde düşmektedir. Öte yandan, tüketici ve gayrimenkul kredisi büyümelerinde bir miktar düşüş olmakla birlikte bu düşüş istatistiksel olarak anlamlı değildir. Bazı bulgular kredi büyümesinde istatistiksel olarak önemsiz bir düşüşe işaret ettiği için kredi stoklarının tepkileri de kontrol edilmiştir. Tüm kredi stoklarında en azından bazı dönemler için önemli düşüşler görülmüştür. Son olarak, sonuçların farklı örneklem dönemlerinden, yeni değişken eklenmesinden ve politika göstergelerinden etkilenmediğini gösterilmiştir. Tüm sonuçlar teori ve literatürle uyumludur.

Anahtar Kelimeler: Finansal Piyasalar ve Makroekonomi; Para Politikası Şokları; Banka Kredileri

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CHAPTER 1

INTRODUCTION

Using vector autoregression (VAR) models to understand the effects of monetary policy shocks on other economic and financial variables is very common in the literature. The VAR literature starts with a well-known and highly influential paper, Sims (1980), and is extended with the employment of different policy indicators, identification strategies, assumptions and restrictions. Such examples include Christiano, Eichenbaum, and Evans (1999), who use Cholesky identification with different policy indicators such as fed funds rate, nonborrowed reserves and the ratio of nonborrowed to total reserves; Bernanke and Mihov (1998), who show the importance of taking into account different monetary policy regimes; Faust (1998), who focuses on monetary policy shock identifying assumptions and different dimensions of robustness; and Uhlig (2005), who imposes sign restrictions on the impulse responses of economic variables other than GDP to understand the effects of contractionary monetary policy shocks on real GDP.

All these studies make use of low-frequency data, i.e., monthly or quarterly data, and employ different identification strategies to capture the variation that is not accounted for by the central bank's reaction to the state of the economy, called shock. It is shown that even though there exist commonly-agreed consensuses for some results, different approaches and policy indicators may lead to different conclusions.

On the other hand, these methodologies suffer from some limitations. Primarily, the identification assumptions may be questionable. Under Cholesky identification, the financial variables and policy indicator does not respond to each other's shocks contemporaneously rather they respond with a lag. Therefore, Cholesky identification is invalid if both financial and macroeconomic variables are present in the model; and none of the ordering structures do not solve the problem. Also, the sign-restrictions, which rely on certain assumptions and return to some varying outputs as a response, may be problematic. Since I also use financial and macroeconomic variables together in my model, using Cholesky or sign-restrictions seems not a proper way to identify the shocks. The timing problem of Cholesky is discussed in a thorough manner in the following chapter.

Furthermore, the VAR model without high-frequency identification must accurately model the Fed's response function to have truly identified shocks, which should be represented by the residuals. The residuals do not imply the shocks if the economy is modeled incorrectly. The reaction function may alter as a result of the changes in the economic structure. It is a bold assumption that the economy is adequately modeled. Also, utilizing the low-frequency data may lead to omitted variable bias. Due to these reasons, identification with low-frequency VAR may fail to identify the shocks. On the other hand, using high-frequency financial variables might solve the identification problem since they take into account the reaction functions of the central bank having a time-varying or nonlinear structure.

Several studies demonstrate that it is appropriate to identify the unexpected element of monetary policy decisions using financial indicators. Krueger and

Kuttner (1996) show that fed funds futures rates can predict the changes in the funds rate accurately; Rudebusch (1998) shows that the funds rate shocks from VARs differ significantly from the shocks in financial markets; and Kuttner (2001) uses the current-month fed funds futures data to decompose changes in the target funds rate into anticipated and unanticipated components. However, using the financial market data that captures the variation in the current economic outlook may lead to missing out on the path factor, an important aspect of monetary policy.

Before Gürkaynak, Sack, and Swanson (2005) (hereafter GSS), the common practice was to use only the interest rate changes for the current month as a policy indicator and ignore the signals for the future. They show that monetary policy shocks can not be represented by a single factor, the target factor, but rather by at least two factors, the target and path, to capture the shocks. Thanks to GSS (2005), we are aware that both the monetary policy actions and the statements have distinct but significant impacts on asset prices. Thus, both the target surprises and the path surprises should be taken into account to identify the shocks. Accordingly, I use the surprises in three month ahead fed funds futures as an instrument and the 2-year government bond rates as a policy indicator to capture both the target and path shocks. However, using financial variables alone may not be sufficient to purify the shocks. Information effects also matter.

The information on the state of the economy that central banks and agents have may not be the same. As a result, the findings may be biased if information asymmetries between central banks and agents are not controlled. Miranda-Agrippino and Ricco (2021) claims that using variations in the futures rate around FOMC meetings is likely to combine the real policy shock with the information about the state of the economy. They show that accounting for the information effect can be useful in comprehending some of the puzzles in the literature.

Several other papers are also pertinent to my analysis in addition to the aforementioned VAR and HFI papers. The transmission of monetary policy is also extensively studied in the literature. Boivin, Kiley, and Mishkin (2010) go over different channels of monetary policy transmission mechanisms and discuss how our understanding has evolved over time. The channels can be summarized as the interest-rate, the intertemporal substitution, the wealth, the exchange rate, the expectations, the balance sheet and the bank credit. I particularly focus on the bank lending channel, which indicates that the contractionary monetary policy decreases the supply of loans. Also, Bernanke and Blinder (1988) and Bernanke and Gertler (1995) show that central banks may affect the economy through the bank lending channel. Even though the channel says nothing about the demand side of the loans, I presume that the loan demand also decreases in response to contractionary monetary policy shocks due to the tightening economic conditions. Therefore, the quantity also decreases since both supply and demand curves decrease, i.e., shift left.

Moreover, credit channel theory (see Bernanke and Gertler (1995)) indicates that endogenous increases in the external finance premium, a spread between the government bond and the private security rates, amplify the impact of the monetary policy shocks. By assuming the theory holds, contractionary monetary policy shocks increase not only the government bond rates but also the external finance premium. The premium increases since the shock leads to a tightening of financial constraints. Gertler and Karadi (2015) (hereafter GK) analyze the response of credit costs to monetary policy shocks and find that monetary policy shocks lead to enhanced movement in credit costs because of term premium and credit costs. Furthermore, they demonstrate how the surprises in market interest rates can be employed as an external instrument in the VAR model to evaluate the effects of shocks on economic and financial variables. The results of GK (2015) are in line with the credit channel theory, but they do not examine how credit growth responds.

In this thesis, I study the bank loans' reaction to monetary policy actions, with a particular emphasis on how the growth of commercial and industrial loans changes. It is demonstrated in the literature that monetary policy actions have an impact on credit costs, credit spreads and term premia; and evidence in favor of credit channel theory is found (see GK (2015)). However, it does not examine how the growth of the credits change with the actions. I contribute to the literature by showing that contractionary monetary policy shocks decrease bank loans' growth. I use the terms credits and loans interchangeably in this research.

To achieve that, I use VAR with an external instrument approach. The 2-year government bond rate is used as a policy indicator, which is consistent with the literature that argues the Fed's forward guidance strategy operates within a roughly 2-year horizon (see Hanson and Stein (2015) and Swanson and Williams (2014)). Using the two-year rates instead of the one-year rates leads to a probability of a weak instrument problem, but I show that the results are robust to using the one-year rate without a possible weak instrument problem. Initially, I employ the surprises in the three month ahead monthly fed funds futures (FF4), which are constructed by GK (2015), as a policy instrument. Then, I show that FF4 is not truly exogenous since the Fed's private information explains some of the variations. Thus, I use Miranda-Agrippino and Ricco (2021) fed funds futures surprises ($FF4_c$), which excludes the variation that can be explained by the Fed's private information, to construct the model.

Then, I examine the response of commercial and industrial loans to the shocks. The findings are consistent with GK (2015), credit channel theory and bank lending channel. In the robustness checks and extensions section, I also examine the responses of the consumer and the real estate loans by adding these variables one by one; exclude the crisis period; replace the two-year rate as a policy indicator with a one-year rate; and add three-month commercial paper spread to the main VAR model to check whether it adds any additional information. The findings demonstrate that the response functions are robust and the contractionary monetary policy decreases the growth of bank loans.

