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Faculty of Social Sciences
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MASTER'S THESIS

The Role of Business Confidence in the Monetary Policy Transmission Mechanism: Evidence from the Euro Area

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Study program: **Economics and Finance**

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Declaration of Authorship

The author hereby declares that he compiled this thesis independently; using only the listed resources and literature, and the thesis has not been used to obtain a different or the same degree.

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Prague, May 14, 2020 Zhaozhi Liu

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With the completion of the graduation thesis, my graduate life is also coming to an end. Thinking back to the time of living in beautiful Prague, this life was so short and wonderful. The beautiful Charles University has knowledgeable teachers and kind and lovely classmates. This experience is unforgettable.

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Abstract

Traditional macroeconomics believes that confidence is not the main cause of economic fluctuations, but when faced with financial crises, monetary authorities still emphasize the role of stabilizing confidence. Although people generally agree that confidence is an important part of the transmission of macro-policies to micro-individuals, there is neither empirical evidence support nor corresponding mechanism research. This thesis attempts to answer the following questions: Does business confidence affect the effectiveness of monetary policy? Does business confidence have the same impact on monetary policy in different economic periods?

This thesis first constructed a structural vector auto-regression (SVAR) model to test the role of business confidence in the transmission of monetary policy in the euro area. The empirical results show that expansionary monetary policy can effectively boost business confidence while stimulating output growth. In addition, this thesis extends the model by introducing share prices and exchange rates to investigate the role of these two important to the monetary transmission mechanism, concluding that business confidence plays a strong role in interest rate transmission and a weaker role in the transmission of asset prices and exchange rates. Subsequently, in order to verify the influence of business confidence with different lead times and different time points on monetary policy, this thesis established a time-varying parameter vector autoregression (TVP-VAR) model. The role of confidence in the transmission of monetary policy is mainly manifested as a short-term impact, which gradually weakens in the long-term. Moreover, at different stages of economic development, the business confidence index has different effects on the transmission of monetary policy. In times of economic crisis, the role of confidence will be more sensitive.

JEL Classification	F830
Keywords	Business confidence, monetary transmission, SVAR model, TVP-VAR model
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Acronyms

VAR Vector auto-regression

TVP-VAR Time-varying parameter vector auto-regression

Master's Thesis Proposal

Author:	Zhaozhi Liu
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Proposed Topic:
The Role of Business Confidence in the Monetary Policy Transmission Mechanism: Evidence from the Euro Area

Motivtion:

When there are fluctuations in macroeconomic performance, expectation management becomes an important concern for policymakers. The regulation of the macroeconomy through expectations management is a concrete expression of the concept of forward-looking monetary policy. The key to the stability of market expectations is business confidence. Business confidence reflects individuals' subjective perceptions and judgments of macroeconomic performance. Some scholars have found that confidence has an important impact on the growth of consumption in macroeconomic performance (Carroll, 1994), inflation (Khumalo and John, 2014), and economic policy effects (Shiller and Akerlof, 2010; Berg, 2019). However, there is still considerable debate on how confidence, a psychological variable, affects the real economy. What's more, there is no clear empirical evidence as to whether business confidence can influence the transmission effect of monetary policy.

At present, views on how business confidence affects macroeconomic performance can be broadly categorized into "animal spirits" and "news approach" (Barsky and Sims, 2012). The "animal spirits" perspective was first developed by Keynes (1936) and by Pigou (1927). The idea is that people's emotions may be detached from fundamentals, thereby amplifying the impact of the economic cycle. However, since such mood swings are unrelated to changes in fundamentals, the effect of animal spirits on the economy should be short-lived. The "news approach" view, on the other hand, is that confidence is not a purely animal spirit and that its fluctuations reflect certain changes in fundamentals, thus confidence volatility can have a lasting impact on the real economy. Studies have shown that while people can learn about new information in the markets, these fluctuations can have a lasting impact on the real economy due to the "friction" in the transmission process. Information is not immediately and fully represented (Mankiw and Reis, 2002; Carroll, 2003), so that confidence may contain news that is captured by people but not fully reflected in the marketplace. Barsky and Sims (2012) find that fundamental news is the main driver of the observed relationship between confidence and subsequent economic activity. Animal spirits shocks had only a limited impact. Bachmann and Sims (2012), on the other hand, focus on the role of confidence in the transmission of fiscal policy, and his empirical results show that the positive response of output and productivity to fiscal stimulus is moderate, gradual, and long-run in terms of impact during periods of slack. During the crisis, the fiscal multiplier would be reduced considerably if the confidence transmission

channels were removed.

The possible role of confidence in macroeconomic performance has been studied to some extent in the literature, but there are still the following shortcomings. Current research has focused more on the predictive power of confidence in the macroeconomy, and little literature has examined the effect of confidence on the transmission of monetary policy. In addition, it should be analyzed whether business confidence will have different effects on monetary transmission in different periods.

Hypotheses:

1. Hypothesis #1: Business confidence will affect the effectiveness of monetary policy.
2. Hypothesis #2: The role of confidence in the transmission of monetary policy is mainly manifested as a short-term impact, which gradually weakens in the long-term.
3. Hypothesis #3: At different stages of the economic crisis, the business confidence index has different effects on the transmission of monetary policy. In terms of economic crisis, the role of confidence will be more sensitive.

Methodology:

The empirical part of this thesis mainly involves three types of indicators: confidence index, monetary policy, and macroeconomic performance. The data source is from OECD database. This thesis uses data from 19 countries in Eurozone from 2000 to 2019.

After selecting variables, we perform impulse response analysis on the data. We first establish the SVAR model, and then the TVP-VAR model, by setting different lead times and different time points to study the impact of business confidence on the monetary policy transmission mechanism in different periods. According to the benchmark SVAR model:

$$AY_t = \sum_{i=1}^{s} F_i Y_{t-i} + \varepsilon_t$$

Among them, s represents the lag order, and ε_t is a 4 × 1 shock term matrix. A and F_i is the coefficient matrix. Y_t represents a matrix of four variables, namely the money market rate, business confidence index, and the growth rate of GDP. Simplify it, and get that when the variable q is impacted by a unit, the response of the variable i ($\varphi_{i,q,h}$) in each period of h = 1, 2, ..., H is:

$$\varphi_{i,q,h} = e_i \Lambda^{h-1} A^{-1} f_q$$

Among them, e_i is a 1 × 4 row variable with the i-th value of 1, and the other is 0, f_q is a 4 × 1 column variable with the q-th value of 1, and the other is 0, used to select the desired value from the matrix. Given that the dimension of Λ^{h-1} is 4s × 4s, it is necessary to insert 4 × (s -1) row or column zero values into $A^{-1}f_q$ and e_i respectively to perform matrix multiplication.

Next, We use the SVAR model to build the TVP-VAR model. We still establish a three-variable TVP-VAR model of proxy variables for monetary policy, business confidence index and GDP growth rate. The order of variable setting is monetary policy proxy variable, business confidence index, CPI, GDP growth rate.

assume that:

$$\mu_t \sim \mathrm{N}(0, \Sigma\Sigma), \Sigma = \begin{pmatrix} \sigma_1 & 0 & \dots & 0 \\ 0 & \ddots & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ 0 & \cdots & 0 & \sigma_k \end{pmatrix}$$

Rewrite the simplified VAR model as:

$$Y_t = \sum_{j=1}^{s} B_i Y_{t-i} + A^{-1}\Sigma\varepsilon_t$$

Among them, $B_i = A^{-1}F, i = 1, \cdots, \mathrm{s}, \varepsilon_t \sim N(0, I_k)$.

Then we write the elements of each row in the stacked matrix B as $k^2\mathrm{s} \times 1$ dimensional column vector β, and define $X_t = I_k \otimes (Y'_{t-1}, \cdots, Y'_{t-s})$, where ⊗ is the Kronecker product, so the model can be transformed into:

$$Y_t = X_t\beta + A^{-1}\Sigma\varepsilon_t$$

Then, let $a_t = (a_{21}, a_{31}, a_{32}, \dots, a_{k,k-1})'$ be the column vector formed by the accumulation of non-zero and 1 elements in the lower triangular matrix A_t, and let $h_t = (h_{1t}, \ \dots, \ h_{kt})', \ h_{jt} = log\sigma_{jt}^2, \ j = 1, \dots, k, \ t = s+1, \dots, n.$

$$\beta_{t+1} = \beta_t + \mu_{\beta t}$$

$$\alpha_{t+1} = \alpha_t + \mu_{\alpha t}$$

$$h_{t+1} = h_t + \mu_{ht}$$

$$\begin{pmatrix} \varepsilon_t \\ \mu_{\beta t} \\ \mu_{\alpha t} \\ \mu_{ht} \end{pmatrix} \sim N\left(0 \ , \ \begin{pmatrix} I & 0 & \cdots & 0 \\ 0 & \Sigma_\beta & \ddots & \vdots \\ \vdots & \ddots & \Sigma_\alpha & 0 \\ 0 & \cdots & \cdots & \Sigma_h \end{pmatrix} \right)$$

Where $\mathrm{t} = \mathrm{s}+1, \cdots, \mathrm{n}, \beta_{s+1} \sim N(\mu_{\beta_0}, \Sigma_{\beta_0}), \ \alpha_{s+1} \sim N(\mu_{\alpha_0}, \Sigma_{\alpha_0}),$ $h_{t+1} \sim N(\mu_{h_0}, \Sigma_{h_0})$.

Expected Contribution:

Business confidence plays an important role in the healthy development of the economy. Previous studies have largely ignored the relationship between business confidence and monetary policy. This thesis makes up for the lack of relevant research in this regard. Additionally, the TVP-VAR model is used to study the influence of business confidence on currency transmission at different lead times and at different points in time, which is of great significance to the formulation of monetary policy in different periods.

Outline:

1. Motivation: At present, there is a lot of controversy about how confidence affects the macroeconomy. There have been studies starting from consumption growth and inflation, and rarely from the perspective of monetary transmission.

I will start from this perspective to explore the role of confidence in monetary transmission under different conditions in time .

2. Related literature: I will briefly describe the previous research methods.
3. Data: I will draw on previous studies, choose and describe representative data.
4. Methods: I will use the benchmark SVAR and TVP-VAR model to calculate and analyze the impulse response.
5. Results: I will discuss my regressions and robustness checks.
6. Concluding remarks: I will summarize my findings and their implications for policy and future research.

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1 Introduction

In the famous "General Theory of Employment, Interest and Currency", Keynes, the founder of modern macroeconomics, first used the term "animal spirit" to describe the influence of emotions on decision-making, and pointed out that human rational behavior may be subject to " interest". However, sentiment indicators including public confidence are rarely seen in traditional macroeconomics research. The reason is that, on the one hand, emotions are psychological indicators that are difficult to quantify. On the other hand, in order to solve the "Lucas Criticism", modern macroeconomics is based on "rational expectations". The theory believes that rational people participating in economic activities can accurately use the information they obtain to make inferences, and there is no long-term deviation of the market from equilibrium due to the emotional fluctuations of the participants. Therefore, under the framework of "rational expectations", public confidence is only a projection of the information set in the economic operation, which is relatively ignored in the modeling process. However, the actual macroeconomic operation is not perfect as described in the rational expectation model, and the performance of the public is not completely calm and rational. When economic entities' confidence in the future macroeconomics declines, will the effectiveness of monetary policy decrease? Both economists and policymakers generally accept the view that confidence plays a vital role in the transmission of monetary policy to the real economy. British economist Pigou emphasized that expected changes are an important factor in determining economic cycles, that is, when people have confidence in the future, they will increase consumption and investment. Keynes pointed out that confidence plays an important role in promoting economic activities. Confidence makes people more active and changes future results. Bernanke and others believe that economic entities are very sensitive to the uncertainty of the future economy, and this uncertainty is one of the potential factors that form the depth and persistence of economic crises. Therefore, monetary policy often does not promote the real economy. If monetary policy fails to restore confidence in economic entities in a timely manner, economic recovery will take longer. The most realistic basis for this theory is the 2008 financial crisis in the United States. First, the public’s overly optimistic sentiment has prompted banks to issue a large number of subprime loans, and to package and sell the funds back from circulation in the form of asset securitization. Because investors generally have expectations for high yields and the structure of asset securitization products is complex, investors purchase subprime mortgage derivatives without

careful review. However, when the bubble disappeared, investors' excessive optimism dissipated instantly, which quickly caused panic in the market. Because the price of subprime mortgage derivatives plummeted, investors had to sell other products to ensure the liquidity of their own assets, which intensified investor panic. Asset prices continued to decline and asset liquidity was also restricted. In order to get rid of the financial crisis as soon as possible, the Fed has repeatedly emphasized the importance of boosting confidence. From the 2008 US subprime mortgage crisis, it can be found that changes in public sentiment will have a significant impact on the macro real economy, and confidence is also included in emotional factors. Therefore, it is of great significance to incorporate the factor of confidence into the monetary policy transmission mechanism and to examine the impact of monetary policy on the macro economy.

Based on the above research significance, this thesis uses the Eurozone data from 2000 to 2019 to study the role of business confidence in the monetary transfer mechanism by constructing a structural vector autoregressive model (SVAR) and a time-varying parameter vector autoregressive model (TVP-VAR). The three hypotheses of this thesis are:

Hypothesis 1: Business confidence will affect the effectiveness of monetary policy.

Hypothesis 2: The role of confidence in the transmission of monetary policy is mainly manifested as a short-term impact, which gradually weakens in the long-term

Hypothesis 3: At different stages of economic development, the business confidence index has different effects on the transmission of monetary policy. In times of economic crisis, the role of confidence will be more sensitive.

Compared with the existing literature, this thesis mainly has the following three contributions: First of all, business confidence plays an important role in the healthy development of the economy. Previous studies have largely ignored the relationship between business confidence and monetary policy. This thesis makes up for the lack of relevant research in this regard. Secondly, the research content of this thesis is more specific. The TVP-VAR model is used to study the influence of business confidence on monetary transmission at different lead times and at different points in time, which is of great significance to the formulation of monetary policy in different periods. Finally, this thesis also adopts counterfactual historical decomposition method, which is conducive to policy makers to intuitively see the effect of business confidence on the economy, which provides a basis for policy makers to formulate both robust and forward guidance monetary policy.

Of course, due to capacity limitations, this thesis also has many shortcomings. The most important point is that since confidence is a psychological variable, modeling is relatively difficult, so this thesis does not establish a theoretical model of monetary policy confidence channels. It can only be explained by the structural setting of structural vector autoregressive and the design of econometric models.

This thesis consists of 7 chapters, of which the first chapter is the introduction, which mainly introduces the background and significance of the research, analyzes the innovations and shortcomings of this thesis. Chapter 2 is a literature review, which respectively introduces the research dynamics of confidence, monetary policy transmission and VAR model. Chapter 3 makes a theoretical analysis of the monetary policy transmission mechanism. Chapter 4 discuss whether business confidence will play a role in the transmission of monetary policy, and analyzes the mechanism of how confidence channels affect investment. Chapter 5 is the construction of the empirical model. This thesis constructs SVAR model and TVP-VAR model respectively to explore the influence of business confidence on the transmission mechanism of monetary policy in different periods. Chapter 6 is empirical analysis. Chapter 7 is the conclusion.

2 Literature review

2.1 Research on confidence

Confidence indicators reflect the subjective perception and judgment of individuals on the operation of the macro-economy. There is a long-term controversy in the academic circle about whether subjective judgments can be self-realized and then truly affect the operation of the macro economy. In the book "General Theory of Employment, Interest and Currency", Keynes specifically elaborated that consumers or investors may make irrational consumption or investment decisions under the influence of impulsive emotions, thereby affecting the operation of the real economy. Subsequently, economists began to study the impact of public sentiment factors such as confidence and expectations on economic growth. With the development of Lucas' rational expectations theory in the 1970s, the research on whether confidence can affect investment and macroeconomic operations has become more extensive and in-depth. Although the theory of rational expectations has been widely used, the theory of rational expectations completely ignores the influence of emotions and other subjective factors on economic operations, which makes it impossible to reasonably explain the various phenomena in actual economic operations. Therefore, from the perspective of the development of expectations theory, on the one hand, it is based on rational expectations theory to reasonably construct an economic operation structure with microeconomic foundations. On the other hand, factors such as personal psychology and emotion are included to enable economic models to more truly reflect the formation of public expectations and actual economic operations.

