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Economic Growth, Inflation and Money Supply in China

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Abstract

The article selects China's quarterly data for the first quarter of 1996-2022, draws on the theories of the modern monetary school and the New Keynesian school, and utilizes the endogenous economic growth model VAR measurement method to select GDP growth rate as a proxy variable for economic growth, the rate of change in prices (CPI) as a proxy variable for inflation, and the growth rate of M2 as a proxy variable for the change in money supply, and empirically analyzes the relationship between economic growth, inflation, and money supply not only at the long The relationship between economic growth, inflation and money supply is empirically analyzed not only at the level of the full sample of the long-period, but also at the level of two short-period samples with 2008 as the boundary. The results show that inflation is a monetary phenomenon in the long run, but not in the short run. In the long run, China's money is "neutral".

Keywords

Economic Growth; Inflation; Money Supply; VAR Models.

1. Introduction

1.1. Introduction

Research on the relationship between inflation, money supply and economic growth is an important area of macroeconomics and monetary economics, from the earliest dichotomy of monetary and economic research to the later integration of research, scholars have not been able to reach a unification of this issue until today. On the study of inflation, money and economic relations, there are currently three views: one is the theory of monetary neutrality; the second is the theory of monetary short-term non-neutral and long-term neutrality, the third is the theory of monetary non-neutrality, and are supported by a large number of empirical studies, the empirical results of the different with the length of time of the data selected, the data of the scale (yearly, quarterly or monthly), and the model of the setting of the residuals of the serial correlation as well as the choice of the number of lag order of econometric analysis have a greater relationship, so it is important for the study of monetary economics and macroeconomics. The choice of the lag order in the econometric analysis has a greater relationship with the length of the data (annual, quarterly or monthly) and whether the residuals of the model are serially correlated or not. In the mainstream analysis of the relationship between the three, VAR (including TVP-VAR, SVAR, and VECM) models will do variance decomposition and impulse response (or Granger causality) analysis of the relevant variables, and finally derive the short-term and long-term dynamic relationship between the variables. This paper also adopts the basic analytical framework of VAR to retest the relationship among the three in three parts.

1.2. The Main Research Methodology of this Paper

The research method of this paper mainly starts from the typicalized facts and classic literature, establishes the relevant theories through the review of the established theories as well as the summary and review of the relevant literature, and then carries out the analysis of the current situation with the help of the statistical analysis method, and then establishes the empirical

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model, and arrives at the reasonable suggestions through the econometric analysis. The following are analyzed from three perspectives: theoretical method, statistical method and empirical method.

1.2.1. Theoretical Analysis Methods

According to the research focus of this paper, i.e. the relationship between China's economic growth, inflation rate and money supply, the paper lays a theoretical foundation for this research by combing through the theories related to this paper and summarizing the existing literature, so as to promote the next step of this research.

1.2.2. Methods of Statistical Analysis

In the paper, on the basis of combing the existing theories and literatures, the three key variables of China's economic growth, inflation rate and money supply are analyzed in the current situation, in which the relevant data are first collected, and then processed and processed, and the relevant research is carried out through the method of statistical analysis, in order to carry out a typical current situation analysis of the relationship between China's economic growth, inflation and money supply.

1.2.3. Measurement and Analysis Methods

On the basis of the theoretical literature review and the analysis of the typicalization status quo, the article establishes an empirical model with the help of the collected statistical data and conducts an empirical test by using the econometric analysis methods such as vector autoregression etc. In the process of the test, the econometric methods such as smoothness test of vector autoregression model, Granger causality test, impulse response analysis and variance decomposition test are adopted respectively to study the relationship between economic growth, inflation and money supply and to analyze how inflation and money supply affect economic growth so as to obtain scientific and reasonable results. money supply, and analyzed how inflation and money supply affect economic growth, so as to get scientific and reasonable results.

1.3. Inadequate Research

Firstly, the scope of this paper is limited to one country, and the relationship between economic growth, inflation and money supply in other countries has not been studied, so it is not possible to make a side-by-side comparison with other countries. Secondly, the research data of this paper covers a limited scope, only radiating to the data of twenty-seven years, for the situation before 1996, due to the difficulty of obtaining the data has not been researched, so the scientificity of this paper needs to be further enhanced.