CHAPTER 2

ECONOMETRIC FRAMEWORK

My econometric model is VAR with macroeconomic and financial variables. I use external instruments to identify the monetary policy shocks and closely follow GK (2015) approach. The structural and reduced form VAR models, have 12 lags, are given in Eq(1) and Eq(2), respectively.

$$\boldsymbol{A_0 Y_t} = \sum_{j=1}^{12} \boldsymbol{A_j Y_{t-j}} + \boldsymbol{\varepsilon_t} \tag{1}$$

$$\boldsymbol{Y_t} = \sum_{j=1}^{12} \boldsymbol{B_j Y_{t-j}} + \boldsymbol{u_t} \tag{2}$$

where $\boldsymbol{B_j} = \boldsymbol{A_0^{-1} A_j}$ and $\boldsymbol{u_t}$ is the reduced form shock that can be written by using structural shocks:

$$\boldsymbol{u_t} = \boldsymbol{S \varepsilon_t} \tag{3}$$

where $\boldsymbol{S} = \boldsymbol{A_0^{-1}}$. Thus, Eq(2) and Eq(3) yields:

$$\boldsymbol{Y_t} = \sum_{j=1}^{12} \boldsymbol{B_j} \boldsymbol{Y_{t-j}} + \boldsymbol{S\varepsilon_t} \tag{4}$$

Cholesky identification, which is straightforward and simple to use, may be considered the first choice to identify the $\boldsymbol{S}$ matrix. When financial variables and a policy indicator are present in the VAR together, however, the timing restrictions of Cholesky identification can be problematic. Monetary policy shocks should have a contemporaneous impact on financial variables and monetary policy should respond to innovations in financial variables, simultaneously, with low frequency. As a result, as an identification approach, I use external instrument methodology, which allows me to study the joint response of economic and financial variables.

In this paper, I am only interested in the response of variables to monetary policy shock and do not need to identify every element of $\boldsymbol{S}$. It is sufficient to identify the column in $\boldsymbol{S}$ that is associated with the monetary policy shock, denoted as $\boldsymbol{s}$. The following equation needs therefore to be estimated.

$$\boldsymbol{Y_t} = \sum_{j=1}^{12} \boldsymbol{B_j} \boldsymbol{Y_{t-j}} + \boldsymbol{s}\varepsilon_t^p \tag{5}$$

Before doing identification, define $\boldsymbol{Y_t} = [Y_t^p \;\; \boldsymbol{Y_t^q}]'$, $\boldsymbol{s} = [s^p \;\; \boldsymbol{s}^q]'$ and $\boldsymbol{\varepsilon}_t = [\varepsilon_t^p \;\; \boldsymbol{\varepsilon}_t^q]'$. Let Y_t^p, $\boldsymbol{Y}_t^q$, ε_t^p and $\boldsymbol{\varepsilon}_t^q$ represent the policy indicator, economic/financial variables, policy shock and structural shocks, respectively. To identify $\boldsymbol{s}$ vector, initially the residuals, $\boldsymbol{u}_t$, are calculated by using the fitted values. Then, they are regressed on the external instrumental variable matrix, Z_t, given in Eq(6).

$$u_t^p = \alpha + \beta Z_t + \eta_t \tag{6}$$

The external instrument, Z_t, should be correlated with $\varepsilon_t^{p'}$ but orthogonal to

$\boldsymbol{\varepsilon}_t^{q'}$, as follows:

$$
\begin{aligned}
&E[Z_t \varepsilon_t^{p'}] \neq 0 \\
&E[Z_t \varepsilon_t^{q'}] = 0
\end{aligned}
\tag{7}
$$

The fitted values of Eq(6), $\widehat{u_t^p}$, are used to calculate $\frac{\boldsymbol{s^q}}{s^p}$ ratio:

$$
\boldsymbol{u}_t^q = \frac{\boldsymbol{s}^q}{s^p} \widehat{u_t^p} + \xi_t \tag{8}
$$

By the following closed form solution, Eq(9), s^p is identified. Once value of s^p is calculated than $\boldsymbol{s}^q$ is calculated since $\frac{\boldsymbol{s}^q}{s^p}$ is already known from Eq(8). Given estimates of $\boldsymbol{B_j}$ and $\boldsymbol{s}$, one can use Eq(5) to compute the responses to monetary policy surprises.

$$
\boldsymbol{S} = [\boldsymbol{s} \;\; \boldsymbol{S}_q] = \begin{bmatrix} s_{11} & \boldsymbol{s}_{12} \\ \boldsymbol{s}_{21} & \boldsymbol{s}_{22} \end{bmatrix}
$$

$$
\begin{aligned}
(s^p)^2 = s_{11}^2 &= \Sigma_{11} - \boldsymbol{s}_{12}\boldsymbol{s}_{12}^{'} \\
\boldsymbol{s}_{12}\boldsymbol{s}_{12}^{'} &= \left(\boldsymbol{\Sigma}_{21} - \frac{\boldsymbol{s}_{21}}{s_{11}}\Sigma_{11}\right)^{'} \boldsymbol{Q}^{-1} \left(\boldsymbol{\Sigma}_{21} - \frac{\boldsymbol{s}_{21}}{s_{11}}\Sigma_{11}\right) \\
\boldsymbol{Q} &= \frac{\boldsymbol{s}_{21}}{s_{11}}\Sigma_{11}\frac{\boldsymbol{s}_{21}^{'}}{s_{11}} - \left(\boldsymbol{\Sigma}_{21}\frac{\boldsymbol{s}_{21}^{'}}{s_{11}} + \frac{\boldsymbol{s}_{21}}{s_{11}}\boldsymbol{\Sigma}_{21}^{'}\right) + \boldsymbol{\Sigma}_{22}
\end{aligned}
\tag{9}
$$

where

$$
E[u_t u_t'] = E[S\varepsilon_t\varepsilon_t' S'] = E[SS'] = \Sigma \tag{10}
$$

CHAPTER 3

DATA, ESTIMATION AND RESULTS

Monthly data of log industrial production, inflation, excess bond premium (introduced in Gilchrist and Zakrajšek (2012) (GZ hereafter)), 2-year bond rate, real bank credit growth and mortgage spread over the period 1979:7 to 2012:6 are used. GZ (2012) introduce a credit spread by taking the average of the different credit spreads of different maturities. Then, they decompose it into two components: a component that captures the systematic component and a residual, the excess bond premium. They find that the excess bond premium is a robust predictor of future economic activity. Therefore, I include it in the model since it adds additional information that the other variables are unable to account for. The variables, other than the credit growth and inflation, are taken from GK (2015) dataset. Inflation is measured as the compounded annual rate of change of CPI[1].

I use commercial and industrial loans to represent bank loans. Aggregate nominal bank loans data is taken from the commercial banks data[2] and by using the producer price index[3], I convert it to a real variable. Then, by taking the per-

[1]Consumer Price Index for All Urban Consumers: All Items in U.S. City Average
[2]Assets and Liabilities of Commercial Banks in the United States - H.8
[3]Producer Price Index by Commodity: All Commodities (PPIACO)