The article published by Carroll et al. (1994) in American Economic Review is an earlier representative study in this field of confidence. The author observes that there is a strong correlation between the US consumer confidence index and consumption growth, and found that the lag term of consumer confidence can explain 14% of future consumption growth fluctuations. However, under the traditional permanent income hypothesis, the impact of changes in consumer expectations on income fluctuations should be achieved in one step. In order to explore possible reasons, the author adopted the Campbell-Mankiw model, assuming that some consumers in the

economy do not follow the permanent income hypothesis, but simply spend all of the current income. Under this setting, the lagged confidence term can affect the changes in consumption growth rate by predicting future changes in income. However, the empirical results reject the conclusion that the lagged confidence term affects consumption only by affecting income. In other words, confidence indicators can directly affect changes in consumption through certain channels.

At present, scholars' views on the mechanism of confidence can be divided into two factions: "Animal spirit" and "News approach" (Barsky & Sims, 2012). "Animal spirit" is an instinctive and emotional thing that can spontaneously influence investor behavior. When the economy continues to heat up, the "animal spirit" plays a positive guiding role. People believe that the economy will continue to improve and profits will continue to increase. This mental state can sometimes even become blind and overheated, resulting in a bubble of psychology power. When the economy is in recession, the rapid changes in the "animal spirit" will make the economy face unstable. It is the spontaneous and instinctive factor of the "animal spirit" that affects the cyclical fluctuations of the economy. The view of the "animal spirit" is the earliest Proposed by Pigou (1927) and Keynes (1936). This view holds that people's spontaneous optimism and pessimism may be divorced from the fundamentals, thereby expanding the impact of the business cycle. Some scholars incorporate mood fluctuations into theoretical models to explain the causes of the business cycle. Azariadis (1981) explained through a theoretical model that even under the framework of rational expectations, if consumers believe that a certain form of confidence index can predict the future direction of the economy，and update his expectations based on the index he observed, then his actions are likely to cause economic fluctuations. Similarly, Farmer & Guo (1995) controlled the supply and demand shocks of the general equilibrium model framework, but there are still economic fluctuations, which shows that the self-realization of animal spirits will affect the formation of the business cycle. Hurtgen (2014) constructed a DSGE model, confirming that when an economy has the characteristics of high price stickiness and low inflation, about 14% of output fluctuations and 25% of consumption fluctuations can be explained by consumers' “animal spirit” fluctuations. Chen Yanbin & Tang Shilei (2009) confirmed that entrepreneur confidence is the Granger cause of economic growth and inflation, while consumer confidence does not have the

corresponding influence. The results of the article show that high animal spirits will push up economic growth and accelerate inflation, but it has no significant impact on the performance of the stock market. The conclusion that entrepreneur confidence can affect inflation is also supported by other documents (Pan Jiancheng & Tang Shilei, 2010).

The "news delivery" view believes that consumer confidence is not pure animal spirit, which contains useful information about the current and future economic conditions. This view believes that confidence is an expectation of economic development made by market entities based on the information they have. Confidence can reflect information related to future economic development to a certain extent, but it is not an independent variable that affects economic operation. This is mainly because changes in economic fundamentals cause fluctuations in economic operation, which in turn impacts confidence (Beaudry & Porttier, 2006; Jaimovich & Rebelo, 2009). Fluctuations in consumer confidence reflect changes in fundamentals, and rational economic participants refer to this information when making decisions. Therefore, fluctuations in confidence will have a lasting impact on the real economy. Studies have shown that although consumers can learn new information on the market, due to the existence of "friction" in the information transmission process, the new information cannot be fully reflected immediately (Mankiw, 1982; Carroll et al. 1994; Mankiw & Reis, 2002; Carroll, 2003). Therefore, confidence may contain some new information captured by consumers but not fully reflected in the market. Barsky & Sims (2012) extended the new Keynesian model in order to identify the relative magnitude of the effects of "news delivery" and "animal spirit" channels. They assume that the confidence index contains both certain information (news delivery) that has predictive power for future fundamentals but not yet recognized by public channels, as well as the general mood swings of market participants (animal spirits). Barsky & Sims calibrated the theoretical model with real data and found that although news spirit, animal spirit, and white noise are all reflected in confidence, the volatility relationship between confidence and macroeconomics can almost all be attributed to news factors. Their research shows that changes in consumer confidence have a lasting impact on economic activity, and this change should be interpreted as an increase in productivity rather than an increase in supply. Dees (2007) studied the impact of confidence shocks on economic operations from an international

perspective. His research on the United States, Germany, France, the European Union and other countries and regions shows that confidence shocks have a continuous and significant impact on consumption and GDP. Shocks are an independent factor or channel that affects economic fluctuations, and the transmission of confidence shocks between countries is also very significant. Other scholars use theoretical models as tools to discuss how confidence affects investor market participation. Wu Weixing & Fu Xiaomin (2010) analyzed the mechanism of confidence from the perspective of investor uncertainty. By solving the optimal investment decision of investors, the article points out that the increase in the feeling of uncertainty or the increase in the level of market uncertainty will lead to limited investor participation, prompt risk-averse investors to stay away from the market, and may also harm the overall social welfare.

Finally, some scholars analyze the linkage between confidence and the effectiveness of economic policies. Geng Peng (2013) paid attention to the relationship between confidence and policy effectiveness in his doctoral dissertation, and discussed in detail the mechanism and principles of public confidence on macroeconomic operations. He pointed out that entrepreneur confidence is the Granger cause of macroeconomic fluctuations, and the fluctuations have time-varying characteristics, which can push up economic growth during periods of prosperity, but will further aggravate the crisis during periods of recession. At the same time, through the DSGE model, the author explained that the optimism of investors contributes to economic prosperity and employment growth, but at the same time it also pushes up inflation, which is not conducive to the stable development of the macro economy. Then, the article further explains that the government's countercyclical policies usually do not achieve the desired results. However, when the market is full of pessimism during the crisis, if the government can decisively intervene and stabilize the confidence of market entities, it can greatly reduce the downward pressure on the macro economy. In addition, De Bondt (2015) uses the economic sentiment indicator issued by the European Commission as a proxy variable for borrowers' confidence. The EU Economic Sentiment Index survey covers many types of borrowers, including consumers, as well as entrepreneurs from manufacturing, construction and service industries. The results show that borrower confidence has a significant impact on the effect of monetary policy. In particular, the confidence index has a much greater

impact on investment and industrial added value than it has on consumption and services. Bachmann & Sims (2012) focuses on the role of confidence in the transmission of fiscal policy. The empirical results show that the role of confidence is also slow and long-lasting. During the normal economic operation period, it is not observed that the confidence channel has a significant impact on the fiscal multiplier. However, during the crisis, if the confidence transmission channel is removed, the fiscal multiplier will be greatly reduced. Li Yongyou (2012) also pays attention to the influence of confidence on the effectiveness of fiscal policy. In his article, he constructed a structural vector autoregressive model to test the influence of confidence on the fiscal multiplier by "closing" the confidence response of market entities. The empirical results show that in the linear autoregressive model, confidence does not have a significant effect on the fiscal multiplier. However, after adopting the nonlinear autoregressive model, if the confidence response is turned off, it will greatly affect the fiscal expenditure multiplier and the tax multiplier, that is, the expansion effect of fiscal policy will be weakened. The author believes that in the case of economic crisis, if the government's measures can effectively stabilize the confidence of market entities, the expansion effect of fiscal expenditure will be amplified and the inhibitory effect of tax increases will be reduced.

2.2 Research on the transmission mechanism of monetary policy

The literature on the influence of monetary policy on economic growth is relatively abundant. Summarizing the existing literature, the main transmission channels of monetary policy include interest rate channels, credit channels, exchange rate channels, and asset price channels. The interest rate channel is an important part of the traditional Keynesian IS-LM model. The central bank affects long-term interest rates by adjusting short-term interest rates. Changes in long-term interest rates affect corporate financing costs and ultimately corporate investment. In the practice of China’s monetary policy, some scholars’ studies have shown that there is an interest rate channel for China’s monetary policy transmission. Money market interest rates can explain the fluctuations in output and prices in the economy, and the central bank

can adjust output and inflation according to the interest rate gap (Qian Xuesong et al., 2015).

At the same time, bank credit volume and credit interest rates are affected by factors such as credit term structure, credit scale, bank scale, and risk distribution during the transmission process, and there is a time-varying effect (Ding Hua & Ding Ning, 2018). In addition, due to the influence of factors such as competition in the deposit and loan market, the process of monetary policy credit transmission is asymmetric (Liu Zhonglu, 2017). Both the price-based monetary policy and the quantitative-based monetary policy have time-varying effects on output and inflation during the implementation process. The central bank should promptly adjust the control model based on policy feedback (Liu Jinquan & Xie Yaoshu, 2016).

Ma Li et al. (2016) studied the transmission mechanism of monetary policy based on adaptive expectations, and the study showed that monetary policy represented by the RRR will impact the money supply curve. In this process, the central bank can change the expectations of market participants and guide market changes. Therefore, expectations may also be one of the transmission channels of monetary policy (Mishkin, 2011). Wordford (2005) constructed a new Keynesian model, and the results showed that under the constraint of zero interest rate lower bound, the effectiveness of monetary policy is affected by inflation expectations, and the higher the inflation expectations, the lower the social loss during a crisis. Furthermore, Wordford puts forward anticipation management and emphasizes that the anticipation management process is a game between the government and the public. The public forms expectations from the implementation of policies, and policy makers adjust policies according to public expectations. Therefore, the goal of anticipation management is to maintain the stability of public expectations (Ma Wentao, 2014). Chen Hong et al. (2016) defined the difference between the economic upturn and the economic downturn. It is assumed that investors make investment or non-investment decisions based on their confidence in the future macroeconomic situation, thereby obtaining an investment formula that includes confidence. This formula shows that the general investor's confidence in the future macroeconomic changes is negatively correlated with investment. When investor confidence is insufficient, investment will be delayed, which will eventually reduce investment even more. Ilut &Saijo (2016)

established a heterogeneous enterprise model. The research results show that the uncertainty in the economy will reduce the confidence of entrepreneurs and inhibit economic growth, while the implementation of monetary and fiscal policies can improve economic development.

2.3 Research on the transmission mechanism of monetary policy based on VAR model

1. Related research based on vector autoregression (VAR) model

At present, the VAR method is widely used in empirical analysis due to its simple method, simple and convenient operation and other advantages. Scholars have made rich research results on the transmission mechanism of monetary policy based on the VAR model. Van Hai (2015) focused on analyzing the dynamic response of economic dynamics to currency demand, interest rate, exchange rate and asset price shocks, and constructed a VAR model to analyze how Vietnam's monetary policy affects the real economy through various channels. The results show that two factors, money demand and interest rates, have caused changes in actual output. Qian Kun (2013) stated in his paper that the credit transmission channel of monetary policy is the most effective monetary policy channel in China, and the transmission mechanisms such as interest rates, exchange rates, and asset prices are all impeded.

2. Research based on structure vector autoregression (SVAR) model

The SVAR model is widely used in the field of economics. For example, Gambetti (1999) used the SVAR model to analyze the effect of monetary policy in the real economy. They believe that the implementation of a tight monetary policy will greatly hinder the growth of real GDP. Karame (2002) mainly studies how monetary policy changes affect the macroeconomic activities of the United States. They believe that the tightening of the money supply will lead to an asymmetric response to output, prices and currencies, and they propose to extend the SVAR model to a non-linear framework. Mountford (2005) used the Uhlig (2005) symbol recognition method to study the effects of British monetary policy using the SVAR model and found that changes in monetary policy had a small impact on the British macro economy. In addition, the SVAR model can also be used to study economic asymmetry shocks, which provides a basis for regional economic cooperation. Blanchard & Quah (1989) established a two-variable SVAR model. They added long-term constraint identification conditions for the first time to test the impact of real demand shocks and real supply shocks on the real output growth rate and unemployment rate in the

United States. After that, Bayoumi & Eichengreen (1992) studied the correlation and adjustment speed of economic shocks in 11 EU countries, and compared them with the regional economic shocks in the United States. They found that EU countries have a higher degree of asymmetry in economic shocks than in the United States, and the speed of adjustment to economic shocks is slower. Marinas (2012) found that the actual demand shock correlation in the euro area is weak, or even negatively correlated, while the actual supply shock correlation is relatively strong.

The SVAR model is also used in research on confidence and investor sentiment. Xu Xin & Chen Yiqing (2012) used the ARMA model to eliminate abnormal fluctuations in the consumer confidence index caused by irregularities, and used the CensusX12 seasonal adjustment method to eliminate irregular factors in the macroeconomic prosperity index. They built an SVAR model on this basis and analyzed the short-term and long-term relationship between consumer confidence and the macro economy. The results show that consumer confidence cannot be transformed into physical consumption and thus affect the operation of the economy, but the macro economy can have an impact on confidence. Bakhmann & Sims (2012) constructed the SVAR model to explore confidence in fiscal policy. The conclusion is that during economic depression and when the fiscal multiplier is greater than 1, increasing government purchases can increase confidence and stimulate economic growth. Xiong Xiaolian & Zhang Heng (2020) used monthly data from January 2010 to December 2019 as a sample, and used economic policy uncertainty, investor sentiment and soybean futures prices to establish an SVAR model for empirical analysis. The empirical results show that economic policy uncertainty has a significant negative effect on investor sentiment and soybean futures prices, and investor sentiment has a positive effect on soybean futures prices.

3. Research based on time-varying parameter vector autoregression (TVP-VAR) model

In order to show that the change of the economic system is a gradual and continuous process, it is generally necessary to describe the economic behavior equation with a state space model. On the one hand, it is necessary to introduce the constant coefficient VAR parameter to be estimated into the drift term and express it in the form of a state-space model to reflect the time-varying characteristics of the linear structure. On the other hand, the introduction of time-varying characteristics into the variance-covariance matrix also reflects the heteroscedasticity of exogenous shocks.

The VAR model with drift coefficients proposed by Canova (1993) and the multivariate stochastic volatility model proposed by Kim et al. (1998) relax the

constraints of the model from the perspective of time-varying coefficients and time-varying covariances. Based on this research, Cogley & Sargent (2005) studied the VAR model with drift coefficient and time-varying variance based on the assumption that the correlation between variables in the same period is constant. Primiceri (2005) is further extended to a fully nonlinear time-varying parameter model in which coefficients, variances and covariances all change over time.

In the application of the TVP-VAR model, D'Agostino et al. (2011) used US macroeconomic data to prove that the TVP-VAR model has a stronger predictive effect than other VAR models. Nakajima (2011) used Kim et al. (1998) mixed sampling to determine the posterior distribution method to improve the maximum likelihood estimation process of the TVP-VAR model proposed by Primieri (2005). Baumeister & Peersman (2012) studied the influencing factors of oil price volatility through the sign-constrained TVP-VAR model, and found that the impact of oil demand shocks on oil prices is greater than the impact of oil supply shocks on oil prices. Baumeister & Peersman (2012) used this method to further study the price elasticity of oil supply and the price elasticity of oil demand.

The TVP-VAR model has also been widely used in research on monetary policy. Zhou Xianping (2013) used the TVP-VAR model to study the feasibility of the scale of social financing as an intermediate target of monetary policy. He found that the transmission effect of monetary policy has very significant time-varying characteristics, and the scale of social financing is not suitable for currency in all periods Intermediate goals of the policy. Zhou Xianping (2013) used this model to study the time-varying characteristics of the transfer effect of exchange rate changes. The empirical results show that RMB-denominated settlement can alleviate the impact of exchange rate changes on prices, exports and output to a certain extent. It is feasible to implement a more flexible exchange rate system in the context of RMB-denominated settlement. Liu Xiaojun et al. (2019) constructed a TVP-VAR model that includes entrepreneur confidence, consumer confidence, monetary policy, economic growth rate, and inflation rate. They analyzed the time-varying characteristics of the impulse response of the economic growth rate and the inflation rate, and found that the adjustment of monetary policy will affect the public's expectations for the future, thereby affecting consumption and investment, and then affecting China's economic fluctuations. Franta (2011) studied Japan's monetary policy transmission in the past 30 years by adding sign constraints to the generalized impulse response function of the TVP-VAR model to constrain the lower bound of the interest rate. Baumeister & Benati (2010) used the spread shock constructed by the symbol-constrained TVP-VAR model to study the effect of the policy of reducing

the spread of long-term and short-term government bond yields from 2007 to 2009. Mumtaz & Sunder-Plassmann (2013) used the TVP-VAR model to study the evolution path of the real exchange rate in the United Kingdom, the Eurozone, and Canada. The results showed that the nominal interest rate shock and aggregate demand shock after 1985 played a significant role in exchange rate changes. Gerba & Hauzenberger (2013) also used the sign-constrained TVP-VAR model to study the interrelationship between fiscal policy and monetary policy in the United States in different periods. Matějů (2013) used the sign-constrained Bayesian TVP-VAR model to study the monetary policy transmission mechanism from the cross-sectional dimension and time dimension based on short-term nominal interest rates and price levels. The results show that the transmission effect of monetary policy in both developed and developing countries has been in the past. In the past few decades, there has been a gradual increase trend.

