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Research on the construction and influence mechanism of China's monetary policy index

Zhou Juanling[1,a,*]

[1]*School of Economics, Beijing Wuzi University, Beijing, China*
[a]*842003132@qq.com*
[*]*Corresponding author*

Abstract: *Monetary policy has always been a hot research topic, but how to measure monetary policy is still a big difference. This paper transforms the price and quantitative monetary policy tools into a unified index form, constructs a new monetary policy index, and studies the influence mechanism of monetary policy through the vector autoregression model. The study found that China's monetary policy index has experienced a process of first rising, slightly falling back to the platform, and then gradually falling, and the overall trend is consistent with the macroeconomic situation of China in different historical periods. At the same time, the positive impact of industrial added value and inflation will lead to the marginal tightening of monetary policy, and the industrial added value will have a greater impact on the dynamics of monetary policy and last for a longer time. In addition, inflation also indirectly affects monetary policy. This paper is of great significance to understand the trend of monetary policy and to conduct investment decision-making activities.*

Keywords: *Monetary policy index, Industrial added value, Inflation, Impulse response*

1. Introduction

At present, China's monetary policy tools can be generally divided into price type and quantitative type. The price type tool is the adjustment of the policy interest rate, while the quantitative tool is the adjustment of the money supply. The different measures of the two types of tools bring difficulties to describe the adjustment of China's monetary policy, and thus restrict the in-depth study of the influence mechanism of China's monetary policy.

In order to describe the trend of China's monetary policy adjustment in detail, this paper transforms the price and quantitative monetary policy tools into a unified index form, and constructs a new monetary policy index. At the same time, this paper also studies the influence mechanism of China's monetary policy through vector autoregression model. This study not only promotes a better understanding of the position of the current monetary policy in the historical dimension, but also promotes a better prediction of the future adjustment of the monetary policy, based on the current macroeconomic data, so as to guide the investment decision-making activities.

2. Literature review

2.1. Construction of monetary policy related index

Monetary policy has always been a hot topic widely discussed in the academic circle, which has a great impact on the macroeconomic trend, financial market operation and foreign exchange market fluctuations. Based on different research perspectives, scholars have constructed different indexes about money and finance.

Yuqiao (1998)[1]constructed China's monetary service index earlier to fully describe the basic characteristics of China's currency, that is, the weighted average value of liquid assets with different attributes after deducting the corresponding opportunity cost. Pu Yongxiang and Zhou Qing (2004)[2]combined with the three factors of interest rate, exchange rate and money supply, and constructed a monetary situation index reflecting the tightness of China's monetary policy.Huang Feiming (2009)[3] constructed the division weighted monetary aggregate index with the "user cost" of monetary assets as the weight based on the liquidity difference and incomplete substitution of monetary

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assets at all levels. Piao Zhicun et al. (2012)[4] used the state space model to build the financial situation index with time-varying coefficient in China and incorporated it into the study of monetary policy response function. Zhang Qi et al. (2019)[5] explored the construction of the expected index of monetary policy tightness from the perspective of objective factors (interest rate components) and subjective factors (expert opinions) of monetary policy. Di Chaolun and Wuyang (2021)[6] constructed the central bank communication index and the central bank behavior index based on the people's Bank of China's monetary policy implementation report and the traditional monetary policy adjustment method, respectively. As for the comprehensive use of price type and quantity type tools by the people's Bank of China to adjust monetary policy, the domestic literature has not unified the two types of tools for research. Wang Yuwei et al. (2019)[7] considered the open market business, interest rate, deposit reserve ratio and other tools to build the central bank behavior index, but this method has not yet included refinancing, mortgage supplementary loans and other tools, and the index value in a certain period will change with the change of sample size. The monetary policy index constructed in this paper effectively overcomes the above shortcomings and has strong stability under sensitivity analysis.

2.2. Research on the influence mechanism of monetary policy

Monetary policy is not only affected by the macroeconomic situation and other factors, but also affects the operation of the macroeconomic economy. There is little research on the influence mechanism of monetary policy, which is related to the ultimate goal of monetary policy from the legal level.