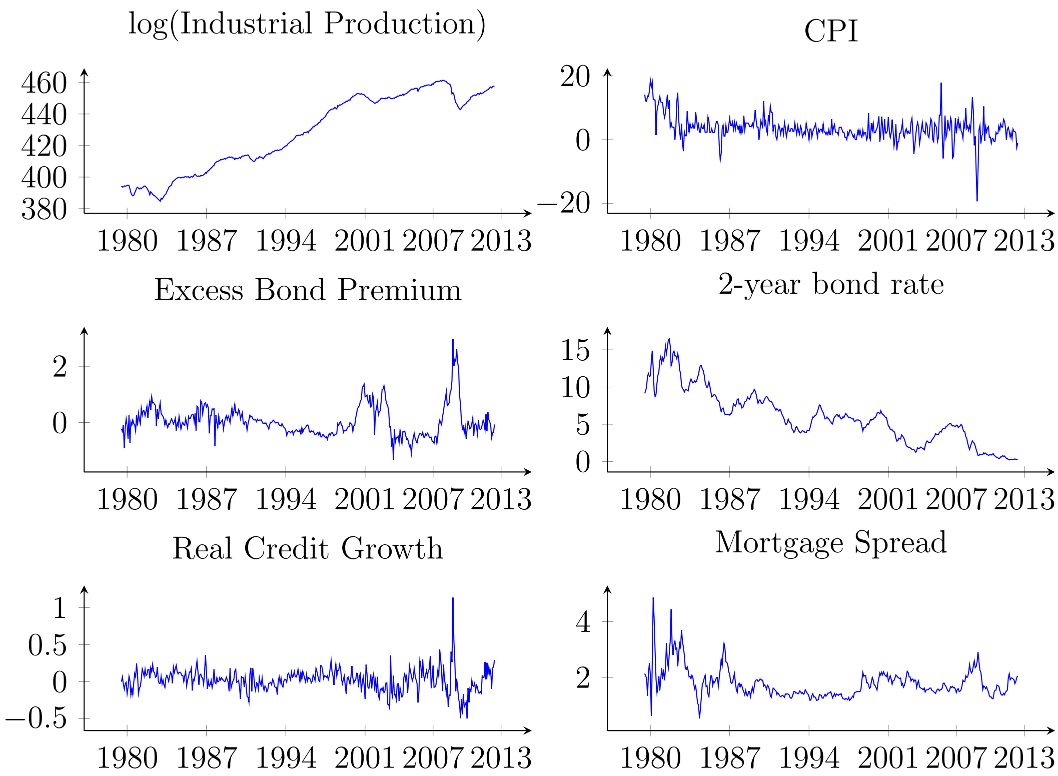

Figure 1: Economic and Financial Variables over the period 1979 - 2012

centage change, I calculate the real bank credit growth. Since firms' credit demand is primarily based on their costs, I choose the producer price index rather than the consumer price index as a deflator. In Figure 1, I plot the values of the variables over the sample period. Log industrial production is given as level and all the other variables are given as percentages.

To demonstrate that the chosen policy indicator and instrument are convenient and the external instrument approach is suitable, I plot the impulse responses from a simple VAR in figure 2. I build a sequence of VARs so that one can observe the additional contribution of each stage. The simple VAR includes log industrial production, inflation, excess bond premium and 2-year government bond rate. I use the full sample, 1979:7 to 2012:6, to calculate the coefficients of the VAR model and use 1991:1 to 2012:6 period to calculate the $\boldsymbol{s}$ since FF4 is not available before 1991.

The left panels depict the case where monetary policy shocks are identified us-

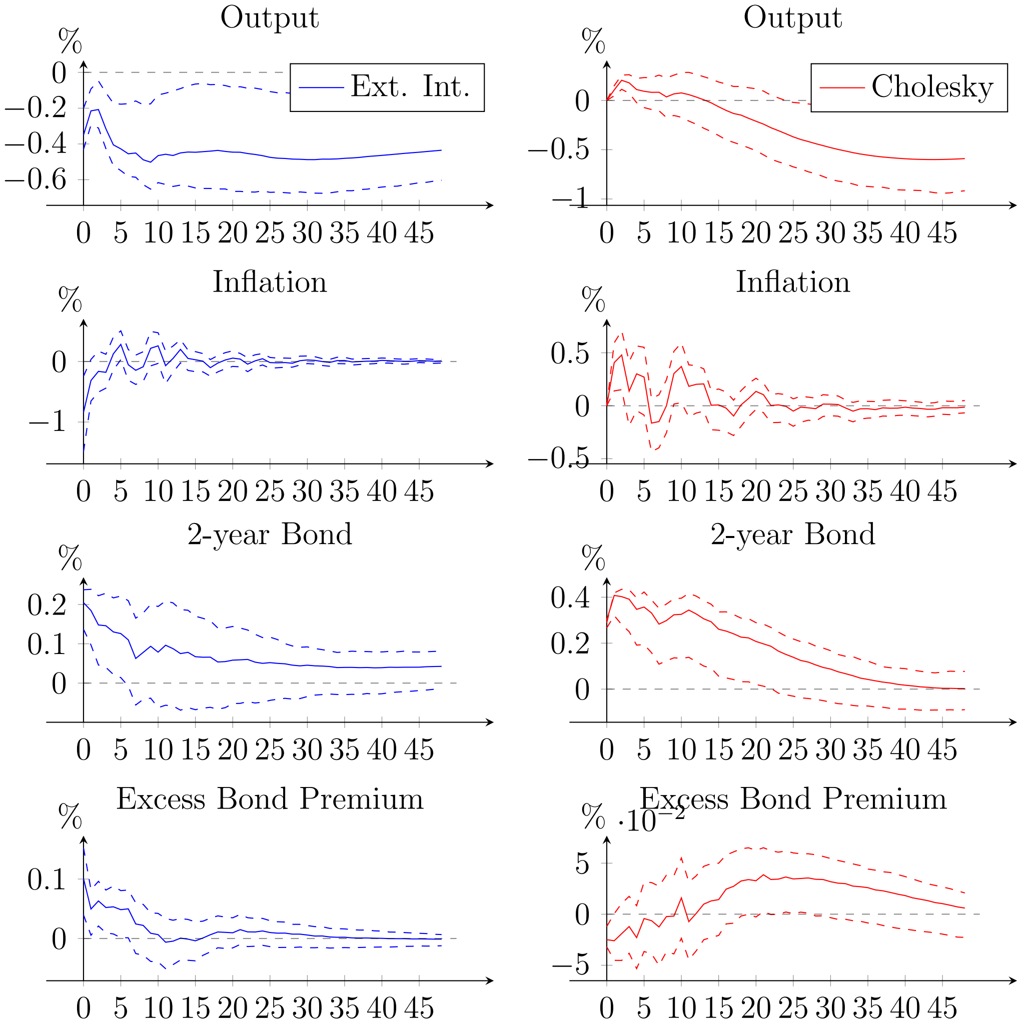

Figure 2: Two-year rate shock with excess bond premium

ing external instruments while the right panels show the case using Cholesky identification. All the plots report the estimated impulse responses along with 95-percent confidence bands, computed using wild bootstrapping methods[4].

As seen in the left panel of figure 2, a unit monetary policy shock results in a rise of the two-year government bond rate of about 20 basis points. There is a significant decline in industrial production which reaches its maximum approximately a year and a half after a shock, consistent with conventional theory. There is a big and statistically significant decline in inflation contemporaneously but the impact dissipates within 2 months. The GZ excess bond premium increases by approximately 10 basis points, which is statistically significant, and

[4]Similar to Mertens and Ravn (2013)

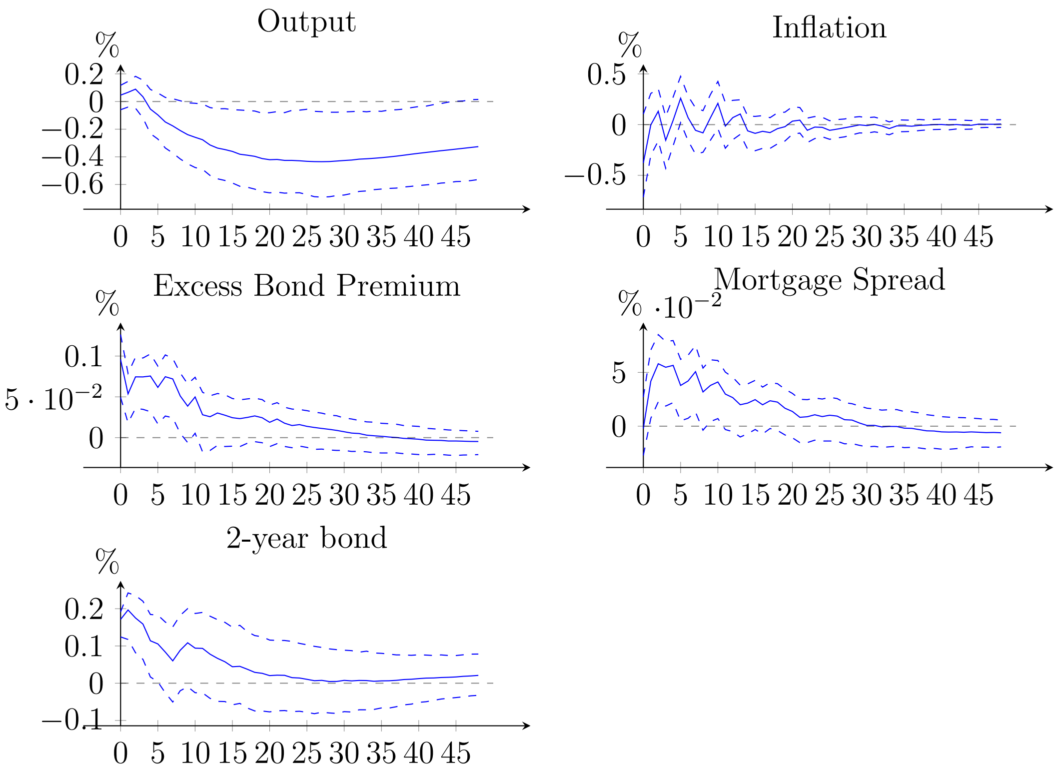

Figure 3: Two-year rate shock with mortgage spread

it remains elevated at 5 basis points for roughly a year. The excess bond premium's response is in line with the credit channel theory. Note that the excess bond premium captures the variation that is orthogonal to the systematic component of GZ spread.