3 Monetary policy transmission mechanism theoretical analysis

3.1 The interest rate transmission channel of monetary policy

The interest rate transmission mechanism is the core of Keynesianism. The theory believes that the interest rate plays a decisive role in the transmission mechanism of monetary policy. The conduction pathway can be expressed as: Monetary policy tool → r (interest rate) ↓ → I (investment) ↑ → Y (total demand) ↑.

3.2 The credit transmission channels for monetary policy

1. Bank lending channels

Commercial banks act as intermediaries in the financial market, which allows the existence of bank loan channels. Commercial banks can provide indirect financing for large enterprises. More importantly, although small and medium-sized enterprises have limited direct financing in the financial market, commercial banks can also provide loans for them. The conduction pathway can be expressed as: Monetary policy tool → bank deposit ↑ → bank loan ↑ → I (investment) ↑ → Y (total demand) ↑. Therefore, companies with different development levels have different responses to monetary policy. For small companies that rely on bank loans, the effect of this channel is more obvious.

2. Balance sheet channel

For a borrowing company, if its equity is lower, moral hazard is more likely to occur. Low net assets means that the lender has only a small amount of collateral. At this time, the bank will reduce the amount of loans to it according to the actual situation to ensure its own profitability, which will eventually lead to a decrease in investment. Similarly, lower net assets will also increase moral hazard, because lower net assets will encourage companies to invest in riskier projects in order to obtain more profits. On the contrary, when the company's equity is larger, it will promote economic development. The conduction pathway can be expressed as: Monetary policy tool

→ PS (stock price) ↑ → net value ↑ → loan ↑ → I (investment) ↑ → Y (total demand) ↑.

3.3 The exchange rate transmission channels for monetary policy

The government influences exchange rate movements by formulating and implementing exchange rate policies, and through exchange rate changes and their interaction with other economic variables, to achieve policy goals. The conduction pathway can be expressed as: Monetary policy tool → EX (exchange rate) ↓ → net export ↑ → Y (total demand) ↑.

3.4 The asset price transmission channel of monetary policy

Another view of monetarism believes that the impact of monetary policy on the macro economy should not only consider the price of one asset, but the prices of multiple assets. The following two monetary policy channels have emerged accordingly: one is Tobin's Q-value theory, and the other is wealth effect channels.

1. Tobin's Q value theory

"Q" is the ratio of the market value of the enterprise to the replacement value of the capital. If the Q value is high, it indicates that the company has superior financing conditions, and the company can issue stocks to raise funds, and then invest in higher-value assets. If the Q value is very low, the situation is just the opposite. When people have more money in their hands, they will look for ways to consume, and investing in the stock market has become a common choice for people. The conduction pathway can be expressed as: Monetary policy tool → r (interest rate) ↓ → PS (stock price) ↑ → q↑ → I (investment) ↑ → Y (total demand) ↑.

2. Wealth effect channels

The premise of the wealth effect channel theory is Friedman's permanent income hypothesis. The consumption level of an individual is determined by his lifetime wealth, which mainly includes human wealth, physical wealth and financial wealth. The most important part of financial wealth is the value of stocks. When stock prices show an upward trend, the total wealth that people have gradually increases, thereby stimulating consumption. The conduction pathway can be expressed as: Monetary

policy tool → r (interest rate) ↓ → PS (share price) ↑ → wealth ↑ → consumption ↑ → Y (total demand) ↑ .

4 Monetary Policy Transmission Confidence Channel

4.1 Discussion about the existence of confidence channel

This thesis believes that the confidence channel of the monetary transmission mechanism refers to the central bank's expected management of confidence through monetary policy, which will affect the confidence level to a certain extent and increase the effectiveness of monetary policy. For example, monetary policy is used to increase the level of business confidence and improve investors' expectations of future economic conditions, thereby increasing the level of investment and ultimately promoting economic development.

I would like to begin by discussing whether the level of business confidence affects the effectiveness of monetary policy using Chinese economic data. When China faced the impact of the global financial tsunami in 2008, decision-makers repeatedly emphasized the important role of confidence and worked hard to increase business confidence. In terms of actual data, although entrepreneur confidence dropped 50% during the financial crisis, however, under the coordination of expansionary fiscal and monetary policies, the economic level recovered rapidly after only two quarters of operation at a low level, and by the fourth quarter of 2009, it had basically returned to the pre-crisis level. At the same time, real GDP output also rebounded rapidly. In the context of the global economic depression, China took the lead in achieving economic recovery. In 2014, China's macro economy faced many challenges. On the one hand, the effects of the stimulus policies implemented since 2008 in response to the financial crisis have basically disappeared, and problems such as overcapacity and structural imbalance have become more apparent. On the other hand, insufficient external demand, weak domestic demand, long-term low inflation, and high financing costs have caused business difficulties. The entrepreneur questionnaire released by the People's Bank of China showed that the business climate index fell from 55.4 points in the second quarter of 2014 to 49.4 points in the third quarter of 2015[1]. In the fourth quarter of 2015, the confidence index dropped directly below 50%, a record

[1] Economic data for China are from the CEIC database.

low of 46 points. The GDP growth rate has also fallen to its lowest level in the past six years. In the first quarter of 2009, when the global financial crisis was the most serious, the business climate index was still 55.1 points, indicating that business operations are facing unprecedented difficulties. At the same time, although the monetary policy has been fine-tuned many times, the capital turnover of enterprises is still very tight, and the corporate capital turnover index in the third quarter of 2015 was also at the lowest value in history. In order to reduce financing costs and prevent economic stalls, the People's Bank of China has cut interest rates six times in a row since November 22, 2014, and cooperated with other monetary policy tools to release liquidity and guide market interest rates to decline. Eventually since the third quarter of 2016, confidence has rebounded, and the GDP growth rate has also risen. In addition, one study found that if the monetary policy implemented by the Chinese central bank fails to influence the level of entrepreneurial confidence, the level of output declines significantly (Sun, Y.C., 2016). Through the analysis of China's economic data, this thesis argues that business confidence does play a role in the process of monetary policy transmission. Therefore, it is of great significance to study whether confidence has any effect on the transmission of monetary policy, whether measures need to be taken to stabilize confidence, and how monetary policy should stabilize confidence.

The above is that the central bank affects confidence through conventional monetary policy, thereby affecting economic development. This is also the main issue discussed in this thesis. But in fact, the central bank can also formulate many unconventional monetary policies to affect confidence. The central bank uses unconventional monetary policies to manage public confidence expectations. The most prominent example is the implementation of forward guidance policy. Forward guidance is not a completely new concept, but one of the tools that the central bank uses to communicate with the public to achieve market expectations management. For example, qualitative information guidance for future policy path expectations or clear time points for future policy changes are an unconventional monetary policy implemented after the failure of conventional monetary policy under the negative interest rate policy. Countries such as the Eurozone, Canada, the United Kingdom, and Norway have all implemented forward guidance policies after the financial crisis, and focused on forward guidance on economic conditions, using economic status indicators such as unemployment rate and inflation to introduce additional conditions for financial stability. From the perspective of policy effects, forward guidance has achieved a certain effect, to a certain extent, has affected the public's expectations of the future policy interest rate path, and has a certain effect on reducing long-term interest rates. As one of the unconventional monetary policies, forward guidance

policies are mainly transmitted by sending signals to the public. Therefore, the independence of the central bank, the credibility and transparency of monetary policy, the market and public expectations determine the effectiveness of this channel (Hayo & Neuenkirch, 2014). On the one hand, the accuracy of information will affect the effectiveness of forward guidance. More information from the central bank may squeeze out private information, thereby causing the forecast to deviate from accuracy. Misunderstanding of the accuracy of central bank information by private entities can also have the opposite policy effect (Kool et al., 2011). On the other hand, a less credible monetary policy will also affect the play of forward guidance. The public's trust in the central bank, the timing of central bank information release, and the central bank's transparency all determine the credibility of monetary policy, thereby affecting the policy effect of forward guidance (Campbell, 2013). This thesis believes that the central bank's forward guidance policy to signal the public will also have an impact on confidence, thereby affecting the effectiveness of monetary policy. Therefore, this article believes that there is likely to be a channel of confidence for monetary policy transmission.

4.2 Confidence and investment theory model assumptions

If there are confidence channels for the transmission of monetary policy, it is very important whether the central bank's loose monetary policy can effectively increase the level of business confidence. When the level of business confidence is low, can the central bank lower interest rates effectively increase investment and promote economic growth? As there is no universally recognized confidence model, it is inspired by the research ideas of Dixit and others. This thesis uses a simplified confidence and investment theoretical model to analyze whether confidence will affect investment from the perspective of investors, so as to test the impact of confidence on the macro economy.

1. Assuming that the number of investors in society is m, every investor is faced with the opportunity to invest in a project. Then the cost of the project investment undertaken by the i-th investor is c_i, and the discrete random variable c_i obeys a uniform distribution with a probability of 1/m.

2. Suppose there are three investment periods, namely 0, 1, and 2. In the 0th period, investors are faced with a decision whether or not to invest. If it is invested, the return on the investment project Y is realized in the first and second periods, but the size of Y is uncertain, in other words, Y is a random variable. Let us assume that there are

two possibilities for Y, either upward or downward, and the amplitude of the upward and downward directions is uncertain, so that we can analyze how the degree of confidence affects the magnitude of the key variable Y. Assume that the probability of $Y = Y^h$ is q; the probability of $Y = Y^l$ is 1-q. Let $d = Y^h - Y^l$ be the difference between the economic upturn and the economic downturn.

3. Assuming that the investment is irrevocable. Investors can make investment decisions in period 0 and period 1. When investors make investment decisions in period 0, investors cannot withdraw their investment decisions and can only wait for the investment results. If the investor chooses to wait and see in the 0th period, since the investor can observe the result of Y in the first period, the investor can still make a decision whether to invest in the first period.

4. Assuming that the capital resale price is less than Y, the assumption is that the investment will not terminate in the first period.

5. On the basis of assumption 2, we make an investment income assumption. Since Y is a random variable, investing in Y may make a loss or make a profit. It may be assumed that when the return on investment is the lowest, investors lose money, which can be expressed by the formula:

$$\frac{Y^l}{1+R_f} + \frac{Y^l}{(1+R_f)^2} - C_i < 0 \tag{4.1}$$

Formula (4.1) shows that the net present value of the lowest return on investment is negative, which is the risk-free interest rate, that is, if you don't invest in the project, you can at least get the rate of return of R_f. In the same way, it can also be assumed that the highest return obtained when the investment is positive, and that the result should be realized in the first period, so that investors can make investment decisions in the first period, expressed by the formula (4.2) as:

$$\frac{Y^h}{1+R_f} - C_i > 0 \tag{4.2}$$

4.3 Analysis of Confidence and Investment Theory Model

Investor i can make a decision to invest or not to invest in the 0th period according to his or her confidence in the future macroeconomic situation, and can calculate the net present value of the investment or non-investment in the 0th period based on assumptions, which are recorded as $NPV_{i,0}^1$ and $NPV_{i,0}^0$. Since it is assumed that the investment is irrevocable, once an investment decision is made in the 0th period,

the net present value should be equal to the discounted value of the investment's expected return, see formula (4.3).

$$NPV_{i,0}^{1} = \frac{E(Y)}{1+R_f} + \frac{E(Y)}{(1+R_f)^2} - C_i \tag{4.3}$$

Once the investor chooses to wait and see in the 0th period, the investor can continue to make the decision whether to invest in the 1st period according to the results of the investment return in the first period. If the observation result of the first period is $\mathrm{Y} = Y^h$, then the investor chooses to invest in the first period. Since the investor has not invested in the 0th period, C_i has a value-added $R_f * C_i$. If the observation result of the first period is $\mathrm{Y} = Y^l$, investors will still choose not to invest in the first period. At this time, the discount value of the investment cost C_i of the 0th period is $(1-q) * C_i$. The discounted present value consists of two parts, that is, the sum of the net present value of the first period of investment discounted to period 0 and the sum of the net present value of the first period of non-investment discounted to period 0, see formula (4.4).

$$NPV_{i,0}^{0} = (1-q) * C_i + q * \frac{(Y^h + R_f * C_i)}{(1+R_f)^2} \tag{4.4}$$

Obviously, only when $NPV_{i,0}^{1} > NPV_{i,0}^{0}$, investors will make investment decisions in period 0. Let formula (4.3) be equal to formula (4.4), the fixed investment cost $\bar{C}$ can be calculated, see formula (4.5). Substituting formula (4.5) into formula (4.6) yields formula (4.7). The formula (4.7) shows that when investor i's investment cost C_i in period 0 is less than the fixed investment cost $\bar{C}$, investor i will make an investment decision in period 0.

$$\bar{C} = \frac{E(Y)(1+R_f) + E(Y) - q * Y^h}{(1-q)(1+R_f)^2 + R_f * q} \tag{4.5}$$

$$\mathrm{E(Y)} = \mathrm{q} * Y^h + (1-q) * Y^l \tag{4.6}$$

$$\bar{C} = \frac{E(Y)(1+R_f) + (1-q) * Y^l}{(1-q)(1+R_f)^2 + R_f * q} \tag{4.7}$$

The total social investment is the sum of the investments of many individual investors. According to assumption 1, the model obeys a discrete uniform distribution. Let I_0 be the total social investment scale of period 0. Then I_0 should be equal to the sum of investment of all investors whose investment cost is less than the fixed cost among the total m investors in the society, see formula (4.8). From the assumption 2, $\mathrm{d} = Y^h - Y^l$. We obtain the partial derivative of formula (4.8) with respect to d, and

obtain formula (4.9), which is the general formula of confidence and investment model.

$$I_0 = \frac{1}{2} + \frac{(\bar{C} - E(C))}{m} \tag{4.8}$$

$$\frac{\partial I_0}{\partial d} | E(Y) = \frac{-(1-q)*q^l}{(1-q)(1+R_f)^2 + R_f * q} \tag{4.9}$$

The general formula of the confidence and investment model shows that the degree of change in the general investor's confidence in the future macroeconomic is negatively correlated with investment, and the uncertainty of the future economy leads to low investment. The meaning conveyed by the general formula of confidence and investment model is that when there is insufficient confidence, it will bring about the effect of delay in decision-making. The delay effect can also be seen from the formula (4.7). When the confidence in the future is less, Y^l will decrease, so that investors are more likely to postpone investment decisions and reduce investment more.