2. Literature Review

2.1. Review of Relevant Theories

2.1.1. Theoretical Developments Related to the Phillips Curve

Phillips (1958) examined the relationship between the rate of unemployment and the rate of change in wages within the UK over a period of 97 years from 1861 to 1957, and his conclusions showed a curve to represent the alternating relationship between the two variables of interest in the UK over the period, which is also known as the Phillips curve. The curve shows that there is a negative correlation between the rate of unemployment and the rate of monetary wage growth in the UK. That is, during the period under study, when the unemployment rate in the UK rises, there is a tendency for the growth rate of money wages to fall to some extent; similarly, when the unemployment rate falls, there is a tendency for the growth rate of money wages to rise.Samuelson and Solow made the same argument in 1960, arguing that money is non-neutral.Okun (1962) found an empirical relationship between the growth rate of the economy

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during cyclical fluctuations and the rate of unemployment, i.e., when the real unemployment rate falls, there is a negative relationship between the growth rate of the economy and the rate of unemployment. The empirical relationship between them is that when real GDP growth declines by 2 percent relative to potential GDP growth, the unemployment rate rises by approximately about 1 percent; when real GDP growth rises by 2 percent relative to potential GDP growth, the unemployment rate declines by approximately 1 percent. This is the famous Okun's Law. Scholars have subsequently added new interpretations to the Phillips curve, namely, to further convert the "unemployment-inflation" Phillips curve into an "economic growth-inflation" Phillips curve, which is also known as the "output-price" Phillips curve. output-price" Phillips curve. Based on the above three transformations of the Phillips curve, Governments also propose corresponding macro or monetary policies that act on a country's economic growth at a time.

After the Second World War, with the vigorous implementation of Keynesianism in Britain and the United States and the expansionary fiscal policy that has been practiced, many countries faced persistent inflation. Against this realistic background, monetarism led by Friedman emerged. Among them, Milton Friedman's Modern Quantity Theory of Money suggests that "inflation is always a monetary phenomenon that arises from a rapid expansion of the quantity of money rather than aggregate output" (1970), which argues that long-run output and returns are unaffected by the money supply, i.e., money remains neutral. Meanwhile, Irving Fisher argued that the value of transactions in an economy must be equal to the amount of money in circulation in that economy, using the formula PY=MV, where Y is real output, P is the price level of the economy, M is the money supply, and V is the velocity of money circulation. In addition to this, between the 1940s and the 1970s, the relationship between the money supply and inflation became a major argument between two major schools of economic thought, Keynesianism and Monetarism. Among them, the Keynesian school of thought argued that the price of money remains relatively speaking for a short period of time , while the monetarists argued that prices lose their rigidity over time and vary with the money supply. Also, Keynesians point out that inflation is mainly influenced by real variables such as the unemployment rate, whereas monetarists believe that it is mainly a monetary phenomenon caused by changes in the money supply. Although the two schools of thought do not share the same views, they both accept Fisher's view. Meanwhile, as part of neoclassical macroeconomics, Lucas (1972) proposed the rational expectations hypothesis, which presupposes that the public is rationally expectant rather than adaptive, and this hypothesis brings about results showing that there is no discrepancy between expected and actual inflation, and that the two continue to be aligned, i.e. money is neutral. And the Phillips curve, under the assumptions of the theory, has a vertical shape in both the short run and the long run, with the position remaining constant at the natural rate of unemployment. Later, the theory proposed by Gail and Gerlter (1999) assumes that the Phillips curve is mixed expectations and argues that the public expects the next inflation rate to be the current inflation rate, i.e. money is neutral in the long run. These above discussions and differences in views constituted the economic theories of the time.

2.1.2. Theoretical Developments Related to Endogeneity

Tobin (1965) proposed the famous Tobin's monetary model, which rejects the assumption of monetary neutrality and introduces it into the utility function of the economy under study, which was one of the few models in academia at the time that treated money as an asset. In the construction of the model, the overlapping generations model was used, and the conclusions obtained firstly showed the relationship between money growth and capital, and that the inflation it brought about was able to contribute to the growth of the economy through the acquisition of capital.Sidrauski (1967) improved on the Tobin's money model, and although the same introduction of the money variable into the utility function was also made, in the process the subject of the study was able to obtain utility not only from the consumption, but also from

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the money they possess, leading to the conclusion that money is super-neutral and that the real economy is not affected by nominal money. Unlike the previous two models, Palley (1996) introduces the monetary variable into the technology function and, using the appropriate analytical tools, finds that money growth leads to inflation, which in turn has a negative effect on economic growth, but that money growth promotes technological progress.

From the above analysis, it can be seen that the differences in the established theories on the relationship between money, inflation and economic growth rate are mainly on the question of whether money is neutral or not, i.e., whether the money supply affects a country's real economic growth in the long run. It should also be noted that there is a close theoretical relationship between money supply and inflation. A review of this theoretical literature will provide a theoretical basis for the relationship between economic growth, inflation and money supply studied in this paper.