On the other hand, the Cholesky identification seems problematic when the right panel of figure 2 is examined. As a response to the policy shock, both industrial production and inflation 'puzzle'. The excess bond premium declines by roughly 3 basis points, statistically significant, which is inconsistent with the theory. Due to the timing restrictions, Cholesky identification does not work well here since under the identification restrictions, the central bank adjustment of the two-year rate has an immediate impact on the excess bond premium while innovations in the excess bond premium do not affect the central bank's adjustment simultaneously. Moreover, any ordering of the variables does not solve the problem as stated earlier. Thus, VAR with Cholesky identification is not appropriate in this case where both financial and real variables are

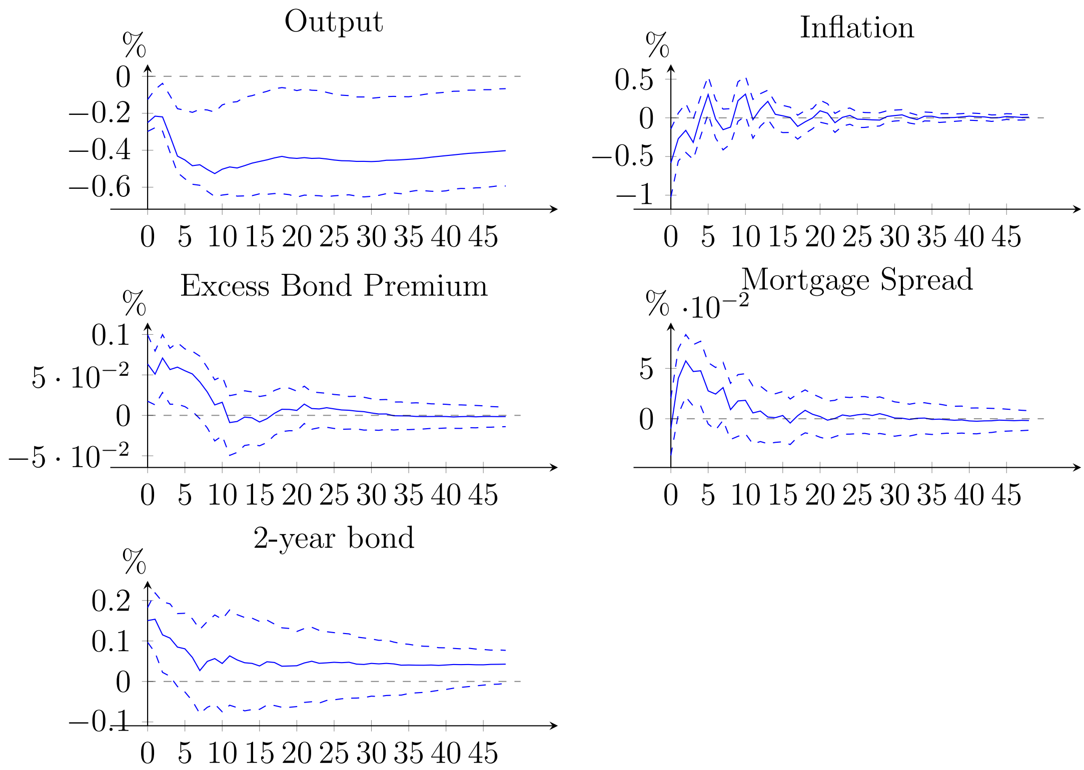

Figure 4: Two-year rate shock with instruments without the Fed's private information

present. However, the external instrument approach seems well suited.

Now, I am able to address the paper's main question: how the bank loans respond to exogenous surprises in monetary policy. The growth of bank loans also depends on the responses of various credit spreads. Even though having excess bond premium in the VAR makes the inclusion of most of the credit spreads unnecessary, adding the mortgage spread, which is related to housing finance costs, can still offer information, especially while considering the responses of real estate loans. Also, having mortgage spread gives me the opportunity to examine the spread and replicate GK (2015) results. In contrast to GK (2015), the three-month commercial paper spread, which is associated with the short-term business credit costs, is not included in the VAR model since it does not significantly alter the impulse response functions, which are covered in more detail in the robustness section, nor does it add any new information to the model.

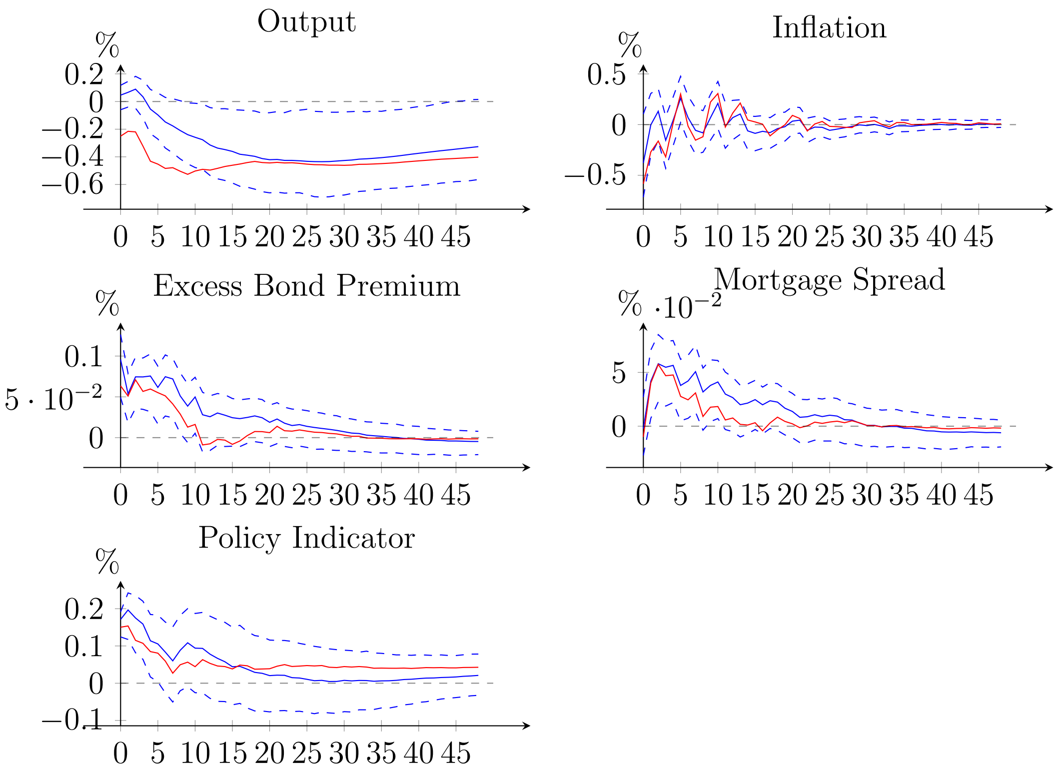

Figure 5: Two-year rate shocks with instruments with and without the Fed's private information. Blue line: responses to a monetary policy shock identified using $FF4$. Red line: responses to a monetary policy shock identified using $FF4_c$.

Figure 3 displays the VAR model's impulse responses, which include the log industrial production, inflation, GZ excess bond premium, 2-year government bond rate and mortgage spread. The 2-year government bond rate is instrumented with FF_4. GK (2015) measurements of the shocks are utilized and the information effect has not yet been taken into consideration. After adding mortgage spread to the model, there are output and price puzzles. The two-year rate increases roughly 18 basis points and reverts back to the trend after a year. There is a statistically significant drop in industrial production, which begins after several months. The inflation does not decrease statistically significantly. Mortgage spread and excess bond premium increase significantly and return to the trend after staying elevated for roughly two years. Also, their response functions are consistent with the credit channel effects, which indicate that the spreads widen in response to the contractionary shock.