Nelson (2009)[8] used historical literature to study the reasons why the Bank of England adopted the inflation targeting system, and believed that the monetary policy decision-making mechanism was affected not only by the final target, but also by the transmission mechanism of monetary policy. Romer & Romer (2008)[9] studies the impact mechanism of monetary policy from a micro perspective, and believes that there should be a reasonable division of labor between central bank employees and decision-makers from outside, so as to better formulate monetary policy.From a macro perspective, this paper constructs China's monetary policy index, and analyzes how macroeconomic factors affect monetary policy decisions through vector autoregressive model, that is, how the impact from industrial added value and inflation will affect the monetary policy index. This study effectively makes up for the deficiency of the existing literature research, and enriches the connotation of the existing monetary policy research.

3. The construction of monetary policy index in China

The People's Bank of China has monetary policy tools in a wide range of types. Based on data availability and completeness of research, the monetary policy index will be listed below.

3.1. Construction method of monetary policy index

The measurement methods of price type and quantity type monetary policy instruments are different, so they cannot be directly compared. Therefore, this paper uses the practices of Xiong Weibo (2012)[10] and Girardin et al. (2017)[11] and other scholars for reference, converts the monthly changes of price type and quantity type instruments into the changes of benchmark interest rate, and then combines them with certain rules and methods to build China's monetary policy index (MPI). The conversion method is performed as follows:

For price tools, (1) conversion factor. The conversion coefficient of 1-year deposit benchmark interest rate, loan benchmark interest rate, rediscount interest rate, reverse repo interest rate, medium-term lending convenience and loan market quotation interest rate is 1, that is, the monthly change BP value is taken as the change of benchmark interest rate; The conversion coefficient of 7-day reverse repo interest rate is 1.25; The conversion coefficient of the quoted interest rate of the five-year loan market is 0.8. (2) Consolidation processing. Based on the mutual conductivity of interest rates, if the change direction of each price instrument is the same, the benchmark interest rate with the largest change is selected; If the change direction of each price instrument is different, take the sum of the maximum positive and negative changes of the benchmark interest rate to obtain the incremental index of price instruments in the monetary policy index.

For quantitative tools, (1) conversion factor. The deposit reserve ratio was reduced by 0.5 percentage points, corresponding to a 25bp decline in the benchmark interest rate, i.e. the conversion coefficient was0.5. If it is a directional adjustment of the deposit reserve ratio, the range of the deposit reserve ratio is comprehensively adjusted according to the proportion of the assets of the financial institutions involved

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to the total assets of the banking financial institutions. For open market operations, medium-term lending facilities, directional medium-term lending facilities, standing lending facilities, mortgage supplementary loans, and special refinancing, first calculate the proportion of the monthly net amount of money released by these quantitative instruments in the balance of deposits of financial institutions in the month, and then according to the balance of deposits of financial institutions at the end of April 2022 of 243.19 trillion yuan, the people's Bank of China reduced the reserve requirement by 0.25 percentage points, releasing liquidity of nearly 530billion yuan, The above-mentioned quantitative instruments can be converted into changes in the deposit reserve ratio and finally into changes in the benchmark interest rate. (2) Consolidation processing. The incremental index of quantitative instruments in the monetary policy index is obtained by summing the changes of benchmark interest rates converted from various quantitative instruments.

The incremental indicators of price type and quantity type tools are combined according to certain rules and methods. If the two incremental indicators change in the same direction, take the greater change; If the two incremental indicators change in different directions, take the sum of the two to obtain the monthly incremental indicator of the monetary policy index. Taking the benchmark interest rate of one-year loan in January 2002 of 5.85% as the starting value of China's monetary policy index, the monthly China's monetary policy index (MPI) can be obtained by accumulating the monthly incremental indicators of the monetary policy index.