2.2. Review of Relevant Empirical Evidence

2.2.1. Empirical Studies on Money Supply and Inflation Rate Correlation

In the study of inflation in a country, the money supply is a variable that is difficult to ignore.Sidrauski (1967) studied a model in which the premise of monetary neutrality implies that the rate of growth of money has a nominal real effect on the equilibrium, but subsequent theoretical studies have shown that, in most cases, the stable capital stock is reduced by an increase in the rate of inflation.Stockman (1981) developed a long-run equilibrium growth model under the assumption of a "cash-in-advance constraint". 1981) modeled long-run equilibrium growth under the assumption of the "cash-in-advance constraint", which, contrary to the findings of the Mundell-Tobin effect, suggests that investment and real money balances are complementary, i.e., that the rate of inflation will reduce both investment and real money balances.

Haug and Dewald (2004) examined the cyclical variations and long-term trends of inflation and money supply in a group of industrialized countries and concluded that there is a strong correlation between the long-term trend of inflation and money supply, however, their cyclical factor did not yield significant results. In addition, Assenmacher-Wesche and Gerlach (2007) showed that the cyclical factor of inflation is correlated with the capacity utilization of the economy, which implies that the results of the paper have a fit with the Keynesian and monetarist studies, and therefore, in the short run, the real economic activity is an important determinant of inflation; whereas, in the long run, the money supply trends will have a more lasting impact.

2.2.2. Empirical Study of the Impact of Money Supply and Inflation on Economic Growth

Existing literature does not have a uniform inculcation of the relationship between the two, with inflation and economic growth yielding different conclusions in different contexts, and relevant studies have found no causal relationship in only a few countries. The effect of inflation on economic growth based on neoclassical growth theory suggests that an inflation-induced rise in nominal interest rates makes investment a better contributor to economic growth than consumption, as investment leads to increased capital accumulation, which further contributes to economic growth. This idea is well known as the Mundell-Tobin effect (1963).Since the 1990s, some scholars have used relevant data for 12 Latin American countries from 1950 to 1985 and conducted empirical tests with the help of the Generalized Least Squares (GLS) method, and the results show that there is a negative correlation between inflation and economic growth (De Gregorio, 1992). Fisher (1993) tested the impact of macroeconomic factors such as inflation on economic growth using panel data for 93 countries. The results found that economic growth is negatively impeded by inflation in both directions and also pointed out the inconsistency between high inflation and sustained economic growth.Barro

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(1995) analyzed the impact of inflation on economic growth using panel data for 100 countries for the period 1960-1990 and the results showed that the estimated impact of inflation on economic growth is significantly negative and can only be obtained if the sample contains statistically significant results are obtained when high inflation data are included in the sample.

Sarel (1996) explored the possibility of a non-linear effect of inflation on economic growth based on data for 87 countries over the period 1970-1990. His findings suggest that economic growth linked to inflation shows a structural breakthrough, while the threshold for structural breakthrough occurs when inflation is higher than 8 percent. Instead, economic growth declines.Paul, Kearney and Chowdhury (1997) examined the correlation between inflation and economic growth in 70 countries over the period 1960-1989 and the results showed that no causality was found between inflation and economic growth in only a few countries, with 20% of the sample countries showing bidirectional causality and the rest of the countries having a unidirectional relationship, therefore, inflation promotes economic growth and economic growth also leads to inflation under certain circumstances.

Bruno and Easterly (1998) examined the inflation-growth correlation for 26 countries that experienced inflationary crises between 1961 and 1992. The empirical results show that the threshold level for the occurrence of an inflation crisis is about 40% and that the effect of low and moderate inflation on economic growth is uncertain.Khan and Senhadji (2001) studied the threshold effect of developing and developed countries on inflation and economic growth based on the relevant data of 140 countries during the period of 1960-1998, and the results show that there is a threshold level above which inflation negatively affects economic growth, and that the estimated threshold levels are not 1-3% for developed countries and 11-12% for developing countries.Mallik and Chowdhury (2001) used an error correction model to explore the short- and long-run relationship between inflation and economic growth in four South Asian countries, and found that inflation rates in the four countries in the long run would be more effective in promoting economic growth than inflation rates in other countries. long run the inflation rate does not promote economic growth and that the sensitivity of inflation to changes in economic growth rate is greater than the sensitivity of economic growth to changes in inflation. This view is also confirmed by another study, Ahmed and Mortaza (2005) studied the relationship between inflation and economic growth in Bangladesh over the period 1980 to 2005 and confirmed the existence of a threshold level of inflation in the country. The paper used the same methodology as Mallik and Chowdhury (2001) to confirm the inflation-economic growth relationship. For the estimation of inflation threshold, the paper refers to the methodology proposed by Khan and Senhadji (2001), and the empirical results show that there is a statistically significant long-term negative relationship between inflation and economic growth. And the inflation threshold is 6%.