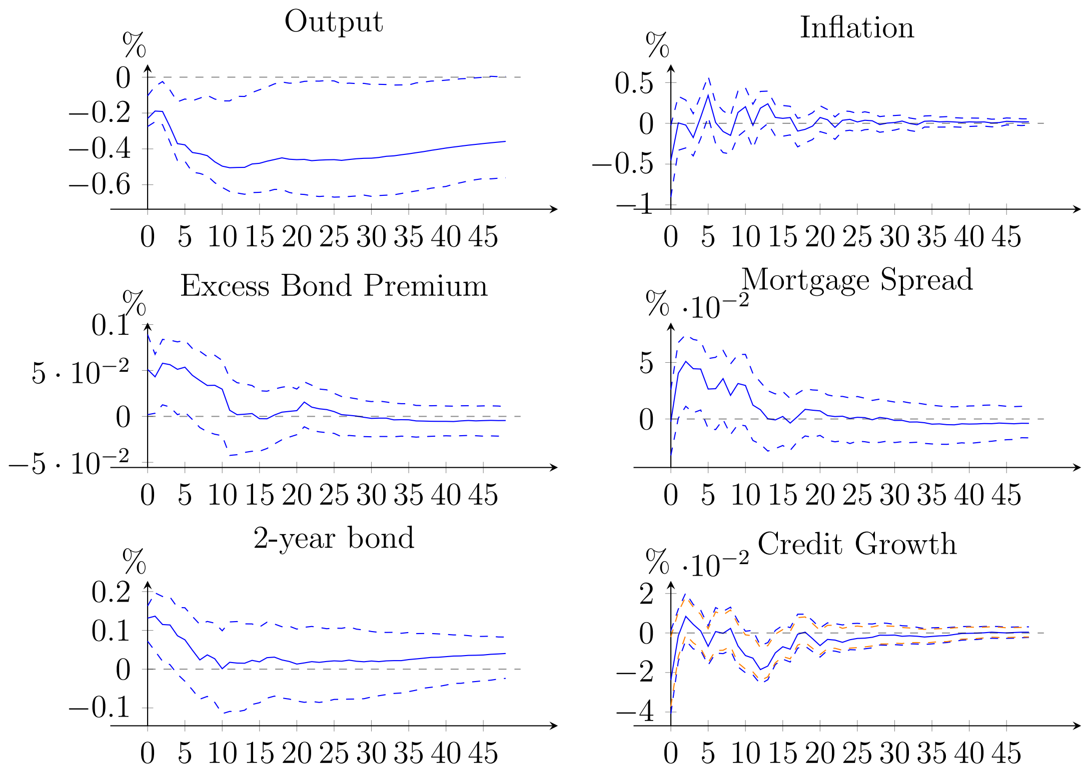

Figure 6: Two-year rate shock with instruments without the Fed's private information: Response of the bank loans. Orange dotted line: 90% confidence intervals

Asymmetry in information between the agents and the central bank may also exist. Up to now, by following GK (2015) methodology and utilizing their instrument, I have assumed that market participants have perfect information. Under this assumption, controlling only the information set of the perfectly informed agent is sufficient to identify the shock. However, the assumption may not hold. Miranda-Agrippino and Ricco (2021) demonstrate how Greenbook forecasts and forecast revisions for real output growth, inflation and unemployment can be used to explain some of the fluctuations in FF4. The variation that can not be explained by Fed's private information is defined as $FF4_c$. In other words, they regress $FF4$ on the Greenbook forecasts and forecast revisions; and label residuals as $FF4_c$. The residuals, which are orthogonal to the FED's private information, capture the variation in $FF4$ on FOMC dates. Thus, I use $FF4_c$ as the policy instrument to have truly exogenous shocks.

The responses that are constructed using $FF4_c$ are plotted in figure 4. The results show that considering information effects solves the puzzles. Industrial production decreases statistically significantly simultaneously and peaks in less than a year. The inflation immediately drops, statistically significantly, and reverts back to zero. Also, the excess bond premium, the mortgage spread and the 2-year rate increases, statistically significant, and revert to their trends within a year. I do not observe any significant movement in the response function after period 24. This is consistent with the view which claims that the Fed controls the 2-year horizon with forward guidance. Since the responses are consistent with the theory, the model is selected as the main econometric model, that models the economy. The bank loan variable is added on top of this.

I also compare the responses of the two models that consider the information effects and not, plotted in figure 5. The red line shows the responses of the main model that considers information effects while the blue line shows the responses of the model that does not consider information effects. As expected, considering the information effect makes the responses stronger than the baseline. Also, the purified shocks have more temporary effects. The responses of the outputs are statistically significantly different than each other while others are not.

Before adding the bank credit to the VAR model, I verify the validity of the instrument. Let's start with the case where the 2-year government bond rate and the three month ahead monthly fed funds futures surprise, FF4, are chosen as a policy indicator and a policy instrument, respectively. Once u_t^p is regressed on Z_t, given in Eq(6), the p-value of the coefficient of Z_t, β, is less than 0.05, which indicates that the coefficient is statistically significantly different than zero, thus the null hypothesis can be rejected. However, the F-statistic and R-squared are calculated as 9.28 (<10) and 3.5%, respectively, which indicates that there may be a potential weak instrument problem. However, when 1-year government bond is used as a policy indicator rather than 2-year government bond, the F-statistic and R-squared values are calculated as 24.56 (>10) and 8.8%. 10 is suggested as a threshold value for F-statistic by Stock, Wright, and Yogo (2002) to reject the likelihood of a weak instrument problem. Once $FF4_c$ is used as the policy instrument instead of FF4, F-statistics and R-squared values are 5.95, 2.3%; and 9.57, 3.6% for the two-year and one-year rates, respectively.

Using 1-year bond instead of 2-year bond as a policy indicator results in fairly similar impulse response functions, regardless of the policy instrument choice. In the robustness section, I show the case, where the 1-year bond and 2-year bonds are instrumented with $FF4_c$, to prove the claim. I use the 2-year bond rate with $FF4_c$ to be consistent with the literature arguing the forward guidance strategy has a 2-year time horizon. Since the responses are similar and do not depend on the choice of the indicator and the instrument. It is safe to use 2-year bond with $FF4_c$ even though its F-statistic is calculated as 6.21.

Now, I can add the credit growth on top of the model. Figure 6 presents the response of the growth after the unit shock. The decline in credit growth just after the shock that is not statistically significant for 95% confidence intervals. However, when 90% confidence intervals are considered, I observe a statistically significant decline. Moreover, I observe a significant decline (for both 90% and 95% c.i.), which lasts for 3 months, after roughly a year and then, it reverts to zero. The response is consistent with the theory, which says that contractionary monetary policy shocks decrease both the credit demand and supply. The responses of other variables do not differ significantly from those of the main model. The unit shock increases the two-year bond rate by roughly 12 basis points and the excess bond premium by roughly 4 basis points. Then, with a delay, I observe a significant drop in credit growth.

CHAPTER 4

ROBUSTNESS CHECKS AND EXTENSIONS

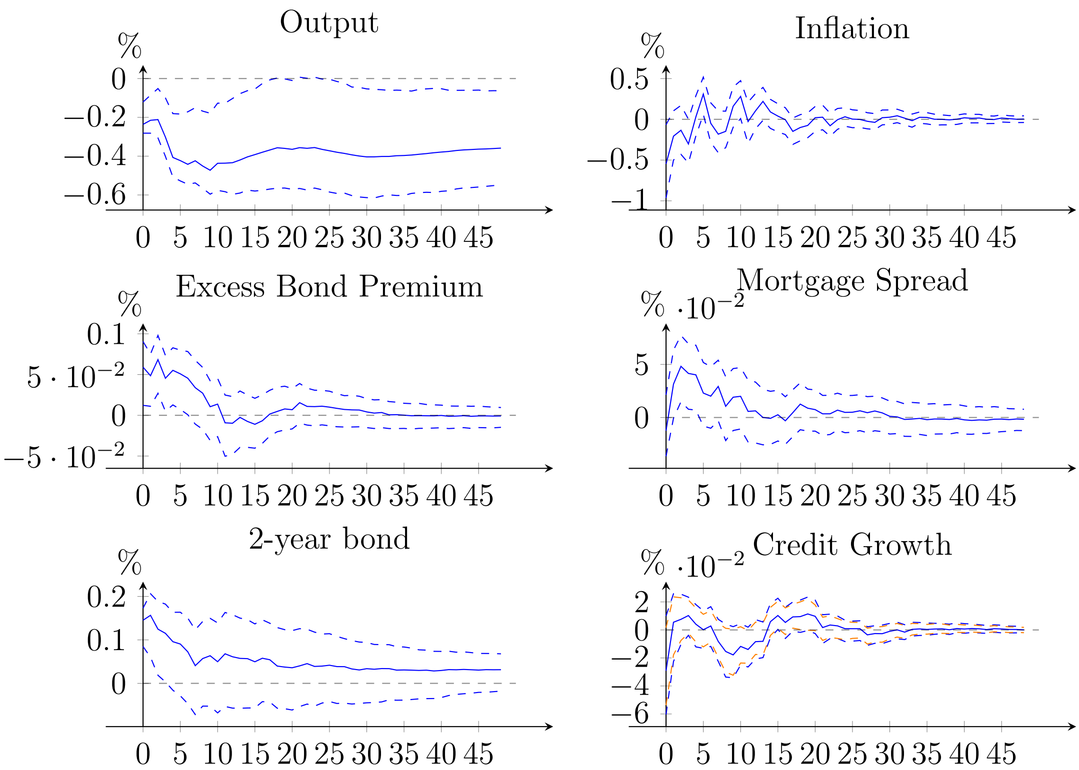

Figure 7: Two-year rate shock with instruments without the Fed's private information: Response of the consumer loans growth. Orange dotted line: 90% confidence intervals