3.2. Analysis of monetary policy index

As can be seen from Figure 1, China's monetary policy index has experienced a process of first rising first, slightly falling behind the high level, and then gradually declining. At present, China's monetary policy is in a relatively loose state.In order to check the stability of the constructed monetary policy index, another three monetary policy index indexes are constructed through technical adjustment, and sensitivity analysis is carried out. MPI1 is an index calculated by changing the conversion coefficient of 7-day reverse repo interest rate and 5-year loan market quotation interest rate to 1 and keeping the others unchanged. MPI2 is the index calculated by setting the conversion coefficient of the deposit reserve ratio to 0.25 and keeping the others unchanged. Mpi3 is an index obtained by directly summing the incremental indicators of price type and quantity type tools without considering the direction of change. As can be seen from Figure 1, the trend of the monetary policy index under different algorithms is roughly the same, but there are only differences in the fluctuation range, which reflects that the constructed monetary policy index has strong stability, and MPI is mainly used for research and analysis later.

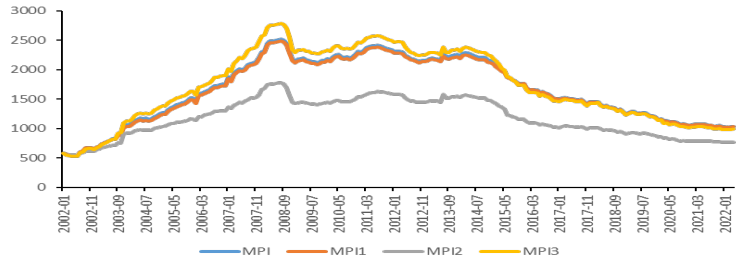

Figure 1: Trend of China's monetary policy index under different algorithms.

3.3. Monetary policy index and economic situation

The overall trend of China's monetary policy index is consistent with China's macroeconomic situation in different historical periods, as shown in Figure 2. From 2002 to 2007, in order to prevent overheated economic growth and excessive investment growth, China adopted a tight monetary policy, and the monetary policy index continued to rise. Due to the negative impact of the US subprime mortgage crisis from 2008 to 2009 and the European debt crisis from 2011 to 2012, China's economic growth slowed down, monetary policy tended to be loose, and the monetary policy index tended to decline. After 2014, the downward pressure on China's economy was great, and the monetary policy index tended to decline due to the marginal loose monetary policy. From the second half of 2020 to the first half of 2021, China's economy recovered from the new crown epidemic, the monetary policy gradually became stable, and the monetary policy index also maintained a stable operation. However, since then, the downward pressure on the economy has increased again, and the monetary policy index began to decline again. Overall, the change of monetary policy index lags behind the adjustment of economic growth.

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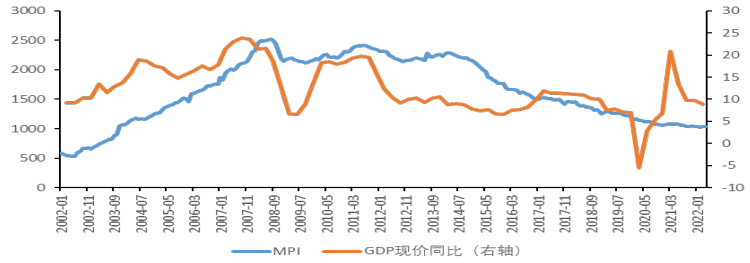

Figure 2: China's monetary policy index and GDP trend.

4. Analysis of vector autoregressive model

4.1. Vector autoregressive model construction and data sources

The previous article briefly compared the relationship between the monetary policy index and the economic situation. In order to further investigate the impact mechanism of the monetary policy index, this paper uses the vector autoregressive model (VAR model) to study how the impact of an endogenous variable will have a dynamic impact on the monetary policy index. According to the law of the people's Bank of China, the goal of monetary policy is to maintain the stability of the currency value and thus promote economic growth. Considering that the GDP data is quarterly data and the monetary policy index is monthly data, this paper will select the consumer price index and industrial added value as the measurement indicators of price stability and economic growth respectively for vector autoregressive model analysis.