Erbay and Okuyan (2008) investigated the relationship between inflation and economic growth in Turkey while validating it with the help of Bonds method proposed by scholars such as Pesaran (2001) and found that there is a significant short-run relationship between inflation rate and economic growth. Wang Sen and Huang Jie (2018) studied the relationship between monetary characteristics and China's economic growth from two perspectives: money supply as well as the velocity of money circulation based on the variance decomposition test, and the results show that money supply can promote China's growth, while economic growth affects the velocity of money circulation. Focusing on the period from the industrialization period to the economic virtualization period, based on the Bayesian learning method and taking the United States as an object, Xiaolin Lu, Kun Guo, and Zhi Dong (2018) investigated the linkage between economic growth and inflation rate under the current environment of economic virtualization, and the results showed that in the current context, the interaction mechanism between economic growth and inflation could not be separated from the influence of the virtual economy.

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There is also some literature that focuses on the relationship between money supply, inflation, and economic growth. Liu Bin (2002) points out that changes in output in the long run are unaffected by changes in prices and money supply, and that changes in output are mainly determined by the municipal sector; changes in the money supply affect prices in both the long and short run. Liu Lin and Jin Yunhui (2005) argue that there is a long-run equilibrium relationship between economic growth, inflation and money supply; in the long run, money supply can promote economic growth, while inflation hinders economic growth; at the same time, economic growth stimulates the expansion of money supply, while inflation causes money supply to contract. Yao Yuan (2007) pointed out that the impact of money supply on economic growth and inflation has a lagged effect, and money is non-neutral in the long run, but economic growth and inflation do not have an impact on the money supply, i.e., money is exogenous. Zhang Wei and Jun Su (2010) show that money supply has an impact on output in the short run, but is neutral in the long run; both long-term and short-term money supply has an impact on prices; at the same time, money supply is affected by output and prices. Wei Rongrong and Cui Chao (2011) found that there is a long-run stable equilibrium relationship between the economic growth rate, the inflation rate and the growth rate of money supply; in the short run, economic growth has a positive effect on the money supply, while inflation has a negative effect on the money supply; there is no significant effect of the money supply on economic growth and inflation, and economic growth does not cause inflation, but inflation has a negative effect on the economy has a promoting effect. Zhang Chengsi (2012) pointed out that there is a long-term stable equilibrium relationship between China's economic growth rate, inflation rate and money supply growth rate, money supply growth rate has a significant effect on inflation rate, but no effect on economic growth rate, and both economic growth rate and inflation rate will have an effect on money supply. Zhang Mingjiu and Pan Hui (2020) found that in the long run, the growth rate of money supply has a significant effect on the inflation rate, but in the short run, money supply is not always the cause of price changes.

In summary, it can be seen that there are more studies on the relationship between economic growth, inflation and money supply, revealing the relationship between the variables, but the conclusions of the studies are more divergent. This paper adopts the basic analytical framework of VAR to re-test the relationship between the three in three parts.

3. Empirical Model Construction and Data Characterization

3.1. Theoretical Framework

3.1.1. Derivation of the VAR Model of Money Supply in the Modern School of Monetary Thought

Friedman proposed the Quantity Theory of Money and the Quantity Equation of Money based on the Fisher Transaction Equation MV=PT:

$$M=kPY \tag{1}$$

Where M is the money supply, k is the rate at which people are willing to hold money (where the inverse 1/k is the velocity of money circulation V), P is prices, and Y is real economic output. Taking logarithms on both sides of the equation and performing a first order difference to represent the growth rate of the variable yields the following equation:

$$\triangle M_t + \triangle V_t = \triangle P_t + \triangle Y_t \tag{2}$$

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Assuming that the velocity of money circulation is essentially stable, $\Delta V_t = 0$, equation (2) can be rewritten as:

$$\triangle P_t = \triangle M_t - \triangle Y_t \tag{3}$$

Due to price stickiness and wage rigidity, the highly programmed and static equation (3) is not quite compatible with the real world, and it is necessary to take into account the dynamic influence process in the real world, and it is more reasonable to introduce the time lag effect, and for this reason, the lag effect factor is introduced into the equation (3), which is obtained:

$$\triangle P_t = \alpha(\mathrm{L}) \triangle M_{t-1} - \beta(L) \triangle Y_{t-2} \tag{4}$$

Where,$\alpha(\mathrm{L}) = \alpha_1 + \alpha_2 L + \alpha_3 L^2 + \cdots + \alpha_n L^{n-1}$ is the lag operator polynomial, n is the optimal lag order, and β(L) is the same as above.