I check the responses of other bank credits to the shocks as well. I employ the consumer loans and the real estate loans one at a time instead of the commer-

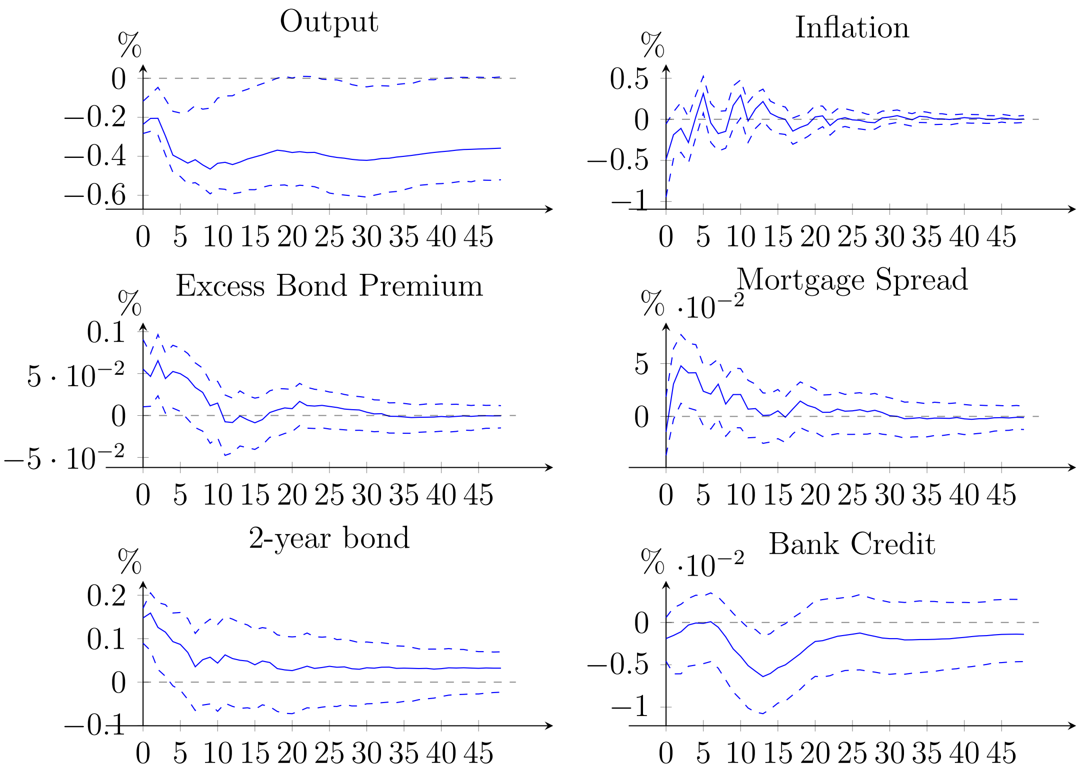

Figure 8: Two-year rate shock with instruments without the Fed's private information: Response of the consumer loans stock

cial and industrial loans. The nominal consumer loans and nominal real estate loans are converted to real variables using the consumer price index[5] and the house prices[6], respectively. Also, by taking percentage change, they are added as credit growth to the model.

The response of the consumer loans is given in figure 7. The real consumer loans growth drops as the shock is given but not significantly; and I observe another drop between periods 7 and 13, but it is also not statistically significant. The response seems not fully consistent with the theory, i.e., the tightening economic conditions do not imply a drop in credit growth. However, note that these results are obtained under 95% confidence intervals and examining the growth may be deceptive to evaluate the theory. Also, I evaluate the responses under 90% c.i which is plotted with the dashed orange line. It indicates

[5]Consumer Price Index for All Urban Consumers: All Items in U.S. City Average (CPIAUCSL)

[6]Average Sales Price for New Houses Sold in the United States (ASPNHSUS)

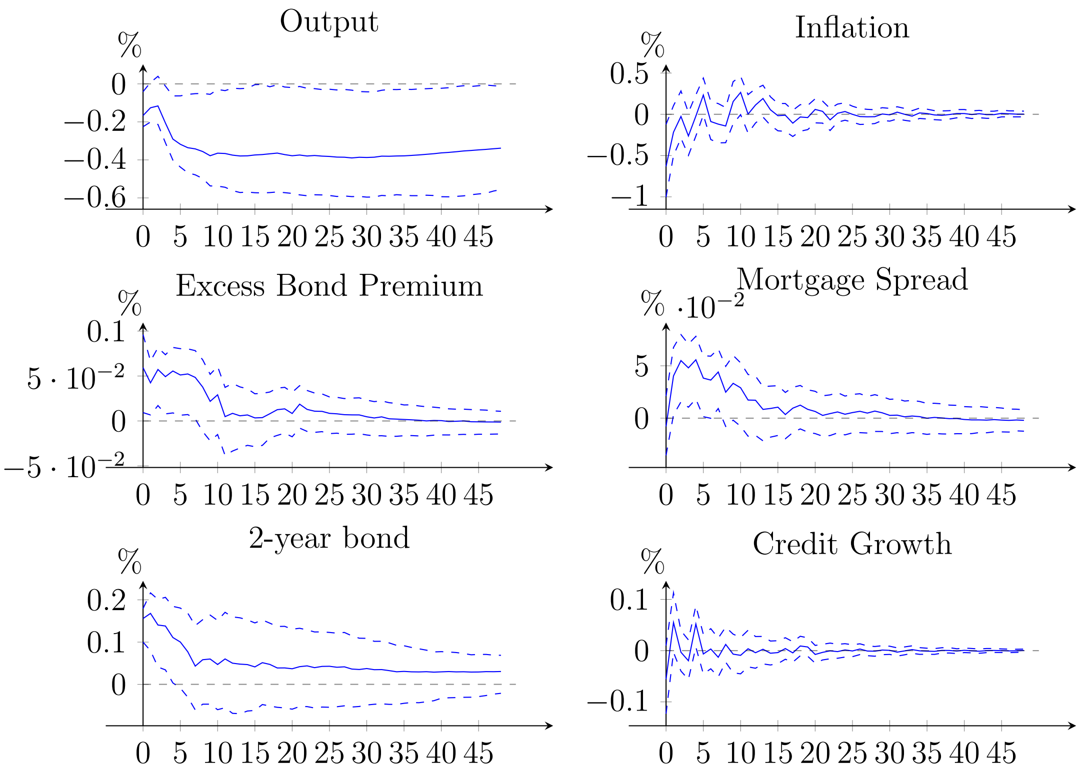

Figure 9: Two-year rate shock with instruments without the Fed's private information: Response of the real estate loans growth

a significant decline for period zero. Since theory claims that the credit supply decreases as a response to the tightening conditions and does not says something about the decomposition of the change, the credit growth for each period. Therefore, the aggregated change is also considered. To do that, I employ the credit level instead of the credit growth.

Figure 8 represents the response of the log credit level to the contractionary shock. The real consumer loans start to decrease a half year after the shock and reach their maximum a year after the shock. Then, they return to their trend. There is a statistically significant drop in bank credits only between periods 11 and 16. The result is consistent with the theory, which contends that contractionary monetary policy decreases the credits.