The vector autoregressive model of ternary lag order p order was constructed as follows:

$$y_t = C + A_1 y_{t-1} + A_2 y_{t-2} + \cdots + A_p y_{t-p} + \mu_t \quad (1)$$

Among:

$$y_t = [MPI_t, CPI_t, IVA_t]^T$$

$$A_i = \begin{bmatrix} a_{11}^i & a_{12}^i & a_{13}^i \\ a_{21}^i & a_{22}^i & a_{23}^i \\ a_{31}^i & a_{32}^i & a_{33}^i \end{bmatrix}$$

$$C = [c_1, c_2, c_3]^T \quad \mu_t = [\mu_{1t}, \mu_{2t}, \mu_{3t}]^T$$

CPI_tAnd respectively represent the year-on-year growth rate of the consumer price index and the year-on-year growth rate of industrial added value in period T. the data are from the National Bureau of statistics and are the readings of the monetary policy index constructed above in period T. the sample data range is from January 2002 to April 2022. Is the model constant term matrix, is the explanatory variable coefficient matrix, is the vector white noise process, there is no autocorrelation, is the lag order of the model.$IVA_t MPI_t CA_i \mu_t p$

4.2. Number of variables and lag order

In order to build a reasonable vector autoregressive model, it is necessary to determine the number of variables in the model and the lag order of variables. In terms of the number of variables, the more variables included in the VAR model, the more coefficients to be estimated, which will make the sample size relatively small and increase the model estimation error. Therefore, the VAR model usually contains only a few variables. However, if the VAR model contains too few variables, there may be a problem of missing variables. According to economic theory, sample size and common practice, this paper constructs a VAR model including monetary policy index, inflation and industrial added value.

In the selection of lag order, the information criterion method and the method of checking whether the residual term of the model is white noise are used. In practice, it is found that the difference processing of MPI is better than that of MPI without difference processing (as shown in Figure 3 a). LR test, FPE test, AIC criterion and aqic criterion all show that there is no difference in the choice of lag order. At the same time, the two LM test values are 12.94 and 16.22, respectively. At the 5% significance level, the original assumption that the residual term has no autocorrelation is accepted, that is, the disturbance term

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is white noise.

Selection-order criteria
Sample: 2002m6 - 2022m4 Number of obs = 239

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-2446.74				160538	20.4999	20.5175	20.5436
1	-2068.51	756.46	9	0.000	7306.52	17.4101	17.4805	17.5847*
2	-2045.73	45.555*	9	0.000	6511.14*	17.2949*	17.4179*	17.6003
3	-2037.77	15.933	9	0.068	6568.33	17.3035	17.4793	17.7399
4	-2030.19	15.155	9	0.087	6648.15	17.3154	17.544	17.8827

Endogenous: delta CPI IVA
Exogenous: _cons

Selection-order criteria
Sample: 2002m5 - 2022m4 Number of obs = 240

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-2006.95				3774.36	16.7496	16.7671	16.7931
1	-969.679	2074.6	9	0.000	.716795	8.18066	8.25078	8.35469*
2	-945.919	47.519	9	0.000	.633864	8.05766	8.18037*	8.36222
3	-935.768	20.303*	9	0.016	.627871*	8.04807*	8.22337	8.48315
4	-928.236	15.065	9	0.089	.635707	8.0603	8.28819	8.6259

Endogenous: MPI CPI IVA
Exogenous: _cons

Figure 3: Information criterion table obtained by making MPI difference and no difference.

In addition, all eigenvalues are clearly within the unit circle (as shown in Figure 4), indicating that the VAR model constructed in this paper is a stationary process. Considering that second-order lag can reduce the sample size of estimation loss and retain more information, this paper first makes differential processing of MPI, and then makes VAR model estimation.