Although equation (4) considers the dynamic influence mechanism, but due to its theoretical assumption of the premise that the central bank can absolutely control the exogenous variables, while in fact the central bank can not decide, not only that, the central government to formulate monetary policy to first set the rate of change in prices and economic growth rate indicators, or to first refer to these two variables, so the three core variables in the model are actually endogenous to each other in a dynamic system So the three core variables in the model are actually endogenous to each other in a dynamic system, and one variable is subject to the constraints of the other variables in the system. For this reason, the mechanism of interaction between the three variables needs to be generalized using a vector autoregressive system, i.e.:

$$X_t = \varphi(L) X_{t-1} + e_t \tag{5}$$

Where, $X_t = [\triangle P_t, \triangle M_t, \triangle Y_t]$, denotes the time series vector of endogenous variables, φ(L) denotes the vector lag operator polynomial, ande_t is the shock vector.

3.1.2. New Keynesian Derivation Of the Money Supply VAR

The main New Keynesian money supply consists of three core equations. the IS equation, the Phillips curve equation and the Taylor rule based monetary policy response equation, whose programmatic equations are represented by Eq. (6) to Eq. (8), respectively, and this system describes the logic of the interaction between interest rate based monetary policy and the economic development and price volatility. It is shown in the figure below:

$$\triangle Y_t = \alpha_{11}(i_t - \triangle P_t) + \varepsilon_{yt} \tag{6}$$

$$\triangle P_t = \beta_{21} E_t \triangle P_{t+1} + \beta_{22} \triangle P_t + \varepsilon_{yt} \tag{7}$$

$$i_t = \gamma_{31} \triangle Y_t + \gamma_{32} \triangle P_t + \varepsilon_{it} \tag{8}$$

Where i denotes the interest rate.ε_{yt} , ,ε_{pt} , andε_{it} denote demand shocks, supply shocks and monetary policy shocks, respectively.

Although the interest rate is an important variable in China's monetary policy, the money supply is still the intermediary target of China's monetary policy based on aggregate control, for this reason, the interest rate can be converted to the money supply by using the LM equation

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(9), and log-linearization, linear differencing, and so on.i_t can be converted into money supply by utilizing the LM equation (9) and performing log-linearization and linear differencing.M_t.

$$\frac{M_t}{P_t} = f(Y_t, i_t) \tag{9}$$

After introducing theM_t After introducing the New Keynesian money supply system and based on the fact that there is a lag effect in the real economy where the variables affect each other, the addition of the lag term lags to the core equation leads to equations (10) through (12).

$$\triangle Y_t = \alpha_{11} \triangle M_t + \alpha_{12} \triangle P_t + lags + \varepsilon_{yt} \tag{10}$$

$$\triangle P_t = b_{21} E_t \triangle P_{t+1} + b_{22} \triangle P_t + lags + \varepsilon_{pt} \tag{11}$$

$$\triangle M_t = c_{31} \triangle Y_t + c_{32} \triangle P_t + lags + \varepsilon_{mt} \tag{12}$$

Introducing an additional random perturbation term further replaces the$E_t \triangle P_{t+1}$ replacing$\triangle P_{t+1}$, then it is easy to see that equations (10) through (12) also constitute a structural vector autoregressive model of money supply, namely:

$$A_0 X_t = A(L) X_{t-1} + \varepsilon_t, \varepsilon_t \sim i.i.d.N(0, \Omega) \tag{13}$$

Whereε_t denotes the structural stochastic disturbance term consisting of supply, demand, and monetary shocks orthogonal to each other, with a diagonal variance-covariance matrix. Based on the standard time-series analysis theory, setting the coefficient matrix in the SVAR modelA_0 set as the lower triangular matrix, the SVAR model can be further converted into a reduced VAR model, i.e:

$$X_t = \varphi(L) X_{t-1} + e_t, e_t \sim i.i.d.N(0, \Omega_e) \tag{14}$$

Where, $\varphi(L) = A_0^{-1}\left(\Sigma_{i=1}^{n} A_i L^{i-1}\right), e_t = A_0^{-1} e_t, \Omega_e = A_0^{-1} \Omega (A_0^{-1})$

Both the monetary school and the New Keynesian school of money supply system model is basically the same, and contains the money supply growth rate, economic growth rate and the rate of price change of the VAR model is the basic model to analyze the interaction of the three.