The response of the real estate loans is given in figure 9. Even though the mortgage spread increases, the change in growth is puzzling and not statistically sig-

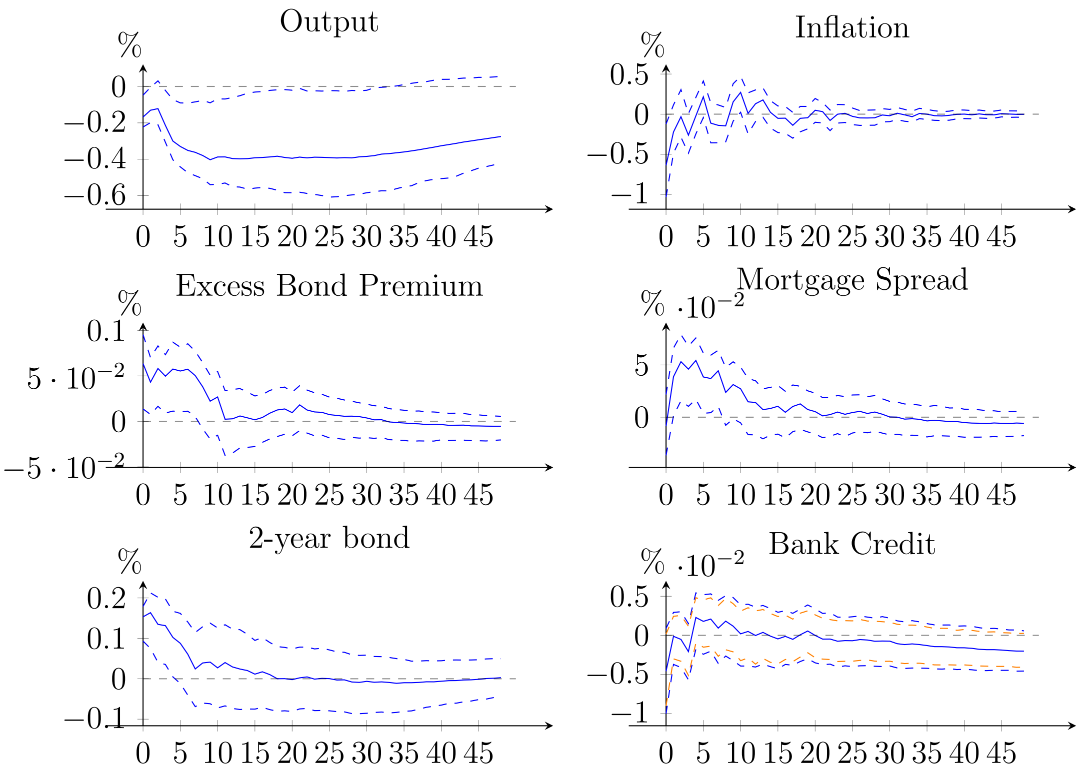

Figure 10: Two-year rate shock with instruments without the Fed's private information: Response of the real estate loans stock. Orange dotted line: 90% confidence intervals

nificant. Since examining the growth does not imply statistically significant results about aggregated change in credit supply, I also check the response of the credit stock. Figure 10 shows the response of the log credit level for mortgage credit. There is not still any significant drop in the credit under 95% confidence intervals. To observe a significant decline in the stocks, the 90% confidence intervals need to be hired. Still, the statistically significant decline lasts for a period.

For the sake of completeness, I also examine the response of the log commercial loans. The IRFs are plotted in figure 11. The IRF of the credit is consistent with the findings that are presented in figure 6. When the credit growth turns negative, I observe a decrease in the credit stock. Also, after the credit growth returns to its mean, the credit stock stays flat. The findings are internally consistent.

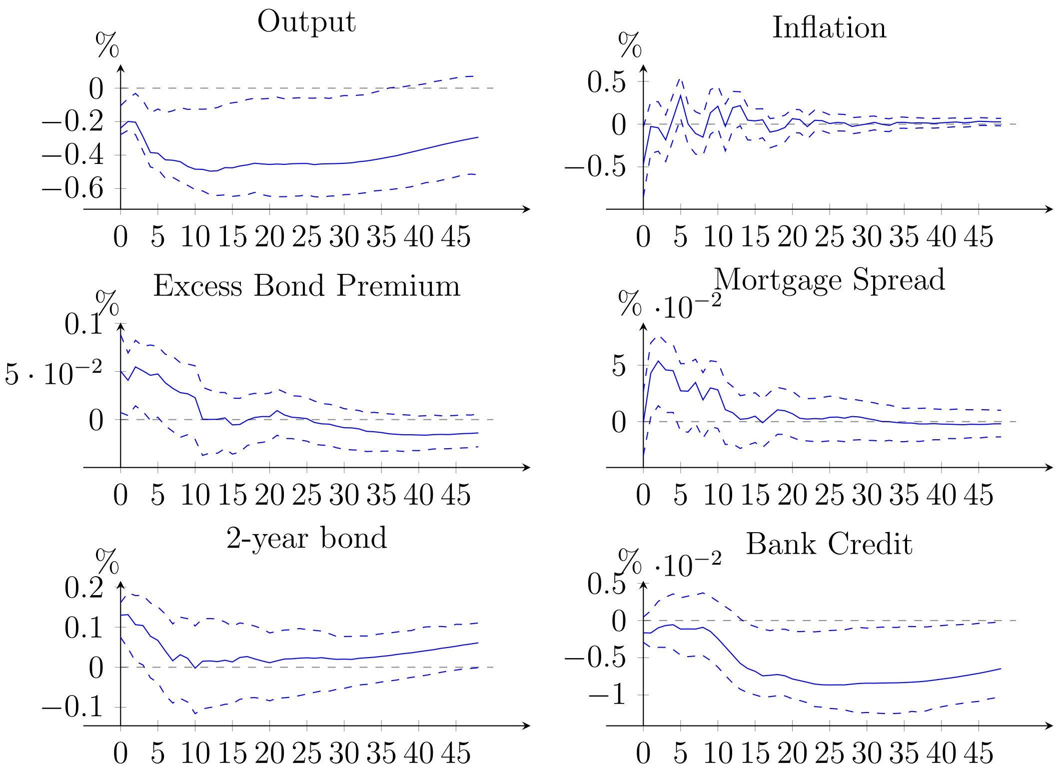

Figure 11: Two-year rate shock with instruments without the Fed's private information: Response of the commercial loans stock

Furthermore, I exclude the crisis period that begins at 2008:6 so that I show that the results are robust for the sample period. The new data covers the period from 1979:7 to 2008:5. None of the responses, except the response of industrial production, are statistically different, as shown in figure 12. On the other hand, I can understand why industrial production is statistically different. In the crisis, the element of $\boldsymbol{s}$ vector that is related to the response of output to monetary policy shock is calculated as if it has a much bigger effect on the output. Thus, I observe an almost parallel upward shift in the output response when the crisis period is not considered. All in all, the findings are independent of including the crisis period.

As I noted earlier, there may be a potential weak instrument problem when the two-year rates are used as an instrument. I show that the responses for one and two-year rates are similar when they are instrumented with $FF4_c$. If the one-year rate was used, there would not be any weak instrument problem, since the

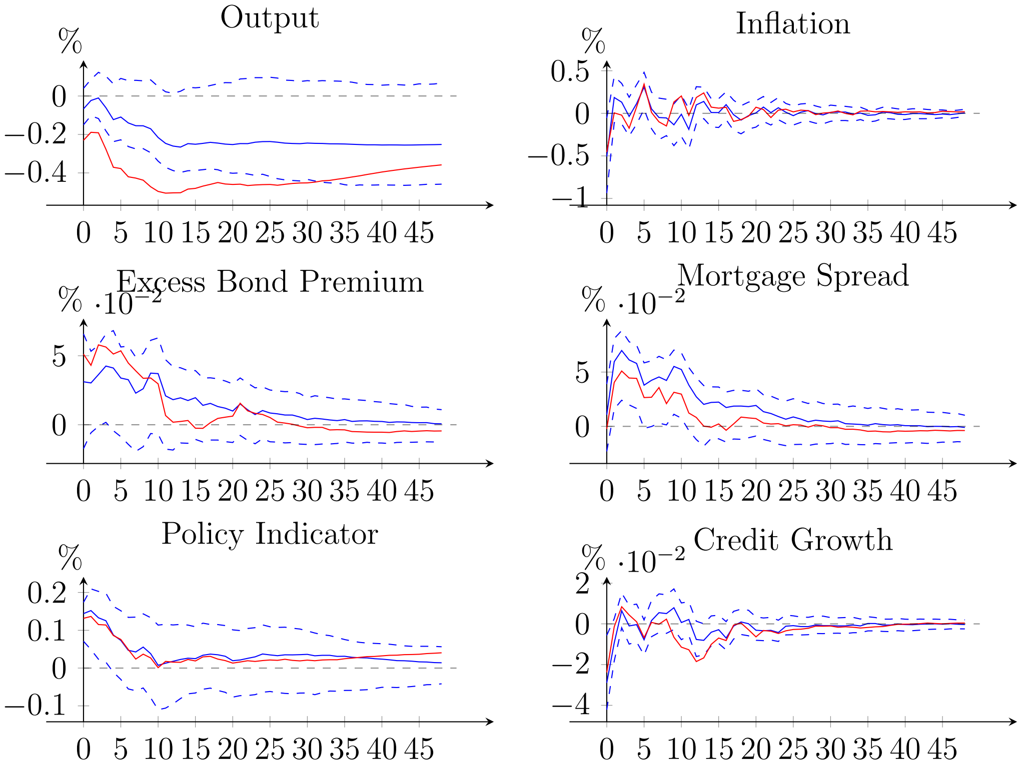

Figure 12: Two-year rate shock with instruments without the Fed's private information, 1979-2008. Blue line: 1979-2008. Red line: 1979-2012