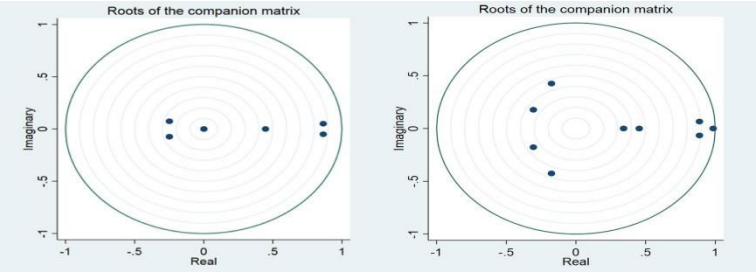

Figure 4: Differential and non post-differential stability discrimination plots.

4.3. Variable sequencing and impulse response

Variable sorting. Since VAR model contains many parameters, and the economic significance of these parameters is difficult to explain, attention is focused on impulse response function. In order to analyze the dynamic impact of inflation and industrial added value on the monetary policy index, based on the non orthogonal impulse response function, the impact of each variable can not be clarified separately, so the orthogonal impulse response function is needed. The orthogonalized impulse response function depends on the order of variables. Therefore, the Granger causality and cross correlation diagram between variables are investigated respectively (as shown in Figure 5 and figure 6).

Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
delta	CPI	12.691	2	0.002
delta	IVA	9.9691	2	0.007
delta	ALL	26.11	4	0.000
CPI	delta	3.811	2	0.149
CPI	IVA	24.6	2	0.000
CPI	ALL	46.382	4	0.000
IVA	delta	7.2271	2	0.027
IVA	CPI	2.0493	2	0.359
IVA	ALL	9.5003	4	0.050

Figure 5: The Granger causality test form.

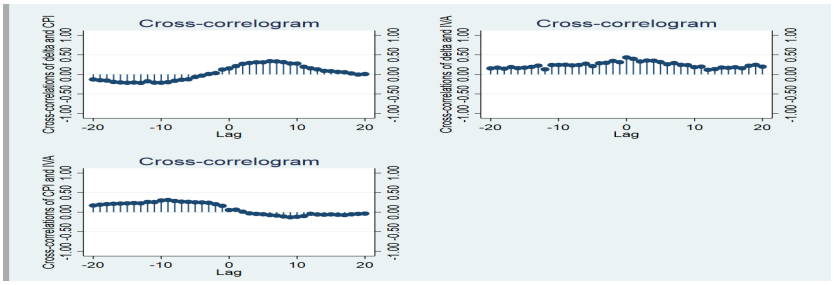

Figure 6: The cross-relation diagram of the three variables.

The test results show that CPI and IVA are the Granger causes of MPI, MPI is the Granger causes of IVA, and IVA is the Granger causes of CPI, but CPI is not the Granger causes of IVA. Combined with Granger causality test and the purpose of this study, the order of the three variables is IVA, CPI and MPI.

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From economic theory, it can be explained that the positive impact on industrial added value can reduce the level of inflation, and lower inflation has less constraints on monetary policy.

Pulse response aspect. Figures 7 to 9 show the impulse response diagram, in which the horizontal axis represents the number of periods of the impulse response function. The blue solid line describes the dynamic response of the response variable to the impact in the next 20 months when the impact variable index is impacted by a unit positive impact, and the gray shadow part is the 95% confidence interval.

Figure 7 shows the dynamic impact of industrial added value on the monetary policy index. The rise of industrial added value indicates that industrial enterprises' production and operation activities are good, they are optimistic about the future economic situation, and the driving force of economic growth is strong. However, in order to prevent economic growth from overheating, monetary policy adopted counter cyclical adjustment and shifted to marginal tightening. The marginal tightening pace of monetary policy in the first five months was significantly faster, and then gradually returned to normalization, reflecting the gradual attenuation of impulse response.