3.1.3. Modeling

This paper draws on the analytical methods of Sims (1980) and others to introduce the VAR model into the macro-analytical framework that contains three endogenous variables, namely, the growth rate of money supply, the economic growth rate and the rate of price change, and at the same time constructs a VAR model of endogenous economic growth by taking each endogenous variable of the system as a function of the lagged values of all the endogenous variables of the system, and then explains the impact relationship among the variables.

The lagged p-order VAR model is as follows:

$$Y_t = \varphi Y_{t-1} + \cdots + \varphi Y_{t-p} + H X_t + e_t, \text{t=1,2,...,T.} \tag{15}$$

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Of these, the Y_t and X_t are the k-dimensional endogenous variable column vectors and d-dimensional exogenous variable column vectors, respectively.φ_1 , ..., ... φ_p is a k*k-dimensional matrix, H is a k*d-dimensional matrix of coefficients to be estimated, P is the lag period, and T is the sample size.e_t is the k-dimensional perturbation column vector.

In order to ensure a sufficient number of lags and a sufficient number of degrees of freedom, the LR test, the AIC information criterion and the SC information criterion are used to determine the lag period. The unit root test is used to determine the smoothness of the VAR model to remove the problem of "pseudo-regression", and if the test is passed, the impulse response and variance decomposition can be performed.

3.1.4. Data Selection

The sample interval of this paper is from the first quarter of 1996 to the first quarter of 2022. On the one hand, due to the fact that the country's monetary policy shifted from overall tightening to easing and interest rate cuts from 1996, the year-on-year growth rate of the CPI dropped sharply from 17.1% in 1997 to 14.9%, and inflation in China has not been above the double-digit level ever since; on the other hand, based on the availability of data availability. Overall, the analysis mainly involves the economic growth rate, the price change rate and the money supply growth rate. In the basic analysis of the model, the year-on-year GDP growth rate for each quarter of the calendar year was used as the indicator of economic growth rate (denoted by GDP), the year-on-year growth rate of the Consumer Price Index (CPI) was used as the indicator of price change (denoted by CPI), and the growth rate of the broad money supply M2 was used as the indicator of the growth of the money supply rate (denoted by M2). Since all three types of IRS are in the year-on-year form of quarterly growth rates, there is no need for seasonal adjustment. The data for the three categories were obtained from the National Bureau of Statistics (NBS).

3.2. Statistical Characterization of Research Variables

Based on the research variables selected above, statistical characterization of the variables of interest, i.e., sample size, mean, standard deviation, maximum and minimum values of each variable, is shown in Table 1.

Table 1. Statistical Characteristics of Relevant Variables (1996-2022)

```
sum GDP CPI M2
```

Variable	Obs	Mean	Std. Dev.	Min	Max
GDP	105	.1202815	.0514828	-.0549044	.2393199
CPI	105	.0218404	.0235532	-.0216667	.0936667
M2	105	.1574828	.0522569	.0797082	.2976363

From the chart, it can be found that from 1997 to 2022, the quarterly year-on-year growth rate of China's GDP has a maximum of 23.93%, a minimum of -5.49%, and a mean of 12.03%; the quarterly year-on-year growth rate of the CPI has a maximum of 9.37%, a minimum of -2.17%, and a mean of 2.18%; and the quarterly year-on-year growth rate of M2 has a maximum of 29.76%, a minimum of 7.97%, and a mean of 15.75%. was 7.97%, and the average value was 15.75%.

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Table 2. Statistical Characteristics of Relevant Variables (1996-2007)

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summarize GDP CPI M2
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Variable	Obs	Mean	Std. Dev.	Min	Max
GDP	48	.1329951	.0494034	.058561	.2393199
CPI	48	.0186597	.0281974	-.0216667	.0936667
M2	48	.1808002	.0398301	.1316211	.2976363

From Table 2, it can be found that before 2008, the quarterly year-on-year growth rate of China's GDP had a maximum of 23.93%, a minimum of 5.86%, and a mean of 13.30%; the quarterly year-on-year growth rate of CPI had a maximum of 9.37%, a minimum of -2.17%, and a mean of 1.87%; and the quarterly year-on-year growth rate of M2 had a maximum of 29.76%, a minimum of 13.16%, with an average value of 18.08%.

Table 3. Statistical Characteristics of Relevant Variables (2008-2022)

```
summarize GDP CPI M2
```

Variable	Obs	Mean	Std. Dev.	Min	Max
GDP	57	.1095753	.0511729	-.0549044	.2150333
CPI	57	.0245189	.0186271	-.0153333	.0803333
M2	57	.1378472	.0536797	.0797082	.2925745

From Table 3, it can be found that after 2008, the quarterly year-on-year growth rate of China's GDP has a maximum of 21.50%, a minimum of -5.49%, and a mean of 10.96%; the quarterly year-on-year growth rate of the CPI has a maximum of 8.03%, a minimum of -1.53%, and a mean of 2.45%; and the quarterly year-on-year growth rate of M2 has a maximum of 29.26%, a minimum of 7.97%, with an average value of 13.78%.