F-statistics for the one-year rate is higher than 10 which means that according to Stock et al. (2002), everything is fine. The two-year rate is chosen since the forward guidance of the Fed operates with an approximately two-year time horizon. The results are compared with the case where one-year rate is selected as an instrument, given in figure 13. I adjust the shock's magnitude so that the funds rate's response is quantitatively comparable to the baseline scenario. The impulse responses are almost identical, two-year rate has a slightly stronger effect, and not statistically different from each other. Since two-year rate has a greater degree of forward guidance, the stronger effects are consistent.

Finally, I address the issue of whether adding the commercial paper spread to the baseline VAR, like GK (2015) did, is necessary. As stated earlier, I do not include it in my model since it neither adds any information nor changes the responses. The comparison of the responses is given in figure 14. The behaviour of bank credit is almost identical, not statistically significantly different. By

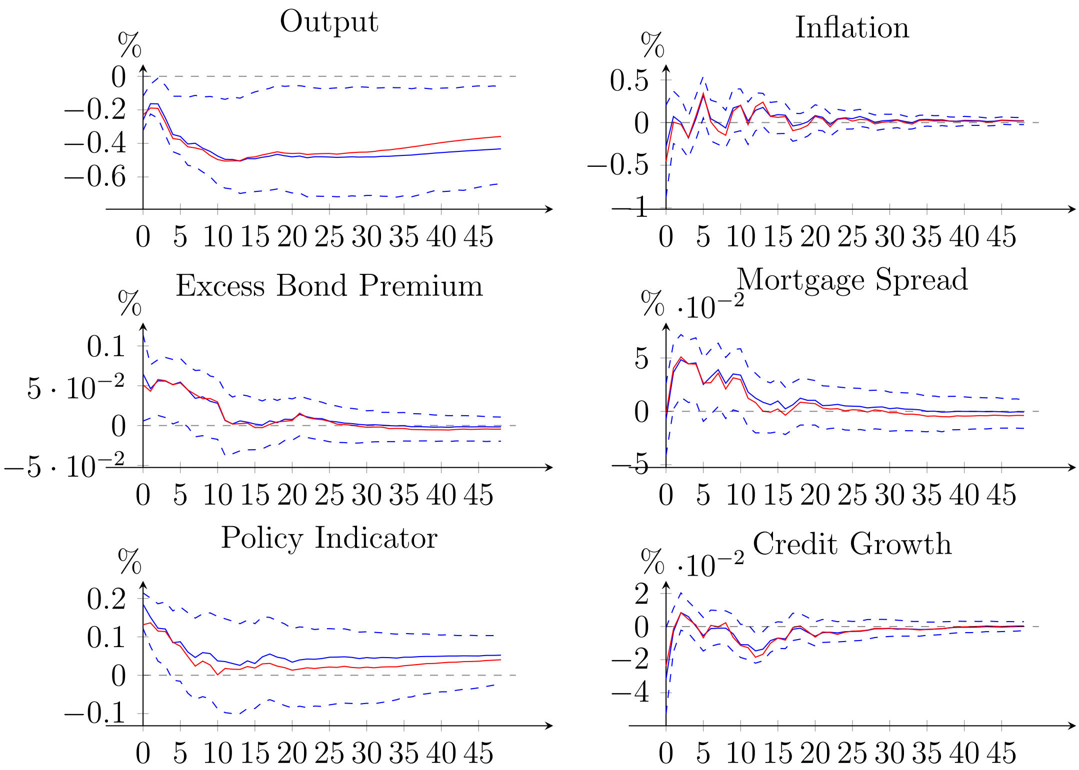

Figure 13: One-year rate shock with instruments without the Fed's private information. Blue line: One-year rate shock. Red line: Two-year rate shock.

considering the results, I can conclude that adding the spread does not change the results, makes the model more complex and may lead to a multi-collinearity problem.

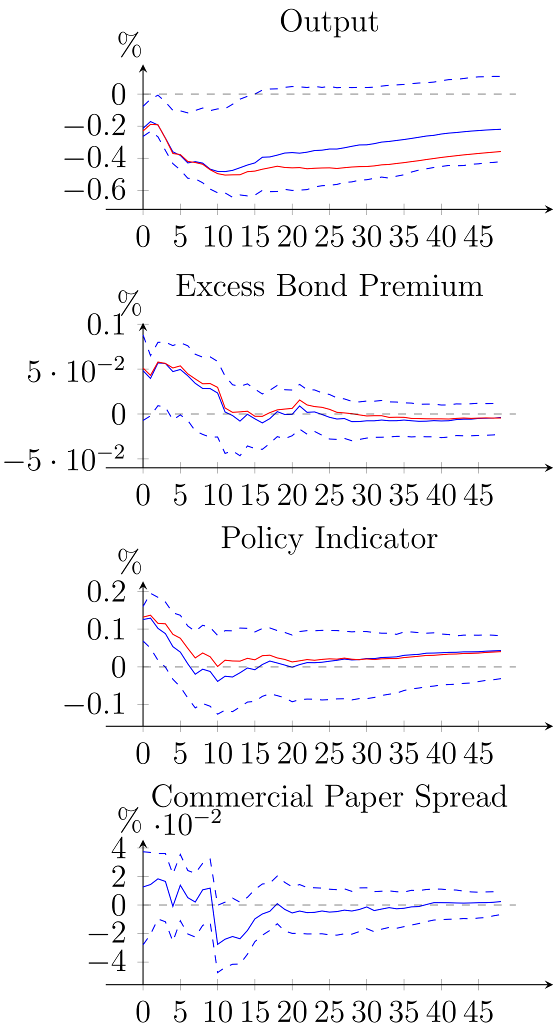

Figure 14: Two-year rate shock with instruments without the Fed's private information: commercial paper spread is also added the model. Blue line: The model with commercial paper spread. Red line: The model without commercial paper spread.

CHAPTER 5

CONCLUSION

I use conventional VAR with an external identification approach, borrowing insights from GK (2015). Even though high-frequency identification is suitable for measuring the immediate impact, it can not establish how lasting the shock is. Therefore, the identification is combined with the VAR to measure the impact of the shocks on financial and macroeconomic variables for longer horizons. I have also discussed why using Cholesky or sign-restrictions are not suitable ways to identify the shocks. By hiring Miranda-Agrippino and Ricco (2021) surprises and the two-year government bond rate, respectively, as an instrument and a policy indicator; I both consider the effects of forward guidance and the information effects.

I show that the policy shocks significantly affect the loans. The movement in the bank credits is consistent with the responses of the other variables and the theory. The contractionary shock decreases the bank loans and the response of the loans depends on their types. Also, I find that the effects of the shocks dissipate within 24 months for all variables. It strongly supports the findings of Hanson and Stein (2015) who claims that the Fed controls the two-year horizon. Moreover, my results are also in line with GK (2015) results, the spreads and the excess bond premium drops in response to the contractionary shock. I further demonstrate that the results do not depend on the choice of the period, the instrument or adding a new variable to the model. Even though there exist some papers that examine the response of credit costs, the response of credit levels is not examined extensively. So, I contribute to the literature by showing this.

On the other hand, there is still room for improvement. The target and path factors without the Fed's private information can be utilized as instruments in future studies to examine the effects of each component individually. Moreover, even though I show that there is a significant drop in the loans, I do not know how much of this change is due to the change in demand and how much of this change is due to the change in the supply. The individual effect of supply and demand can be examined.

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