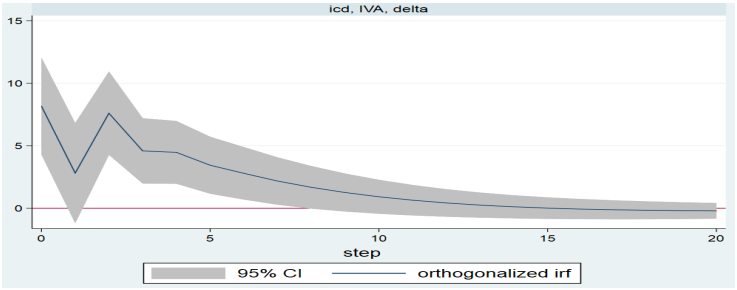

Figure 7: Dynamic impact of industrial added value on monetary policy index.

Figure 8 shows the dynamic impact of inflation on the monetary policy index. The rise of inflation indicates that prices will rise rapidly, the purchasing power of RMB will decline, residents' income and consumption will also be greatly affected, and the national economic structure may be unbalanced. In order to maintain the stability of the currency value and the healthy development of the economy, the monetary policy may adopt the regulation mode of marginal tightening, and the adjustment range of the monetary policy in the first three months is obvious, and then the monetary policy will return to normalization. Compared with the industrial added value, the impact of inflation on the monetary policy index is relatively small, the adjustment of monetary policy is relatively slow, and it returns to normalization faster.

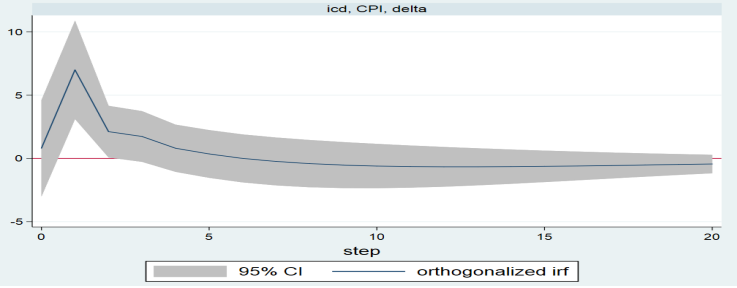

Figure 8: Dynamic impact of inflation on the monetary policy index.

The dynamic impact of industrial added value and inflation on the monetary policy index is quite different. What are the reasons for this. Impulse response function depends on the order of variables. According to Granger causality test and cross correlation diagram, the order of variables is industrial added value, inflation and monetary policy index. Industrial added value can affect the monetary policy index by affecting inflation, and may also directly affect the monetary policy index. Therefore, we observe the dynamic impact of industrial added value on inflation (as shown in Figure 9). The rise of industrial added value will reduce the inflation level in the short term, but inflation will soon change from negative to positive, and it has not converged to zero for a long time (20 months), reflecting that although industrial added value will reduce the inflation level in the short term, it will significantly increase the inflation level in the long term.

From the perspective of economics, the rise of industrial added value will significantly increase the supply of goods and reduce the price of goods related to consumers, thus reducing the level of inflation in the short term. However, in the long run, the continuous rise of industrial added value may cause

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overheating of economic growth, a sharp decline in the unemployment rate and a significant increase in residents' income, thus stimulating investment and consumption, and the overall price level will also tend to rise. This explains why the dynamic influence of industrial added value on the monetary policy index in the first two months a V-shaped trend, industrial added value rise, short-term price level decline, inflation on monetary policy constraints, but as the economic overheating and inflation rise at the same time, the necessity of marginal tightening of monetary policy to rise. At the same time, in a long period of time, because the industrial added value has an upward effect on inflation, the monetary policy index has a greater response to the industrial added value and lasts longer.

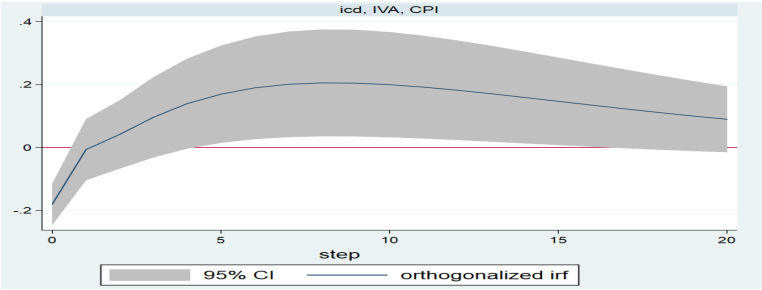

Figure 9: Dynamic impact of industrial added value on inflation.