5 Empirical Model Construction

5.1 SVAR model construction

Before the 1980s, the traditional simultaneous equation model was popular for a while, especially in the field of macroeconomics. However, the realization of these structural models often requires the addition of many incredible constraints. Therefore, as a solution, the VAR model is proposed. However, the simple VAR model cannot reveal the current effects between variables, so economists re-included the structure into the VAR model to form the SVAR model. Therefore, in order to study the effect of the same period between variables, we construct a standard four-variable SVAR model as the benchmark model (Bachmann & Sims, 2012):

$$AY_t = \sum_{i=1}^{s} F_i Y_{t-i} + \mu_t \tag{5.1}$$

Among them, s represents the lag order, and μ_t is a 4 × 1 shock term matrix. $A\ and\ F_j$ are the coefficient matrix. Y_t represents a matrix of four variables, namely the proxy variable of monetary transmission mechanism money market interest rate r_t, the business confidence index $Busi_t$, Consumer price index cpi_t and the growth rate of GDP gdp_t . The subscript t indicates the period of the variable. More specifically, the model can be written as follows:

$$\begin{pmatrix} 1 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 \\ a_{41} & a_{42} & a_{43} & 1 \end{pmatrix} \begin{pmatrix} r_t \\ Busi_t \\ cpi_t \\ gdp_t \end{pmatrix} = \sum_{j=1}^{s} F_j \begin{pmatrix} r_{t-i} \\ Busi_{t-i} \\ cpi_{t-i} \\ gdp_{t-i} \end{pmatrix} + \begin{pmatrix} \mu_{1,t} \\ \mu_{2,t} \\ \mu_{3,t} \\ \mu_{4,t} \end{pmatrix} \tag{5.2}$$

a_{21} represents the coefficient in the second row and first column of the matrix, and the others are similar. Left multiply both sides of formula (5.2) by A^{-1}, and convert the SVAR(s) model to a VAR(s) model form:

$$Y_t = A^{-1} \sum_{i=1}^{s} F_i Y_{t-i} + A^{-1} \mu_t \tag{5.3}$$

Then, further transform the VAR (p) model into a VAR (1) model:

$$Z_t = \Lambda Z_{t-1} + u_t \tag{5.4}$$

among them:

$$Z_t = \begin{pmatrix} Y_t \\ Y_{t-1} \\ \vdots \\ Y_{t-(S-1)} \end{pmatrix}, \quad \wedge = \begin{pmatrix} A^{-1}F_1 & A^{-1}F_2 & \dots & \dots & A^{-1}F_S \\ I & 0 & 0 & \dots & 0 \\ 0 & I & 0 & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & \dots & \dots & I & 0 \end{pmatrix}, \quad u_t = \begin{pmatrix} A^{-1}\mu_t \\ 0 \\ \vdots \\ 0 \end{pmatrix}$$

Then the impulse response function can be expressed as the following form:

$$Z_t = \wedge Z_{t-1} + u_t = \wedge(\wedge Z_{t-2} + u_{t-1}) + u_t = \cdots = \wedge^n Z_{t-n} + \sum_{i=0}^{n} \wedge^{n-i} u_{t-\mathrm{i}} \quad (5.5)$$

Therefore, in each period of h = 1, 2, ..., H, the impulse response of the SVAR system to ε_{t-i} is $\wedge^{h-i} u_{t-i}$. More specifically, when the variable q is impacted by one unit, the response of the variable i in each period of h = 1, 2, ..., H is:

$$\varphi_{i,q,h} = e_i \wedge^{h-1} A^{-1} f_q \quad (5.6)$$

Among them, e_i is a 1 × 4 row variable with the i-th value of 1, and the other is 0, f_q is a 4 × 1 column variable with the q-th value of 1, and the other is 0, used to select the desired value from the matrix. Given that the dimension of $\wedge^{h-1}$ is 4s × 4s, it is necessary to insert 4 × (s -1) row or column zero values into $A^{-1}f_q$ and e_i respectively to perform matrix multiplication.

5.2 TVP-VAR model construction

The SVAR model can measure the time series impact and current impact between variables at the same time. However, in real macroeconomic issues, we need to pay attention to many special time points. Based on such needs, we can use the time-varying parameter VAR (TVP-VAR) model (Nakajima, 2011). Moreover, in reality, many economic variables have the characteristics of random volatility, so we assume random volatility in the TVP-VAR model. Although the likelihood function becomes difficult to handle and makes the estimation of stochastic volatility difficult, the Markov chain Monte Carlo (MCMC) method can be used to estimate the model. The MCMC method can be traced back to the early 1950s. The method is based on the Bayesian formula through a computer simulation of the Monte Carlo method. This method introduces the Markov process into the Monte Carlo simulation, which makes the sampling distribution change as the simulation progresses. It is a dynamic simulation method, which makes up for the traditional Monte Carlo integration that can only be statically simulated.

We still establish a four-variable TVP-VAR model of proxy variables for monetary policy, business confidence index and GDP growth rate. When building a TVP-VAR model, the order of variables will affect the final empirical results. The order of variables may be a reason why the empirical results do not meet expectations. This

thesis puts the most concerned variable in the first place, so that it can be better displayed in the time-varying relationship diagram. Because this thesis mainly wants to study whether business confidence will respond when monetary policy changes, and whether it will affect monetary policy objectives (such as inflation rate, GDP growth rate). Therefore, according to the correlation of each variable, the order of the variables is adjusted to money market interest rates, business confidence index, CPI growth rate and GDP growth rate. According to Nakajima (2011), we set $Y_t = \{r_t, Busi_t, cpi_t, gdp_t\}$, k=4. According to the simplified VAR(s) model (5.3), assume that:

$$\mu_t \sim \mathrm{N}(0, \Sigma\Sigma), \Sigma = \begin{pmatrix} \sigma_1 & 0 & \dots & 0 \\ 0 & \ddots & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ 0 & \cdots & 0 & \sigma_k \end{pmatrix}$$

Rewrite the simplified VAR model as:

$$Y_t = \sum_{j=1}^{s} B_i Y_{t-i} + A^{-1}\Sigma\varepsilon_t \tag{5.7}$$

Among them, $B_i = A^{-1}F, i = 1, \cdots, \mathrm{s}, \varepsilon_t \sim N(0, I_k)$.

Then we write the elements of each row in the stacked matrix B as $k^2\mathrm{s} \times 1$ dimensional column vector β, and define $X_t = I_k \otimes (Y'_{t-1}, \cdots, Y'_{t-s})$, where ⊗ is the Kronecker product, so the model can be transformed into:

$$Y_t = X_t\beta + A^{-1}\Sigma\varepsilon_t \tag{5.8}$$

Then, let $a_t = (a_{21}, a_{31}, a_{32}, \dots, a_{k,k-1})'$ be the column vector formed by the accumulation of non-zero and 1 elements in the lower triangular matrix A_t, and let $h_t = (h_{1t}, \ \dots, \ h_{kt})'$, $h_{jt} = log\sigma_{jt}^2$, $j = 1, \dots, k$, $t = s + 1, \dots, n$.

$$\beta_{t+1} = \beta_t + \mu_{\beta t}$$

$$\alpha_{t+1} = \alpha_t + \mu_{\alpha t}$$

$$h_{t+1} = h_t + \mu_{ht}$$

$$\begin{pmatrix} \varepsilon_t \\ \mu_{\beta t} \\ \mu_{\alpha t} \\ \mu_{ht} \end{pmatrix} \sim N\left(0 \ , \ \begin{pmatrix} I & 0 & \cdots & 0 \\ 0 & \Sigma_\beta & \ddots & \vdots \\ \vdots & \ddots & \Sigma_\alpha & 0 \\ 0 & \cdots & \cdots & \Sigma_h \end{pmatrix} \right)$$

Where $\mathrm{t} = \mathrm{s} + 1, \cdots, \mathrm{n}, \beta_{s+1} \sim N(\mu_{\beta_0}, \Sigma_{\beta_0})$, $\alpha_{s+1} \sim N(\mu_{\alpha_0}, \Sigma_{\alpha_0})$, $h_{t+1} \sim N(\mu_{h_0}, \Sigma_{h_0})$.

There are a few points to explain about the construction of the TVP-VAR model:

(1) Assume that the lower triangular matrix of the matrix A is the recursive recognition of the VAR system.

(2) The model does not require the parameters to be stable, but only requires it to obey the random walk process.

(3) Previous studies have shown that whether the Σ_h matrix is diagonal or not has little effect on the research results. In order to reduce the difficulty of the research, this thesis also assumes that Σ_h is a diagonal matrix.

(4) It is not necessary to assume that each parameter variable in the model has time-varying characteristics, because it may cause over-fitting problems. The specific solution can be solved by referring to the method proposed by Primiceri (2005). This thesis refers to Primeri to specify the normal prior distribution for β_{t+1}, α_{t+1}, h_{t+1}, and use constant coefficient VAR to calculate the mean and variance based on the data before the sample period.

6 Empirical analysis

6.1 Data selection

The empirical part of this thesis mainly involves three types of indicators: business confidence index, monetary policy proxy variables and macroeconomic variables. We briefly list the data sources and calculation methods of the indicators involved in this thesis in Table 6.1, and Table 6.2 is the descriptive statistics of related variables.

In order to explore the role of confidence in the transmission of monetary policy, we first need to find suitable indicators to measure the confidence of economic entities. Since confidence is a kind of psychological expectation, it is difficult to observe directly, so researchers usually use survey methods to inquire about the subjective feelings of economic entities. For example, the well-known Michigan Consumer Sentiment Index is calculated based on the results of telephone interviews. This thesis selects the business confidence index published by the OECD database to measure entrepreneurs' views on the European macro economy.

This thesis chooses three-month short-term money market interest rate and Wu-Xia shadow rate to reflect monetary policy. In related macroeconomic indicators, we use GDP growth rate to measure output. In addition, we convert the quarterly data in the original GDP data from low-frequency data to high-frequency data through the Eviews 8 software, that is, monthly data. All the macro data in this thesis are from the OECD database, and the euro area Wu-Xia shadow rate is from the website *https://sites.google.com/view/jingcynthiawu/shadow-rates#h.p_b3LK6od1FMOk*, and the sample interval is from January 2000 to December 2019 (Due to the availability of data, the shadow interest rate is from September 2004 to December 2019.).

Table 6.1: Variable description

Name	Description	Variable
Business confidence	This business confidence indicator is based on opinion surveys on the development of production, orders and finished goods inventories in the industrial sector, and provides information on future developments. This index can measure	Busi

		people's confidence in economic growth.	
GDP growth rate		As a macroeconomic indicator, it measures the level of economic growth. This thesis uses seasonally adjusted quarter-on-quarter GDP growth rates, and uses Eviews to convert quarterly data into monthly data.	gdp
Inflation rate		This thesis uses the yearly growth rate of CPI and adjusts to a monthly data. Because controlling inflation is also one of the goals of monetary policy, we also include the CPI index into the model.	cpi
Interest rate transmission channel	Money market rate	The short-term interest rate is the interest rate for short-term borrowing between financial institutions. In this thesis, the short-term money market interest rate is used as the monetary policy indicator.	rate
	Wu-Xia Shadow rate	Since the lower bound of the effective federal funds rate set by the Federal Reserve is 0, scholars have constructed an indicator called the Shadow Rate to measure the true risk-free interest rate in the financial market. In this thesis, we introduce the Eurozone shadow interest rate as a proxy variable for currency transmission.	shadow
Asset price transmission channel	Housing price	In this thesis, the housing price is used as one of the proxy variables of the asset price channel of the monetary transmission mechanism. In addition, using 2015 as the base year, set the price to 100.	house
	Share price	This thesis uses the index as a proxy variable for the asset price channel of the	share

		monetary transmission mechanism. In addition, using 2015 as the base year, set the price to 100.	
Exchange rate transmission channel	Exchange rate	This thesis uses this indicator as a proxy variable for the exchange rate channel of the monetary transmission mechanism and uses the exchange rate of the euro against the dollar.	ex

Source: Author's based on OECD database

Table 6.2: descriptive statistic

Variable	Mean	Std. Dev.	Min	Max
Busi	100.301	1.732	93.933	102.953
gdp	.461	.621	-2.029	1.511
cpi	1.748	.934	-.600	4.100
rate	1.586	1.781	-.538	5.113
shadow	-0.813	3.347	-7.823	4.279
house	96.066	13.302	66.254	121.192
share	87.940	18.303	51.369	126.906
ex	.842913	.1229932	.676143	1.12122

Source: Author's calculation in STATA 16

This thesis draws figures including GDP growth rate, CPI growth rate, business confidence index, and monetary transmission mechanism proxy variables money market interest rates, Wu-xia shadow rates, housing price and other variables to visually show the changes in the main variables from 2000 to 2019. Since the measurement unit of each variable is different, we use the following four figures to visually show the changes of each variable over 20 years.

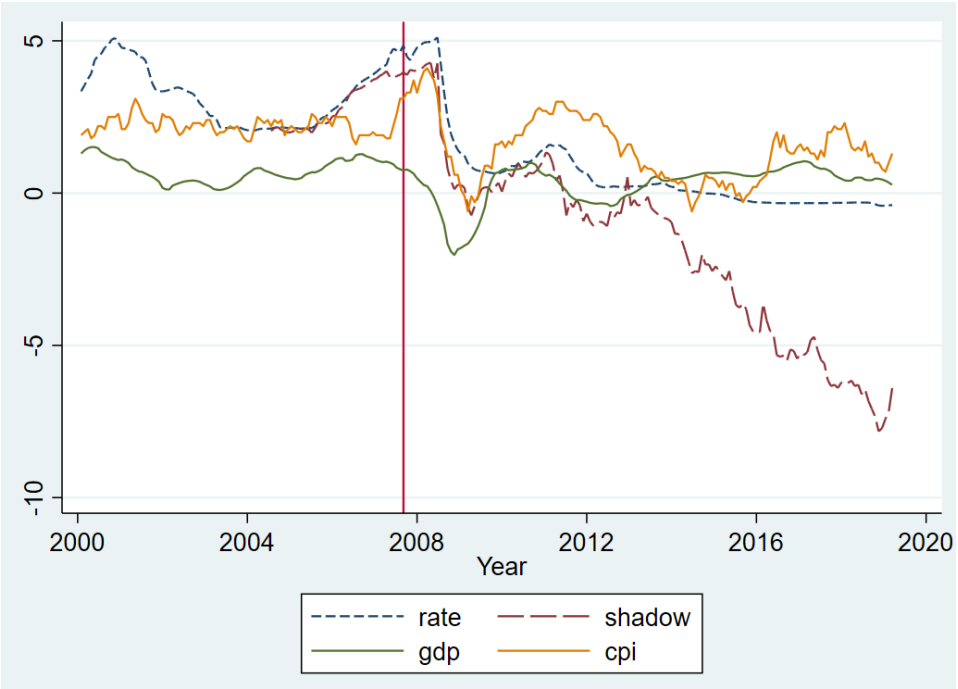
Figure 6.1 shows the changes in money market interest rates, Wu-xia shadow rates, GDP growth rates and CPI growth rates in euro area. It can be seen that in 20 years, the three rates have fluctuated greatly. Before the third quarter of 2000, interest rates in the euro area continued to rise, peaking at around 5%, and then continued to fall. From 2001 to 2003, the Eurozone economy continued to be in a downturn. The ECB kept lowering money market interest rates, mainly because the burst of the economic bubble led by the United States triggered a global economic downturn. From 2003 to 2005, the Eurozone economy recovered somewhat, and interest rates on the Eurozone money market remained basically stable. From 2005 to 2008, affected by the continuous increase in global demand, the rapid growth of the company's income and favorable financing conditions, the Eurozone economy continued to recover and money market interest rates increased. After 2008, the U.S. subprime debt crisis led to a global economic recession, and the euro zone GDP growth rate continued to decline, reaching its lowest point of -2% in 2009 and then recovering. ECB continued to reduce money market interest rates and subsequently fluctuated, reaching negative interest rates in 2015. It can be seen from the figure that the shadow interest rate was basically consistent with the real money market interest rate before 2013. After 2013, due to the “zero lower bound” of the nominal interest rate, the real market risk-free interest rate will be lower. The figure shows that the shadow interest rate continues to fall until 2019. Before 2012, the CPI growth rate was roughly the same as the GDP growth rate. The CPI growth rate fluctuated and declined from 2012 to 2015, and then rose, reaching 2% around 2018.

Figure 6.2 shows the housing price and share price from 2000 to 2019 (2015=100). From the figure, we can find that the housing price has basically maintained a steady upward trend in the past 20 years, and was basically stable from 2008 to 2013. The share price fluctuated strongly in 20 years. From 2000 to 2003, the share price continued to fall during the Eurozone economic downturn, and then rose steadily after 2003. In the 2008 economic crisis, the share price dropped to its lowest point. After the economic crisis, the share price showed an upward trend in fluctuations.

Figure 6.3 shows the change in the exchange rate of the euro against the dollar from 2000 to 2019. It can be seen that the exchange rate of the euro against the US dollar continued to fall from 2000 to 2008, indicating that the euro has continued to depreciate in the past few years, reaching its lowest point around 2008. After 2008, the exchange rate of the euro against the dollar rose, which indicates that the euro is generally appreciating.