From the three tables above, we can find that the average value of quarter-on-quarter GDP growth rate before 2008 is larger than the average value of quarter-on-quarter GDP growth rate after 2008, indicating that China's GDP growth rate has slowed down after 2008, which is mainly due to China's economic volume increasing year by year. China's total GDP grew from RMB 195.866 billion in 1981 to RMB 114.37 trillion in 2021, a more than 580-fold increase in three decades. It is unrealistic to maintain a fixed growth rate every year on this base. Secondly, the structural imbalance of the national macro-economy and the over-development of real estate have affected the development of other industries; lastly, the lack of momentum in the internal cycle of the economy is also one of the reasons for the slowdown in economic growth. Consumption, the most important of the troika of economic growth, has remained stagnant, with no significant breakthrough in the last decade. Production cannot be driven on a large scale by income growth without consumption growth.

As can be seen from the table, the mean value of the quarterly year-on-year growth rate of CPI before 2008 is smaller than the mean value of the quarterly year-on-year growth rate of CPI after 2008, and its variance before 2008 is larger than that after 2008, indicating that the volatility of inflation has decreased after 2008, but due to the multiple rounds of monetary easing and proactive fiscal policy after 2008, as well as the real estate industry's However, due to several rounds of monetary easing and active fiscal policy after 2008, as well as the rapid development of the real estate sector, the increase of foreign exchange account, the inflow of hot money into China's capital market and real estate market, all of these are the reasons for the increase of CPI growth rate after 2008.

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As can be seen from the table, the average value of the quarterly year-on-year growth rate of M2 before 2008 is greater than the average value of the quarterly year-on-year growth rate of M2 after 2008, which is due to the central bank's stimulus plan in 2008 brought about asset inflation, the central bank's frequent open market operations, increasing the control of credit funds in the financial sector, which made the growth rate of M2 fall back.The foreign exchange account declined by 2 trillion yuan in 2015, which led to a decrease in the base money The passive reduction in investment and the tightening of regulation led to a reduction in the money multiplier, which became the main reason for the decline in M2 growth. But overall the supply scale of M2 grew from 47.52 trillion yuan in 2008 to 249.97 trillion yuan in 2021, a fivefold increase. From the perspective of monetary policy, since 2008, China has experienced a total of five rounds of cyclical rate cuts and interest rate cuts. The first round began in September 2008, when the central bank waterproofed 4 trillion yuan to rescue the market in response to the impact of the global financial crisis. The second round began in November 2011, the impact of the European debt crisis superimposed on the accelerated downward trend of the domestic economy, the central bank to start monetary easing policy. The third round began in April 2014, real estate control tightened to make the economic downward pressure, monetary policy turned to easing until 2016 to gradually end. The fourth round began in April 2018, in the context of the trade friction between China and the United States and the slowdown in investment growth, the central bank opened a new round of easing, the early period was dominated by the reduction of the quota, and the domestic interest rate reduction cycle was also opened after the Federal Reserve opened the easing. The fifth round began in 2020 after the epidemic, the new crown epidemic on the economy caused a greater impact, the policy quickly added support, cut rates and interest rates at a faster pace. Loose monetary policy and proactive fiscal policy, as well as the underlying cause of the RMB's non-convertibility, were the driving forces behind the exponential rise in the size of M2.