4.4. Robustness test

In order to test the robustness of impulse response results, this paper analyzes them from two perspectives. First, choose different monetary policy indexes. In order to investigate the stability of the constructed monetary policy index, we obtained another three monetary policy indexes through technical adjustment. In the robustness part, by replacing the MPI variables mentioned above with MPI1, MPI2 and mpi3 variables in turn, vector autoregressive analysis is performed to obtain the corresponding impulse response graph. The results show that the overall trend of the impulse response graph (Fig.10 show the results of mpi3 variables) is consistent, with only slight differences, which does not affect the conclusions of the previous analysis. This shows that the impulse response results have strong robustness, and the research conclusion is relatively reliable.

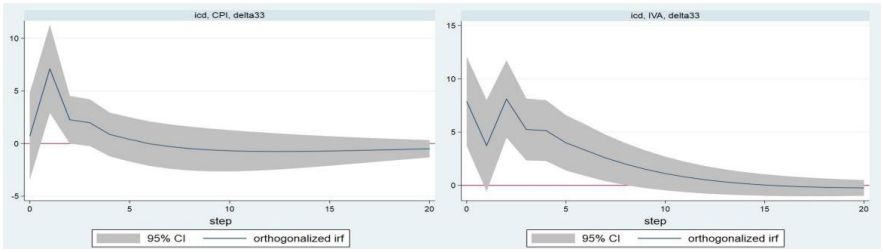

Figure 10: CPI and IVA on MPI dynamics.

Second, change the variable order of the pulse response function. Because the purpose of this paper is to investigate the dynamic impact of industrial added value and inflation on the monetary policy index. The order of variables in the monetary policy index remains unchanged, and the order of industrial added value and inflation is changed. It is found that the confidence interval becomes very irregular, whether it is the dynamic impact of inflation on the monetary policy index or the dynamic impact of industrial added value on the monetary policy index, The upper and lower limits are also very large (as shown in Fig.11). From the negative side, the sequence of variables used above has both practical economic interpretation and statistical significance.

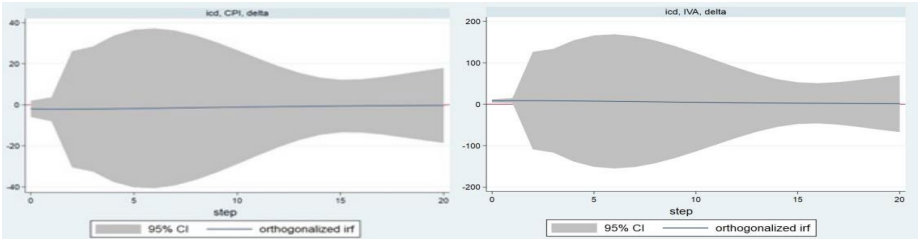

Figure 11: CPI and IVA on MPI dynamics.

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5. Conclusion

By drawing on the relevant academic research results at home and abroad, and combining with the actual use of monetary policy tools in China, this paper constructs a new monetary policy index. It is found that China's monetary policy index has gone through a process of first rising, slightly falling behind the platform, and then gradually declining. Overall, the trend of the monetary policy index is consistent with the macroeconomic situation of China in different historical periods. At the same time, this paper also through the vector autoregression model research monetary policy influence mechanism, namely the analysis of economic growth and price level on the dynamic influence of monetary policy index, the results found that the positive impact of industrial added value and inflation, will lead to the monetary policy marginal tightening, and industrial added value more dynamic impact on monetary policy, lasts longer. Industrial added value can not only directly affect monetary policy, but also indirectly affect monetary policy through inflation.

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