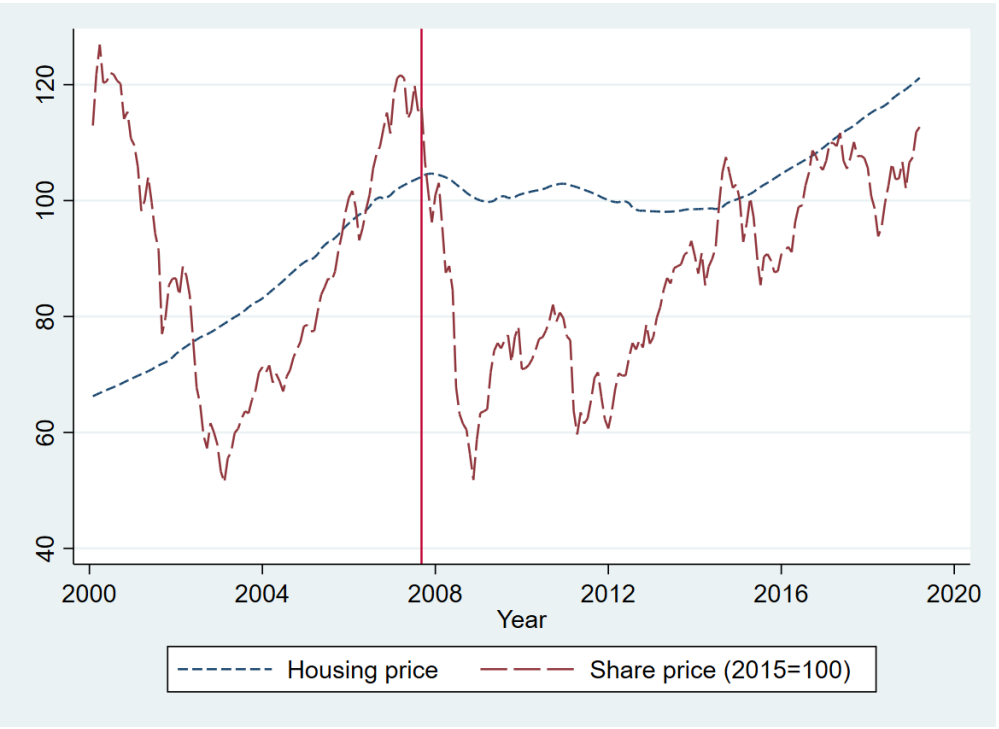
Figure 6.4 shows the trend of changes in business confidence from 2000 to 2019 (Long-term average=100). When business confidence is higher than 100, it means people are more optimistic about future business performance, and when business confidence is lower than 100, it means people are more pessimistic about the future. We can find that in 20 years, the business confidence index has fluctuated continuously, and it continued to fall to the lowest point of 94 after the 2008 financial crisis.

Figure 6.1: Money market interest rate, Shadow rate, GDP and CPI growth rate trend figure



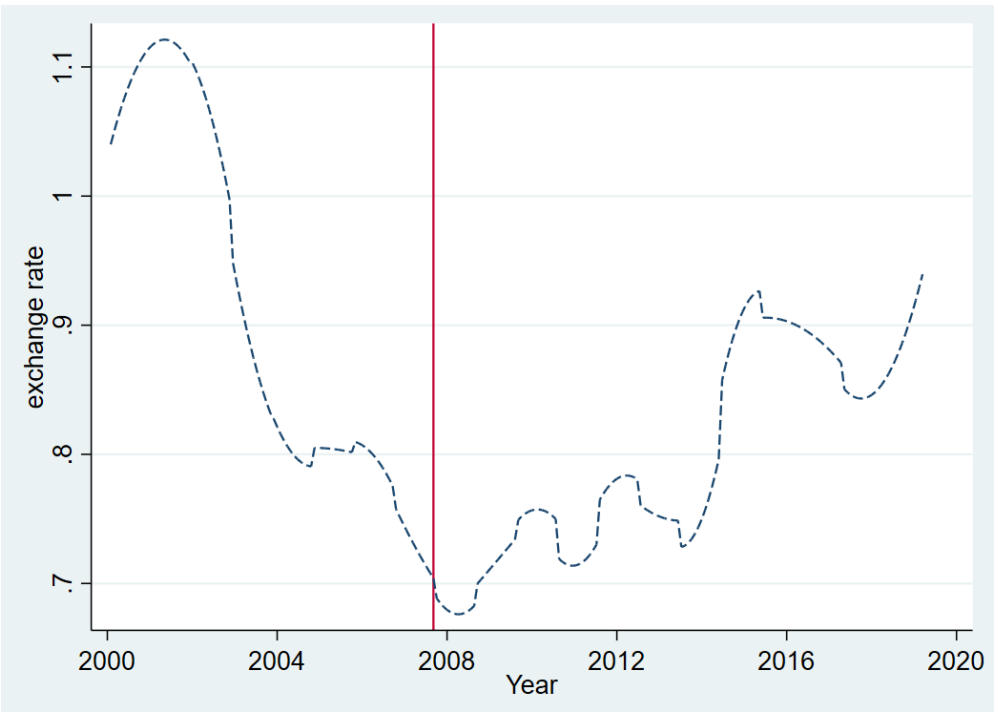
Source: Author's calculation in STATA 16

Figure 6.2: Housing price and Share price trend figure



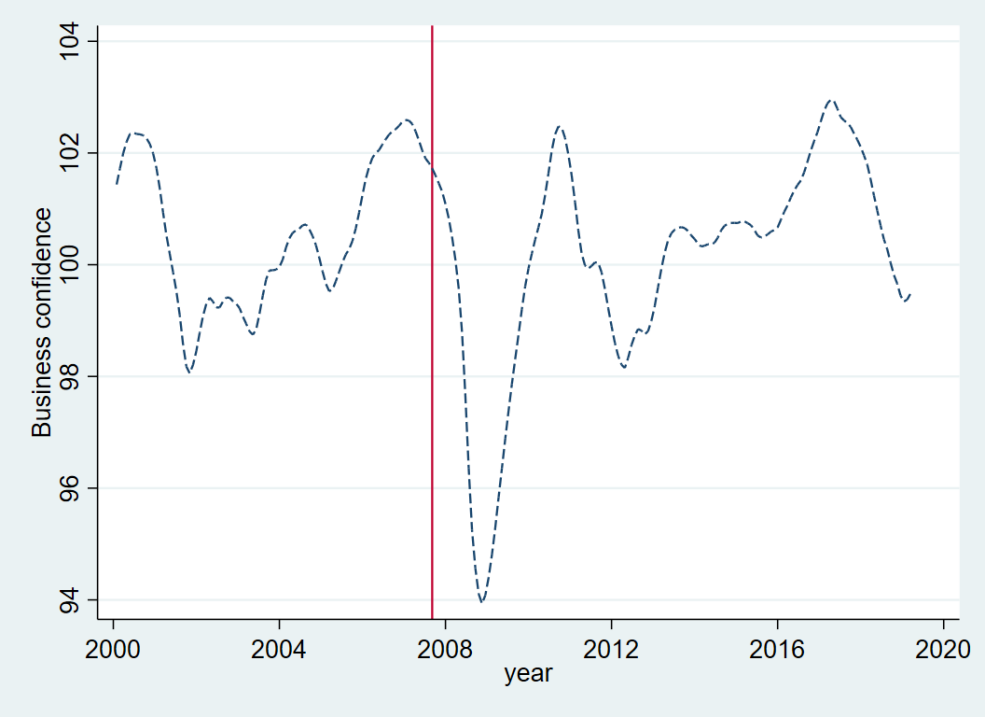
Source: Author's calculation in STATA 16

Figure 6.3: Exchange rate trend figure



Source: Author's calculation in STATA 16

Figure 6.4: Business confidence trend figure



Source: Author's calculation in STATA 16

6.2 Methodology

This thesis analyzes the role of confidence in the monetary transmission mechanism. There are many proxy variables for monetary policy, such as money market interest rates, Wu-xia shadow rates. We first analyze the Busi, gdp and money market rate variables, and shadow rate will be analyzed in the robustness test.

First, we perform basic processing on the data and use Census X-12 to eliminate seasonal effects (except the GDP growth rate which has been already eliminated the seasonal effect). Then, in order to use the SVAR model, it is necessary to ensure that all time series in the model are stationary, so we will perform unit root tests on all variables of the model to determine whether the variables meet the stationarity condition. In this thesis, we use the ADF unit root test and find that the first-order difference of all the data is stationary. The test results are shown in Table 6.3.

Table 6.3: Unit root test of market interest rate channel model

Variable	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value	P value

D.rate	-6.479316	-3.997083	-3.428819	-3.137851	0.0000
D.Busi	-4.695741	-3.999552	-3.430013	-3.138555	0.0009
D.cpi	-8.819273	-3.997083	-3.428819	-3.137851	0.0000
D.gdp	-4.116511	-3.999180	-3.429834	-3.138449	0.0069

Source: Author's calculation in STATA 16

After that, we carried out the optimal lag order test. According to the AIC and HQ criteria, we found that the optimal lag order of the model was 2th order. The test results of Eviews are shown in Table 6.4.

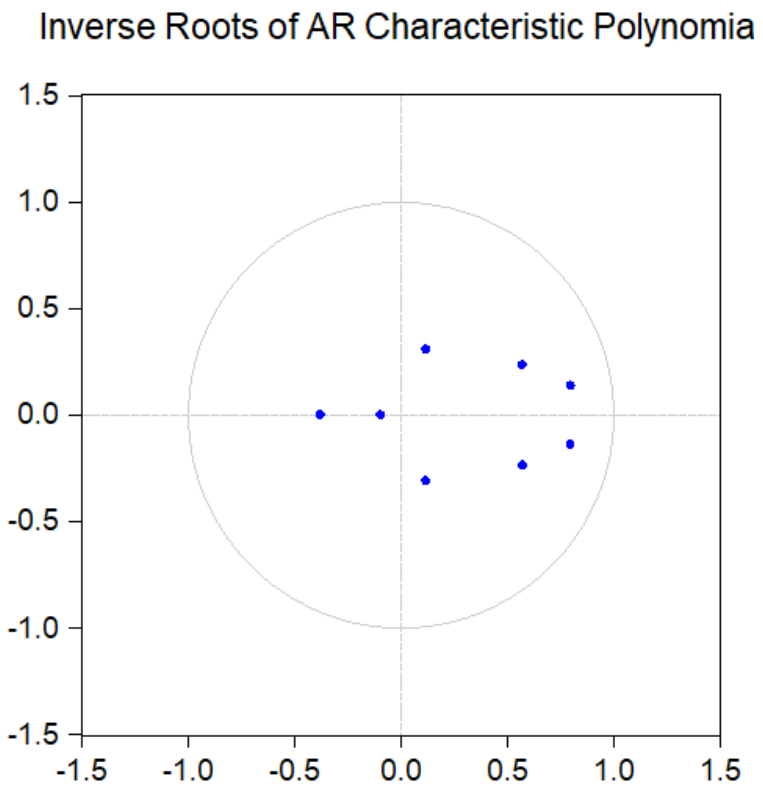
Table 6.4: Optimal lag order test of market interest rate channel model

Lag	LogL	LR	FPE	AIC	SC	HQ
0	415.9160	NA	3.63e-07	-3.476084	-3.417552	-3.452492
1	822.9306	796.8556	1.34e-08	-6.775786	-6.483122	-6.657824
2	871.8335	94.09173*	1.02e-08*	-7.053447*	-6.526654*	-6.841116*

Source: Author's calculation in STATA 16

After the above steps, the non-stationary series are all transformed into stationary series, and we can use the AR root figure to test the stationarity of the entire model. In the AR root table test, when the reciprocal of the absolute value of all the characteristic roots of all sequences in the model is less than 1 (that is, all points are in the circle), it proves that the entire model is stable. As shown in Figure 6.5, the model is stable.

Figure 6.5: AR root figure of interest rate channel model



Source: Author's calculation in STATA 16

6.3 Results based on SVAR model

1. Impulse response analysis

In order to study the impact of confidence on the monetary transmission mechanism, we mainly focus on two aspects. The first is to test whether monetary policy has an impact on confidence, and the second is to test whether confidence will ultimately affect economic growth. Figure 6.6 shows the relevant impulse response figures of the SVAR model.

From the response of business confidence to short-term money market interest rate, it can be seen that the positive shock of short-term money market interest rates has a negative impact on business confidence and reaches its lowest point in the 6th period. Subsequently, the negative impact gradually weakens and tends to zero at the end of the 20th period. This may be because tight monetary policy will reduce business confidence.

From the response of GDP growth rate to short-term money market interest rate, we can see that the positive short-term money market interest rate shock causes a negative response to the GDP growth rate from the 0th period, and the impact reaches its lowest point around the 7th period. Then the impact gradually weakened by the

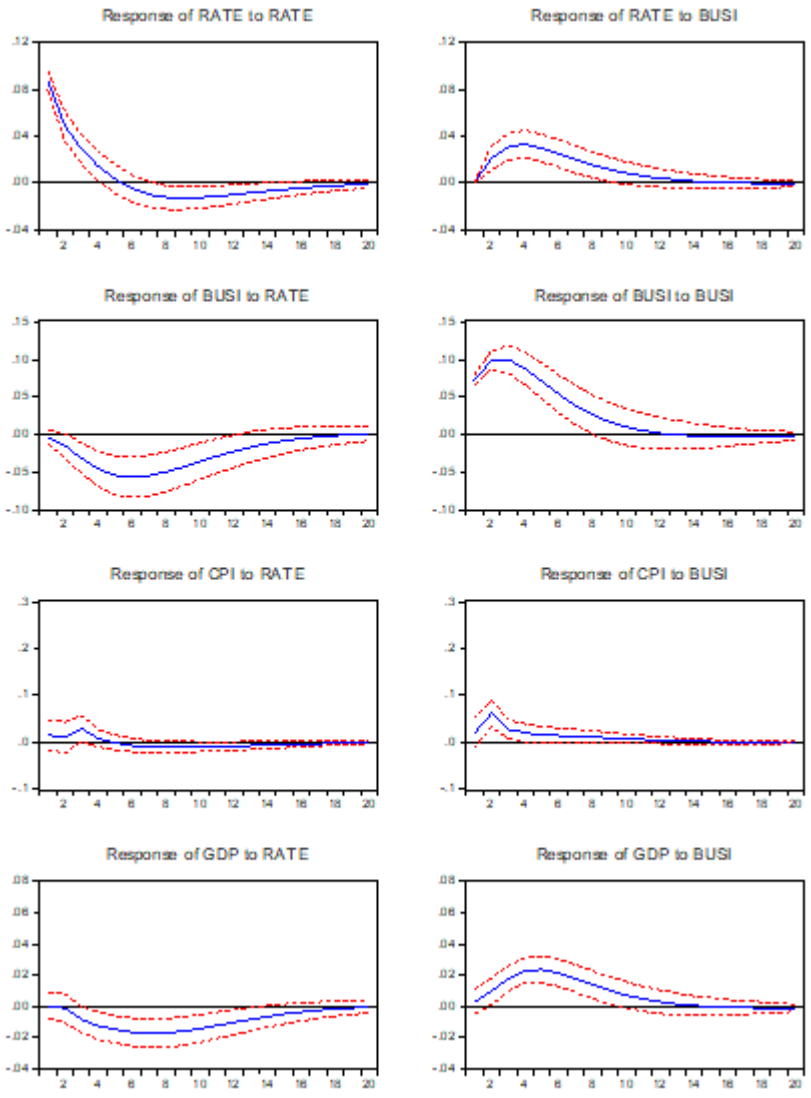
end of the 20th period. This is because the tightening monetary policy has a negative impact on the economy. Therefore, we can also draw the conclusion that the expansionary monetary policy has a significant promoting effect and a longer lasting effect on the increase in GDP.

From the response of GDP growth rate to business confidence, it can be seen that the positive shock of business confidence has a positive impact on GDP growth rate, and it peaks around the 5th period. This shows that the increase in business confidence has a positive effect on the economy. Similarly, a positive shock of business confidence also has a positive impact on CPI growth rate, but the strength is smaller than business confidence on GDP growth rate, it only produces a positive response at the beginning of the period and then gradually weakens.

From the response of short-term money market interest rate to business confidence, it can be seen that the positive shock of business confidence has a positive impact on interest rates, and this impact reaches a peak around the third period and then gradually weakens. This may be because monetary policy responds to the stimulative effect of business conficende on the real economy and subsequently inflation.

In summary, based on the above analysis, on the one hand, a tightening monetary policy will reduce business confidence and ultimately have a restraining effect on GDP and CPI. On the other hand, business confidence will also promote the increase in interest rates, that is, the implementation of tightening monetary policy.

Figure 6.6: Impulse response of interest rate transmission channel



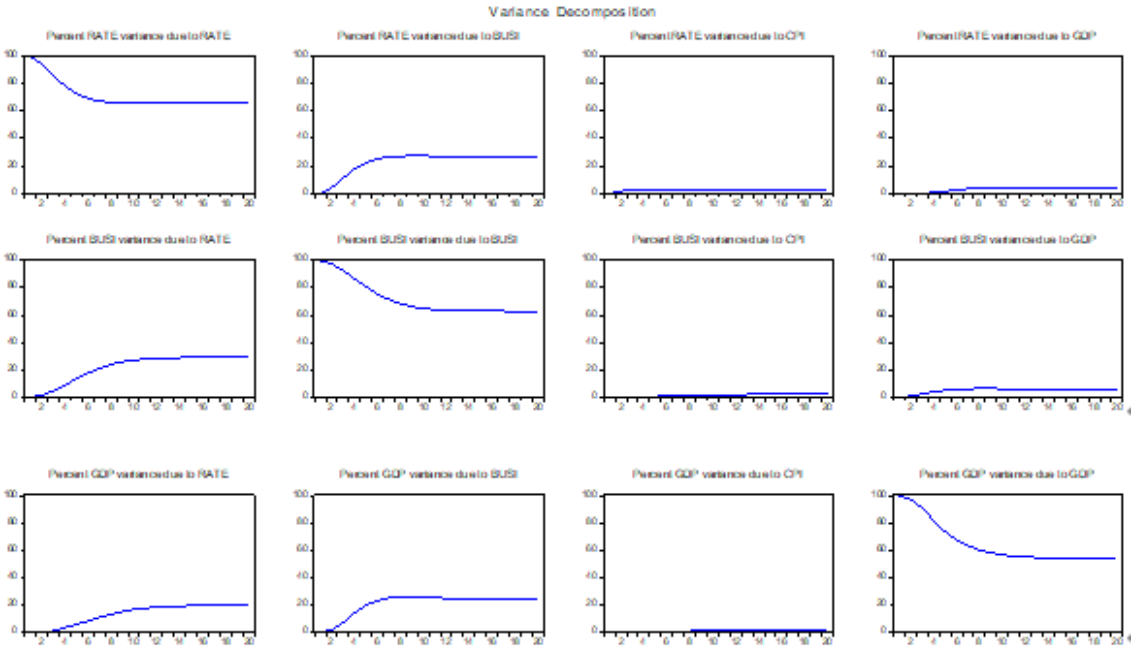
Source: Author's calculation in Eviews 8

2. Variance decomposition

The impulse response figure above describes the mutual influence of money market interest rates, business confidence, CPI growth rate, and GDP growth rate. Next, we will use variance decomposition to evaluate the importance of variable structure by analyzing the contribution of variable structure shock to endogenous variable changes. Figure 6.7 shows the decomposition of the variance of money market interest rate, business confidence, and real GDP growth rate. The results of the money market interest rate variance decomposition figure show that, regardless of the contribution of the interest rate itself, business confidence contributes the most to the money market interest rate. This shows that: confidence affects money market interest rate, that is, confidence has an impact on the implementation of monetary policy. The results of the variance decomposition of the business confidence index show that,

regardless of the contribution of the business confidence index itself, the money market interest rate contributes the most to the change of the confidence index, with an average of about 25%. Moreover, the figure also shows that the contribution of money market interest rate to business confidence is relatively stable in the medium and long term. This shows that changes in business confidence are affected by monetary policy shocks. This further verifies that the process of monetary policy transmission will affect output through confidence channels. The results of variance decomposition of real GDP growth rate show that, excluding the contribution of GDP growth rate itself, confidence has the largest contribution rate to real GDP changes, basically above 20%. This shows that confidence shocks can explain 20% of real GDP fluctuations.

Figure 6.7: Variance decomposition of interest rate transmission channel



Source: Author's calculation in Eviews 8

3. Robustness test

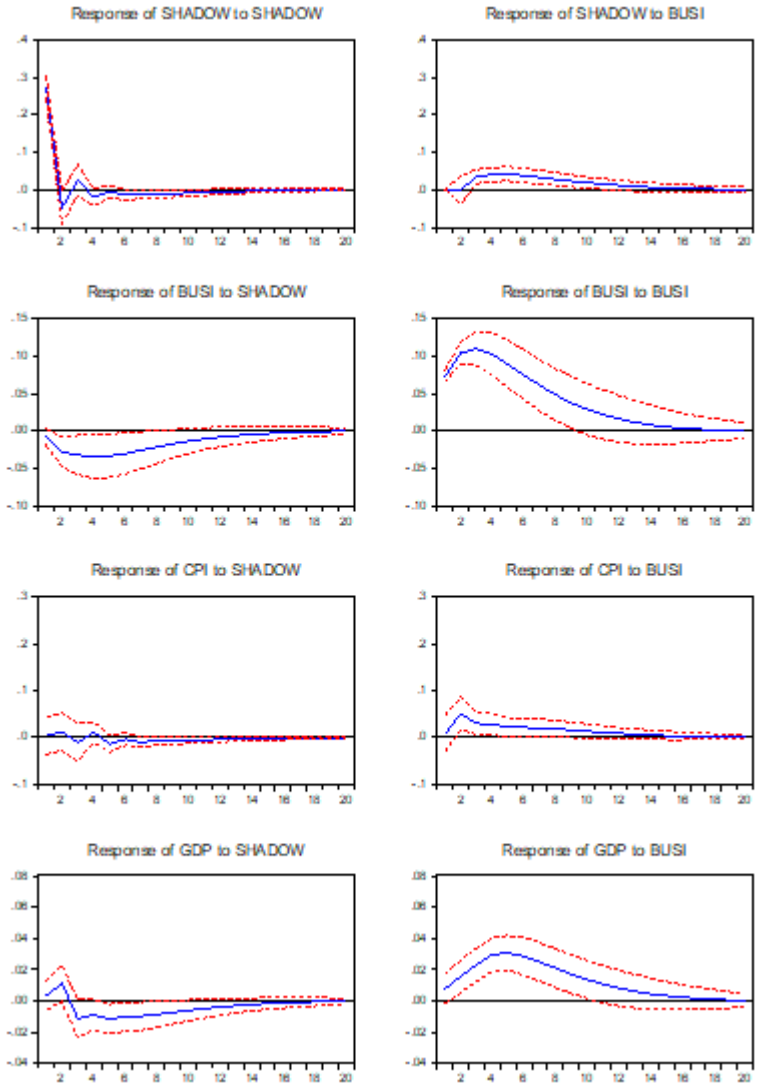
In the above, we used the money market interest rate as a proxy variable of monetary policy for empirical analysis. In order to ensure the robustness of the results, we analyzed the Wu-Xia shadow interest rate as a proxy variable of monetary policy. The reason for adopting this indicator is that although conventional monetary policy has extended the lower limit of interest rates below zero, the monetary authorities of major economies are still cautious about negative official interest rates. After 2008, in order to promote economic recovery after the crisis, the Federal Reserve created an extraordinary monetary policy method called quantitative easing after the target interest rate fell to near zero. This monetary policy injects large amounts of liquidity

into the market through the purchase of government bonds and backing securities of government agencies, lowers the real interest rate in the market, and encourages borrowing and spending. Many scholars have established models to measure the impact of QE on the real economy. Since interest rates have a "zero lower bound", scholars have constructed indicators called shadow interest rates to measure the true risk-free interest rates in financial markets. Among them, the Wu-Xia shadow interest rate created by the two scholars of Wu Jing and Xia Fan is the most famous.

First, we perform unit root test, optimal lag order test, and AR root test on the model that uses shadow rate as the proxy variable of the currency transmission mechanism (see Appendix A). The optimal lag order is 2 order.

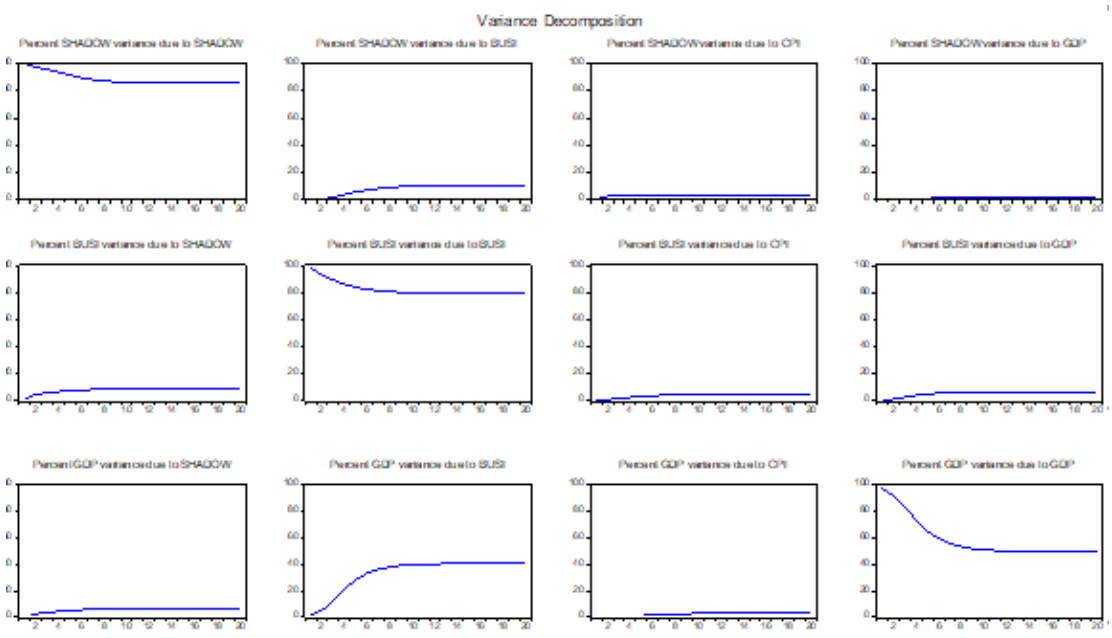
Figure 6.8 and Figure 6.9 are the impulse response figure and the variance decomposition figure, respectively. From the impulse response figure, we can see that the conclusion is basically the same as the previous one. There are some differences between the new variance decomposition figure and the previous one. The results of the shadow interest rate variance decomposition figure show that, regardless of the contribution of the business confidence index itself, the contribution of business confidence to the shadow interest rate is still the largest, but it is not as good as its contribution to the money market interest rate. Similarly, the contribution of shadow interest rates to business confidence is relatively small. However, the variance decomposition results of the real GDP growth rate show that excluding the contribution of GDP growth rate itself, the contribution rate of confidence to real GDP changes is very large, above 40%. This shows that when the shadow interest rate is used as a proxy variable for monetary transmission, the mutual influence between monetary policy and business confidence is relatively small, but confidence has a great influence on GDP growth rate.

Figure 6.8: Impulse response of interest rate transmission channel (Robustness Test)



Source: Author's calculation in Eviews 8

Figure 6.9: Variance decomposition of interest rate transmission channel (Robustness Test)



Source: Author's calculation in Eviews 8

4. Extended model

Above, we used the money market interest rate as a proxy variable of monetary policy for empirical analysis. Next, we will expand the model to introduce housing price, share price and foreign exchange rate into the model for analysis, because these variables play an important role in monetary transmission. Similarly, we perform ADF test on all variables to check whether there is a unit root. As shown in Table 6.5, the first-order difference variables of all variables except housing price have passed the ADF test, so we exclude the housing price variable. In the following, we only introduce share price and foreign exchange rate into the model for analysis.

Table 6.5: Unit root test of other transmission channels

Variable	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value	P value
D.Busi	-4.695741	-3.999552	-3.430013	-3.138555	0.0009
D.gdp	-4.116511	-3.999180	-3.429834	-3.138449	0.0069
D.share	-12.51871	-3.997083	-3.428819	-3.137851	0.0000
D.house	-1.912517	-3.998457	-3.429484	-3.138243	0.6448
D.ex	-4.657709	-3.997418	-3.428981	-3.137946	0.0010

Source: Author's calculation in STATA 16

Then, we do AR root test, optimal lag order test for the model. All models have passed the test, these will not be repeated in the text, and the results are shown in Appendix A.

According to the results of the optimal order test, in the model containing the share price variable, the optimal lag order is one period, the impulse response function is shown in Figure 6.10, and the variance decomposition diagram is shown in Figure 6.11. The line in the middle of each figure is the impulse response line, and the upper and lower lines are the 95% confidence range.

From the response of share price to short-term money market interest rate shock, it can be seen that share price has a negative response to positive money market interest rate shocks. This shows that higher interest rate implies lower future GDP, and thus lower earnings of the firms listed on the stock exchange. At the same time, higher rates mean a higher discount factor for future earnings.

It can be seen from the response of business confidence to share price that the positive shock of share price has an insignificant positive impact on business confidence. This may be because the increase in share price makes people have better expectations of the future economic situation, thereby increasing confidence, but this effect is not significant.

From the response of GDP growth rate to share price, it can be seen that the positive shock of share price also has a positive effect on GDP growth rate. This is in line with economic expectations.

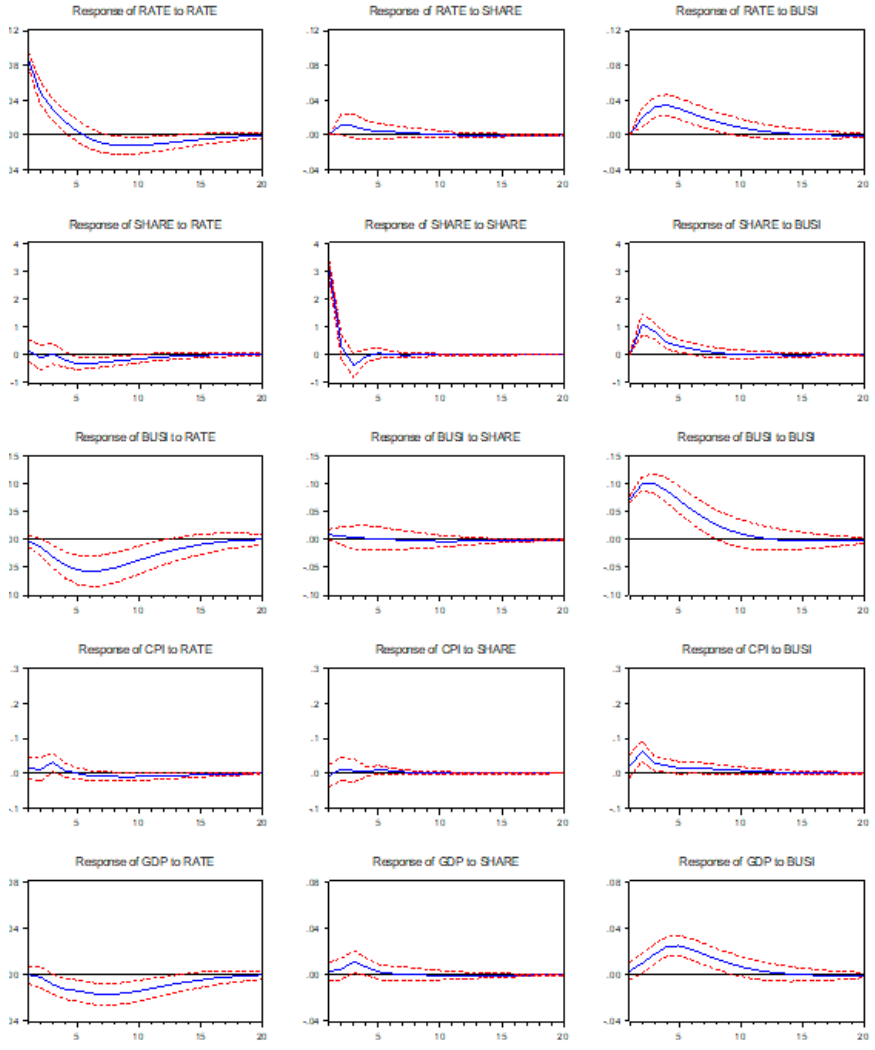
The response of share price to business confidence also shows that business confidence has a positive effect on share price, which shows that rising business confidence can increase stock price.

The response of GDP growth rate to business confidence shows that business confidence has a positive impact on GDP growth rate, reaching its peak around the fifth period. This shows that the rise in business confidence does indeed promote the economy. In addition, the CPI growth rate also shows a positive impact from a positive shock of business confidence, which is consistent with the above model.

In short, money market interest rates can build asset price monetary transmission channels through share price. Tightening monetary policy will cause a decline in share price, thereby reducing business confidence (there may be an insignificant

impact) and ultimately inhibiting economic development. Similarly, the decline in business confidence will also have a depressing effect on the share price.

Figure 6.10: Impulse response of asset price transmission channel



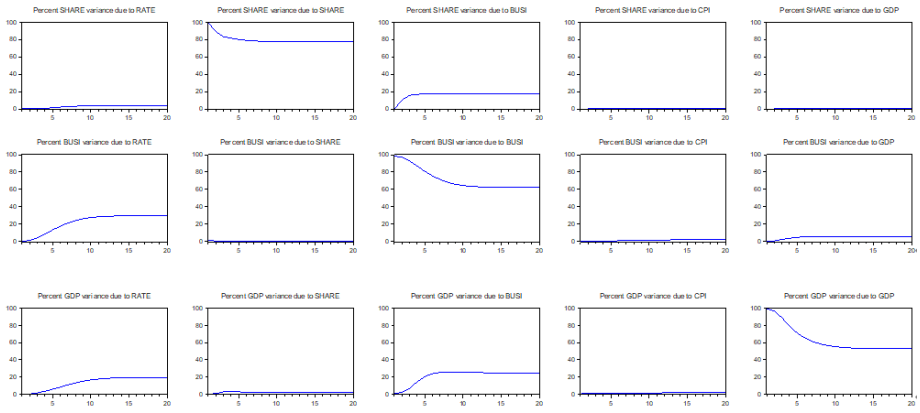
Source: Author's calculation in Eviews 8

The result of the variance decomposition of share price shows that, in addition to the contribution of share price itself, the contribution of business confidence to share price is about 20%. This shows that confidence can have an impact on share price.

The results of the variance decomposition of the business confidence index show that, regardless of the contribution of the business confidence index itself, interest rates contribute the most to business confidence, while the contribution of share price to business confidence is not obvious. This shows that changes in business confidence are mainly affected by interest rates, and asset price channels are not very obvious. The result of variance decomposition of real GDP growth rate shows that excluding the contribution of GDP growth rate itself, the contribution rate of confidence to real

GDP is very large, around 25%, which shows that business confidence has a high contribution to economic growth.

Figure 6.11: Variance Decomposition of asset price transmission channel



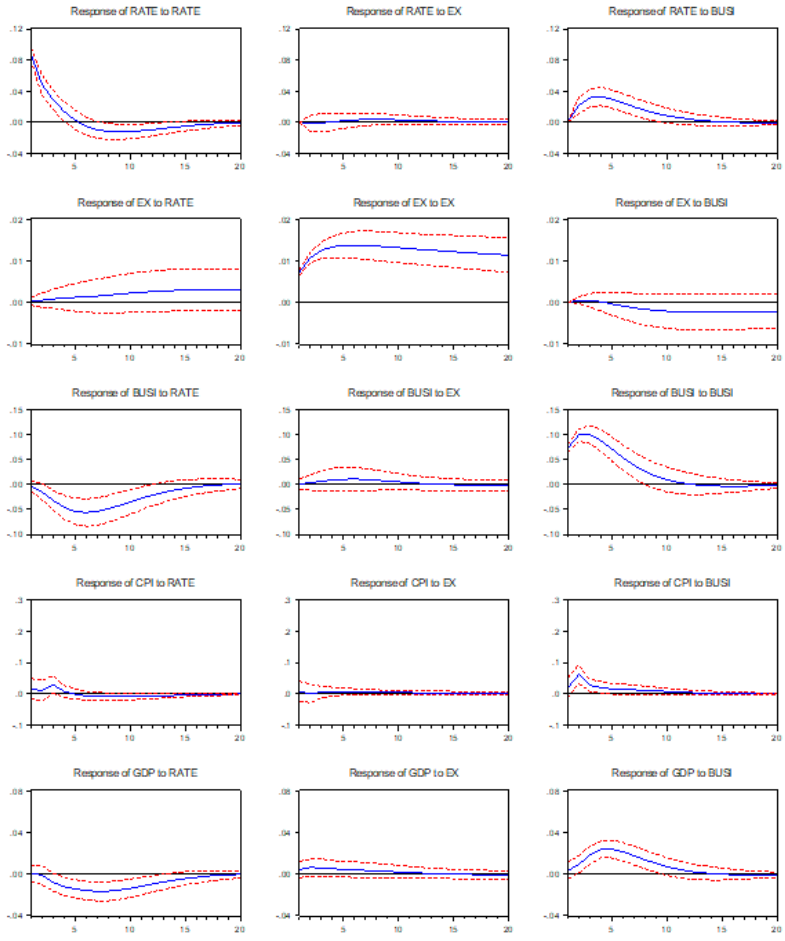
Source: Author's calculation in Eviews 8

Similarly, we also introduce the exchange rate into the model to explore the exchange rate mechanism of monetary transmission. At this time, the optimal lag order of the model is 2 order, and part of the impulse response figure is shown in Figure 6.12.

From the response of exchange rate to short-term money market interest rate, it can be seen that the exchange rate has a positive response to a positive money market interest rate shock, and the response lasts for a relatively long time.

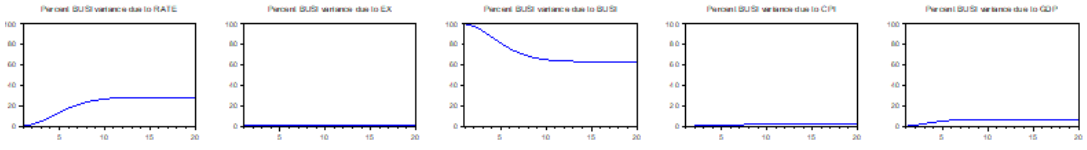
It can be seen from the response of business confidence to foreign exchange rate that the positive shock of foreign exchange rate has an insignificant positive impact on business confidence. This result is similar to the asset price channel of monetary transmission. And according to the variance decomposition figure, we can see that among the variance of business confidence, the money market interest rate contributes the most to it, while the contribution of the foreign exchange rate is almost zero. This also shows that the foreign exchange channels for monetary transmission are not obvious.

Figrue 6.12: Impulse Response of exchange rate transmission channel



Source: Author's calculation in Eviews 8

Figrue 6.13: Variance decomposion of exchange rate channel



Source: Author's calculation in Eviews 8

In summary, from the analysis of the SVAR model, it can be concluded that the confidence channel of monetary policy can have an impact on the economy. In addition, confidence plays a strong role in the transmission of interest rates and weaker in the asset price channel and exchange rate transmission channel. This also confirms the first hypothesis of this thesis: business confidence will affect the effectiveness of monetary policy.

6.4 Results based on TVP-VAR model

1. Parameter estimation results and validation of MCMC algorithm

According to the results of the SVAR model in the previous chapter, business confidence has a strong effect on the interest rate channel of monetary transmission. However, the role of confidence in the asset price channel and exchange rate channel are not obvious. Because of the complexity of the TVP-VAR model, in the construction of the TVP-VAR model, we will only study the interest rate channel of monetary transmission.

First, because this thesis mainly wants to study whether business confidence will respond when monetary policy changes, and whether it will affect monetary policy objectives (such as inflation rate, GDP growth rate), so, according to the correlation of each variable, the order of the variables is adjusted to money market interest rates, business confidence index, CPI growth rate and GDP growth rate. Then, we use Ox Metrics6 to process the TVP-VAR model and set the model lag order to 2. This thesis uses the MCMC algorithm to sample 1,0000 times, discards the first 1,000 sampling results, and then uses the latter 9,000 sampling to estimate the parameters of the posterior distribution, and finally uses Geweke statistics and inefficiency factors to test the rationality of the MCMC algorithm. The posterior estimation results of parameters are shown in Table 6.7.

It can be seen from Table 6.6 that the posterior means of all parameters fall within the 95% confidence interval, and their standard deviations are very small, which can conclude that the parameter estimation results are very good. The invalid factor of all parameters did not exceed 100, indicating that enough uncorrelated samples were obtained by using the MCMC algorithm, that is to say, the ideal sampling result was obtained.

Table 6.6: Estimation results

Parameter	Mean	Stdev	95%L	95%U	Geweke	Inef.
$(\Sigma_\beta)_1$	0.0226	0.0025	0.0184	0.0282	0.288	8.66
$(\Sigma_\beta)_2$	0..0221	0.0024	0.0180	0.0272	0.797	11.79
$(\Sigma_\alpha)_1$	0.0641	0.0182	0.0381	0.1091	0.161	63.26
$(\Sigma_\alpha)_2$	0.0762	0.0244	0.0435	0.1412	0.172	71.63

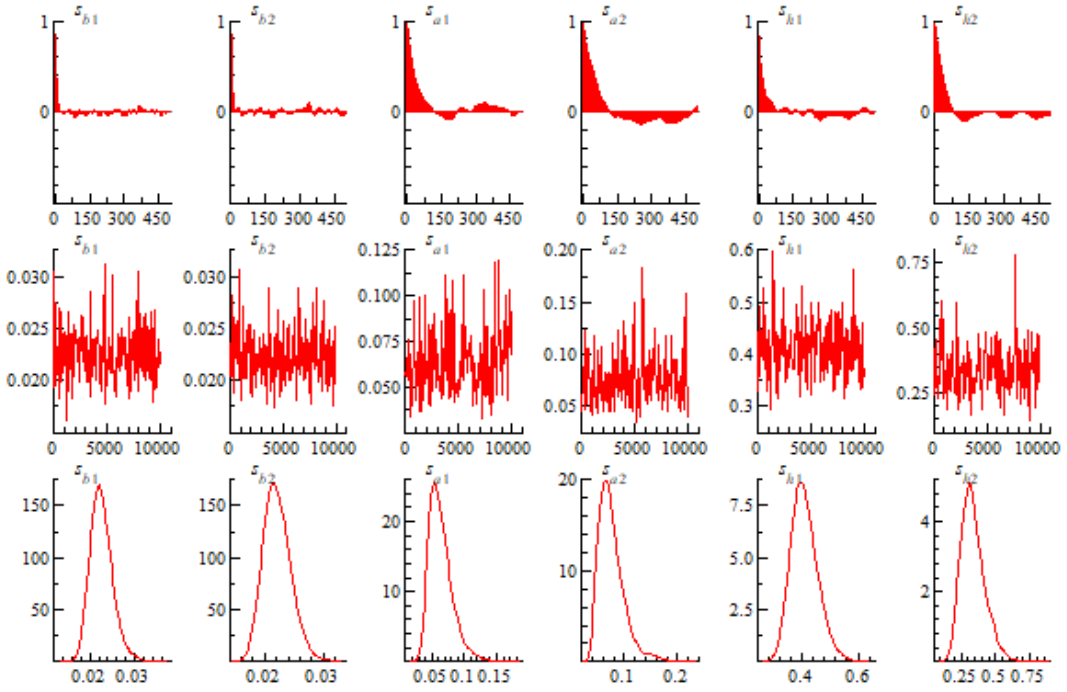
$(\Sigma_h)_1$	0.4086	0.0480	0.3261	0.5131	0.262	33.42
$(\Sigma_h)_2$	0.3375	0.0879	0.2001	0.5340	0.851	50.91

Note: This thesis refers to Nakajima (2011), the prior values $(\sum \beta_t)^{-2}$, $(\sum \alpha_t)^{-2}$, $(\sum h_t)^{-2}$ satisfy the distribution: $(\sum \beta_t)^{-2}$～Gamma (40,0.02), $(\sum \alpha_t)^{-2}$～Gamma (4,0.02), $(\sum h_t)^{-2}$ ～ Gamma (4, 0.02).

Source: Author's calculation in Ox Metrics6

Figure 6.14 shows the sample's autocorrelation coefficient, sample convergence trajectory, and posterior density distribution from top to bottom. As shown in Figure 6.14, the autocorrelation coefficients of the samples converge to 0 as the number of simulations increase, indicating that the sampling times set in this thesis can well eliminate the autocorrelation between samples. In addition, the sample sequence fluctuates with a trajectory of "white noise" around the mean value. At the same time, Figure 6.14 also verifies that the samples obtained by sampling using the MCMC algorithm are irrelevant and effective, and can simulate the distribution of parameters well. The independent VAR model has been widely used as a basic measurement analysis tool, and the parameters estimated by the impulse response function obtained by it are fixed. In order to study the role of confidence at different time points in monetary transmission, this thesis uses the TVP-VAR model to analyze the positive shocks of money market interest rate, business confidence, CPI growth rate and GDP growth rate at different lead times and at different time points.

Figure 6.14: Sample autocorrelation , sample path and posterior density



Note: In this figure, sb1, sb2, sa1, sa2, sh1, and sh2 are consistent with the previous $(\Sigma_\beta)_1$, $(\Sigma_\beta)_2$, $(\Sigma_\alpha)_1$, $(\Sigma_\alpha)_2$, $(\Sigma_h)_1$ and $(\Sigma_h)_2$.

Source: Author's calculation in Ox Metrics6

2. Time-varying impulse response analysis

(1) Analysis of time-varying characteristics of impulse response with different lead times

Since this thesis focuses on the impact of money market interest rate shocks on business confidence and GDP growth rate at different lead times, and the shocks of business confidence on economic growth, this thesis only intercepts the corresponding impulse response figures. Figure 6.15 reflects the time series of the impulse response formed by a unit of standard forward shock under different lead times. The lead times are 4 periods (solid line) and 12 periods (dashed line). It can be seen from the figure that the impulse response formed by the shock of two different lead times is different in direction and magnitude. In general, as the set values of different lead times increase, the mutual influence between various variables becomes smaller. Moreover, the time-varying nature of the impulse response is very obvious.

The upper left figure shows the response of business confidence to a money market interest rate shock. In the face of interest rate shocks with different lead times, the impulse response of business confidence is negative. Among them, the four-period

interest rate shock has a greater impact on business confidence. This shows that in the short term, an increase in interest rates will cause business confidence to fall. Moreover, the response intensity of business confidence suddenly increased around 2008, reaching around -0.075. Subsequently, the negative shock gradually weakened from 2008 to 2015, and has stabilized since 2015. As for the previous 12-period monetary market interest rate shock, the response intensity of business confidence was smaller than the former, but it was still negative. Especially around 2008, there was a significant negative impact. This shows that the short-term transmission effect of interest rates on business confidence is relatively obvious, while the long-term effect is weakened.

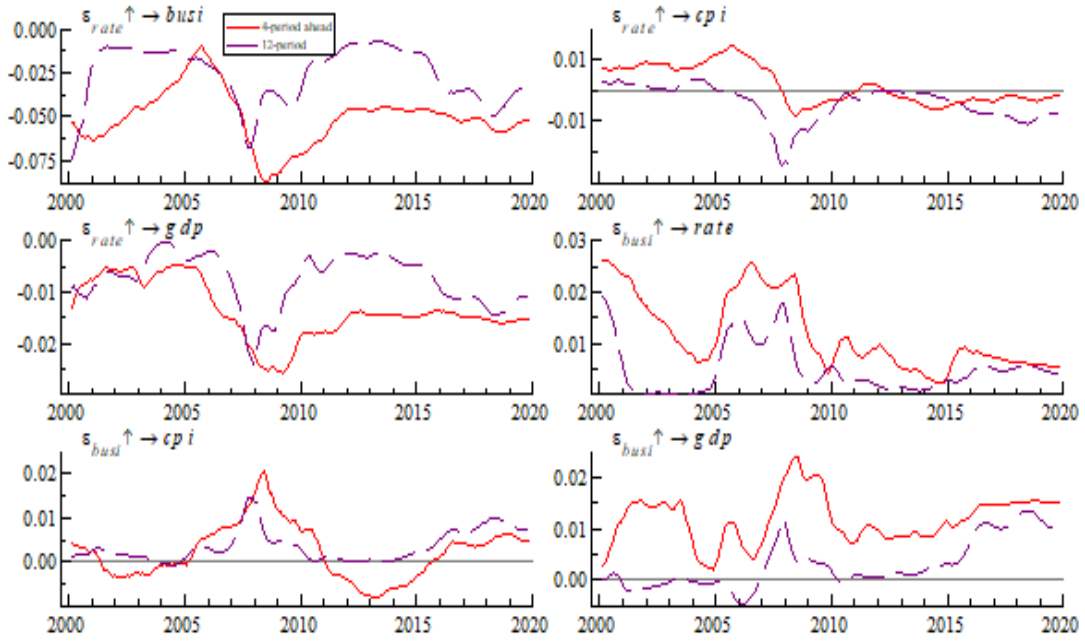
The middle left figure is the response of GDP growth rate to interest rate shocks. The figure shows that in the face of a 4-period interest rate shock, the GDP growth rate was relatively stable from 2000 to 2005, and the negative impact of interest rates on the GDP growth rate increased from 2005 to 2008, even below- 0.025. In the face of interest rate shocks with a 12-period lead time, the decline in GDP growth rate was smaller than that of the former, and it only dropped sharply during the economic crisis.

The middle right figure shows the response of interest rates to business confidence shocks. The figure shows that in the face of business confidence shocks with a 4-period lead time, the response intensity of interest rates is greater than that of a 12-period lead time. This shows that business confidence and interest rates have a stronger effect in the short term.

The lower right figure shows the response of GDP growth rate to the shock of business confidence. It can be seen from the figure that facing the positive shock of business confidence with a lead time of 4 periods, the GDP growth rate has shown a positive growth trend for most of the period from 2000 to 2019. This shows that business confidence has a promoting effect on economic growth, especially during the economic crisis. The impact of business confidence with a 12-period lead time has a limited effect on GDP growth.

In summary, we can once again confirm the conclusion of the SVAR model, that is, business confidence has a short-term impact on the monetary transmission mechanism, and the effect will be weakened in the long-term. In this thesis, the short-term is 4 months and the long-term is 1 year.

Figure 6.15: Impulse response for different lead times



Source: Author's calculation in Ox Metrics6

(2) Analysis of time-varying characteristics of impulse response at different time points

Figure 6.16 is the impulse response figures at different time points. In order to study the difference between the period of economic crisis and the stage of economic development, this thesis sets two different time points, one is October 2008 and the other is January 2015.

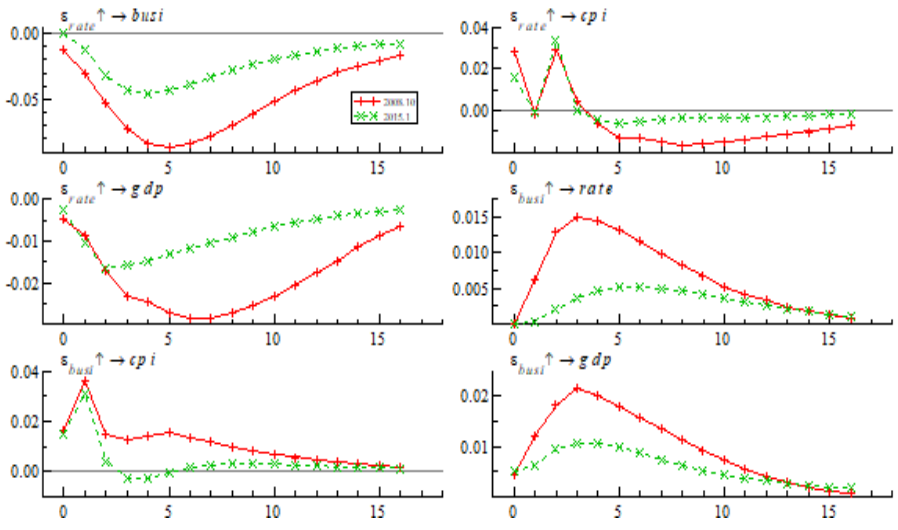
The upper left figure shows the response of business confidence to the shock of money market interest rate. It can be seen from the figure that the positive shock of interest rates during the economic crisis (that is, raising interest rates at this time) has a greater negative impact on confidence, reaching its lowest point in the fifth period. During the economic recovery period in 2015, the increase in interest rates had less inhibitory effect on confidence. This shows that in an economic downturn, if a tightening monetary policy is adopted, people's confidence will be seriously reduced. At the same time, this also shows that the expansionary monetary policy should be very effective during the economic crisis. The boosting effect on confidence will be enhanced and the depth of the economic recession will be effectively reduced.

The middle left figure is the response of GDP growth rate to the shock of money market interest rates. It can be seen from the figure that the increase in interest rates during the economic crisis will also have a greater negative impact on the economy.

The bottom right figure is the response of GDP growth rate to the shock of business confidence. It can be seen from the figure that the boosting of confidence during the economic crisis has a strong effect on economic growth, reaching its peak around the third period. During the economic recovery period in 2015, the increase in business confidence had little effect on the increase in GDP growth rate. Although it could promote economic development, the degree of improvement was not as good as during the economic crisis. Moreover, as the response of CPI growth rate to the shock of business confidence shows, during the economic crisis, the positive response of CPI is stronger than the recovery period.

In summary, we can draw the following conclusion: in the period of economic crisis, adopting an expansionary monetary policy can effectively boost confidence, and the role of confidence in promoting the economy during the period of economic crisis is greatly enhanced. During the economic recovery period in 2015, confidence played a smaller role in monetary transmission. This also confirms the third hypothesis of this thesis: at different stages of economic development, the business confidence index has different effects on the transmission of monetary policy. In times of economic crisis, the role of confidence will be more sensitive.

Figure 6.16: Impulse response for different point times

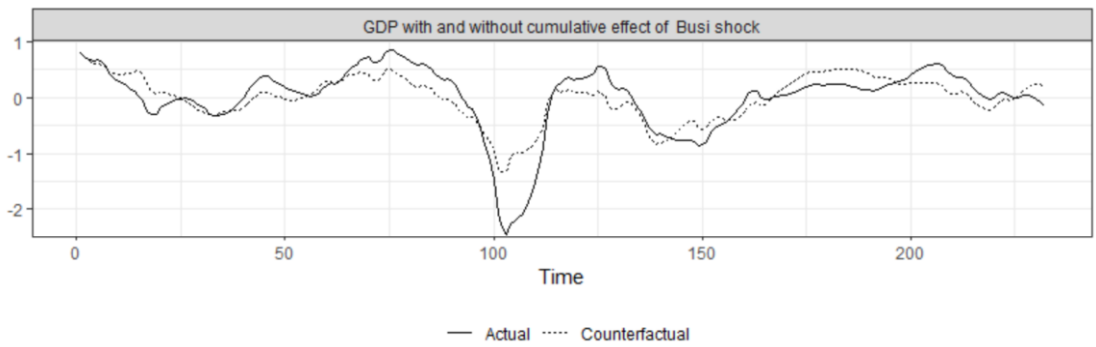


Source: Author's calculation in Ox Metrics6

Above, we have studied the impulse response of different lead times and different time points between variables, in order to more intuitively see the impact of confidence on GDP growth. We conduct counterfactual analysis based on real data from 2000 to 2019 through historical decomposition. The meaning of counterfactuals is: First, a certain event or thing has existed in history, but it is assumed that it does not exist. According to this assumption, the result that may be caused by the

economic operation is estimated. Second, a certain event or thing has never existed in history, but it is assumed to have existed, and then the possible consequences in economic life are estimated based on this assumption. This thesis adopts the first meaning of counterfactual analysis to observe the trend of GDP growth rate when there is business confidence and when there is no business confidence. From Figure 6.17, we can see that in the absence of shocks to confidence, the GDP growth rate changes more slowly. Especially in the period of economic crisis, when there is no business confidence, the decline of GDP growth rate is obviously smaller, which shows that confidence has an important impact on economic development. During the economic crisis, business confidence fell sharply, which had a negative impact on the economy. This also further confirms the third hypothesis of this thesis: at different stages of economic development, the business confidence index has different effects on the transmission of monetary policy. In times of economic crisis, the role of confidence will be more sensitive.

Figure 6.17: Counterfactual analysis of GDP with and without confidence shock



Source: Author's calculation in Eviews 8

7 Conclusion

This thesis studies the role of business confidence in the monetary transmission mechanism. It mainly studies two aspects. The first is to test whether monetary policy has an impact on confidence, and the second is to test whether confidence will ultimately affect economic growth. Since the various variables adopted in this thesis: money market interest rates, business confidence, GDP growth rate, etc., have current impacts, we have established an SVAR model that considers current impacts. And in order to study the time variation in the economic system, this thesis uses the TVP-VAR model to analyze and establish 4 and 12 periods of lead time to study the long-term and short-term effects. And set two time points in October 2008 and January 2015 to study the impact of business confidence in different periods of economic recovery. The conclusions of this thesis are:

Business confidence can affect the effectiveness of monetary policy, and the channel of confidence in monetary policy can have an impact on the economy. In addition, confidence plays a strong role in interest rate transmission channel, but it has a weaker role in exchange rate transmission channel and asset price transmission channel.

The role of confidence in the transmission of monetary policy is mainly manifested as a short-term impact, which gradually weakens in the long-term. In this thesis, the short-term is 4 months, and the long-term is 1 year.

At different stages of economic development, business confidence has different effects on the transmission of monetary policy. In times of economic crisis, the role of confidence will be more sensitive.

Based on the above conclusions, we also get some enlightenment. At present, if there are major changes in macroeconomic fundamentals, confidence will definitely be affected. When the level of business confidence is low, investors may decide to postpone investment, which will further weaken the economy. If policymakers only pay attention to economic fundamentals and ignore the influence of the psychological factors of economic entities, it will have an adverse effect on economic recovery. At this time, monetary policy makers can influence the formation mechanism of economic entity confidence and enhance business confidence through expansionary monetary policy.

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Appendix A

Table A.1: Unit root test of interest rate channel model (Robustness Test)

Variable	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value	P value
D.shadow	-7.660035	-3.997083	-3.428819	-3.137851	0.0000
D.Busi	-4.695741	-3.999552	-3.430013	-3.138555	0.0009
D.cpi	-8.819273	-3.999180	-3.429834	-3.138449	0.0000
D.gdp	-4.116511	-3.999180	-3.429834	-3.138449	0.0069

Source: Author's calculation in Eviews 8

Table A.2: Optimal lag order test of interest rate channel model (Robustness Test)

Lag	LogL	LR	FPE	AIC	SC	HQ
0	133.2878	NA	2.79e-06	-1.436531	-1.365577	-1.407762
1	400.3160	519.2214	1.72e-07	-4.225733	-3.870960	-4.081888
2	443.3375	81.74091*	1.27e-07*	-4.525972*	-3.887381*	-4.267051*

Source: Author's calculation in Eviews 8

Table A.3: Optimal lag order test of asset price channel model

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-191.5174	NA	3.61e-06	1.658375	1.731541	1.687865
1	219.6709	801.5570*	1.39e-07*	-1.600598*	-1.161603*	-1.423656*

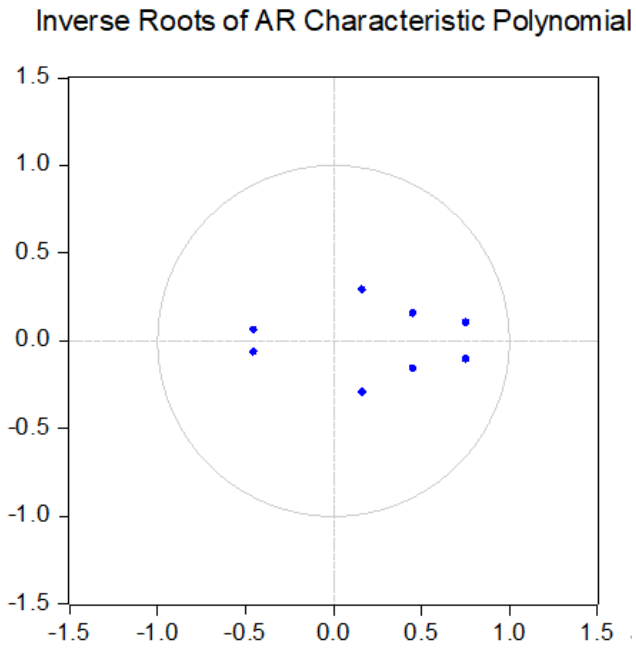
Source: Author's calculation in Eviews 8

Table A.4: Optimal lag order test of exchang rate channel model

Lag	LogL	LR	FPE	AIC	SC	HQ
0	579.1501	NA	5.41e-09	-4.845149	-4.771983	-4.815658
1	1623.765	2036.339	9.92e-13	-13.44950	-13.01050	-13.27255
2	1712.658	169.5338*	5.79e-13*	-13.98868*	-13.18385*	-13.66428*

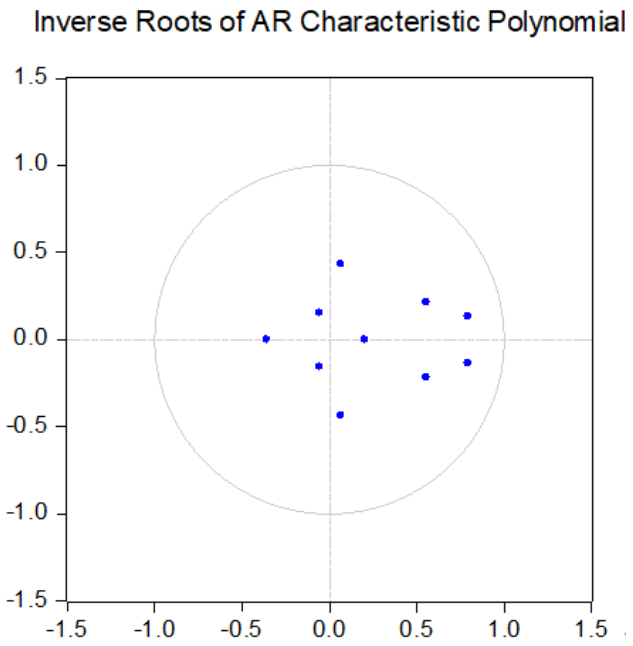
Source: Author's calculation in Eviews 8

Figure A.1: AR root figure of interest rate channel model (Robustness Test)



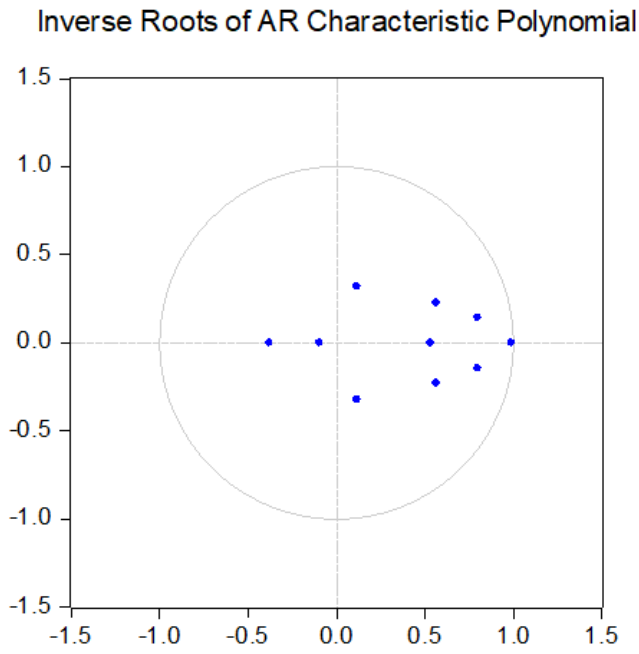
Source: Author's calculation in Eviews 8

Figure A.2: AR root figure of asset price channel model



Source: Author's calculation in Eviews 8

Figure A.3: AR root figure of exchange rate channel model



Source: Author's calculation in Eviews 8