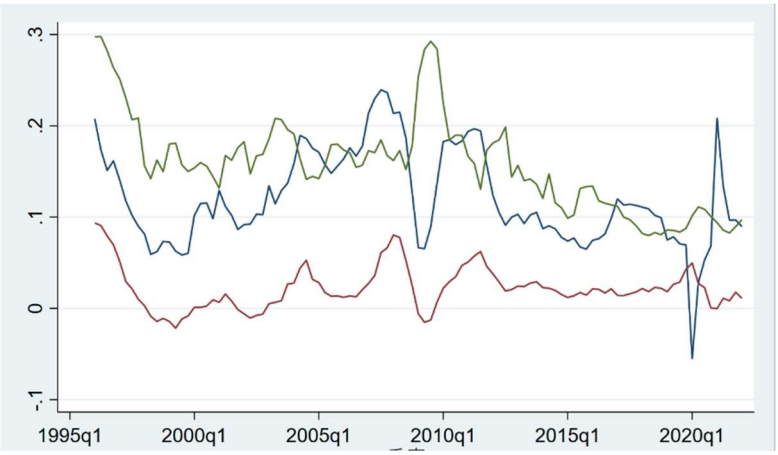

Figure 1. Time Trend Graph

The blue line in the figure represents the year-on-year GDP growth rate by quarter, the red line represents the year-on-year CPI growth rate by quarter, and the green line represents the year-on-year M2 growth rate by quarter. As can be seen from the figure, China's economic growth rate, inflation rate and money growth rate exhibit typical interactive characteristics. As can be seen from the figure, although the time-series paths of each of the three variables are not exactly the same, the overall evolution is relatively similar. Along with the rise and fall of the monetary growth rate, there are also subsequent peaks and valleys in the inflation rate, and in most of the periods, the monetary growth rate leads the inflation growth rate by a period of 1-2 years, and this trend is particularly obvious before 2008. After 2008, the time lag effect of monetary policy improved significantly, implying a high dynamic correlation between the two.

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From the comparison of the time-series paths of economic growth rate and monetary growth rate, there is also a high correlation between the two. It can be known that there exists a dynamically sequential change relationship between the three variables, which implies a high degree of correlation between the three in the real economic operation. Although in a strict sense, correlation does not mean that there is necessarily a causal relationship between economic variables. Therefore, the driving relationship between economic growth rate, inflation rate and money growth rate will be tested below.

4. Empirical Tests and Analysis of Results

Chapter 3 of this paper analyzes the VAR model between China's economic growth rate, inflation rate and economic growth, and characterizes the statistical properties of the three explanatory variables in the model. This chapter begins the empirical testing of the VAR model. Considering the subprime crisis in 2008, China implemented the policy of stimulating the economy with 4 trillion dollars, so in order to get a clear relationship between the three variables, this chapter divides three time periods to empirically test the VAR model, and denotes the data model of 1996-2022 as VAR1; the data model of 1996-2007 as VAR2; and the data model of 2008- The data model from 1996 to 2022 is denoted as VAR1; the data model from 1996 to 2007 is denoted as VAR2; and the data model from 2008 to 2022 is denoted as VAR3. More comprehensive conclusions are drawn by analyzing the differences in the results of the empirical tests within the three periods.

4.1. 1996-2022

4.1.1. Unit Root Test

Since the endogenous variables used in this paper are time series variables, before the empirical analysis of this model, the first step is to conduct a smoothness test on the relevant endogenous variables as a way of circumventing the pseudo-regression phenomenon that exists between mutually independent variables in this model. For the smoothness test of the time series, this paper utilizes the Stata software and adopts the ADF test proposed by Dicky and Fuller (1981) to conduct the unit root test for each variable, which calculates the t-statistic through regression, denoted as Z(t), and the smaller the value is, the more inclined it is to reject the original hypothesis, and thus the test is a one-sided test on the left side, and its rejection domain is only distributed on the leftmost side. In practice, when the time series is non-stationary, the new time series is usually obtained and tested for stationarity again by taking logarithmic calculations or performing difference calculations. In this paper, first of all, the three explanatory variables for the smoothness test, the results of the reality of non-smooth, then the time series for the differential transformation, and then again for the smoothness test, the specific test results are shown in Table 4:

Table 4. ADF test results for VAR1

variable name	Type of test	ADF test value	1% threshold	smoothness
GDP	(C,T,8)	-1.753	-4.049	uneven
d_GDP	(C,T,7)	-5.359	-4.049	smoothly
CPI	(C,0,8)	-2.487	-3.516	uneven
d_CPI	(C,0,7)	-6.009	-3.516	smoothly
M2	(C,T,9)	-2.011	-4.051	uneven
d_M2	(C,T,7)	-5.666	-4.049	smoothly

Note: (C,T,K) denote whether the ADF test contains a constant term, a trend term, and an optimal lag order, respectively.

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From the above table, it can be observed that all the data series are not all smooth time series at 1% level of significance, but their first order differences (D) are all smooth time series. Therefore, all the variables are first order single integer, i.e., they are I(1).

4.1.2. Stability Tests

In this paper, LR test, AIC information criterion and SC criterion are used to determine the optimal lag.

Table 5. Optimal Lag Selection for VAR1

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	741.967				2.5e-11	-15.8918	-15.8588	-15.8101
1	763.063	42.191	9	0.000	1.9e-11	-16.1519	-16.0199*	-15.8251*
2	768.248	10.369	9	0.321	2.1e-11	-16.0698	-15.8389	-15.498
3	778.501	20.506	9	0.015	2.1e-11	-16.0968	-15.7669	-15.2798
4	802.011	47.021	9	0.000	1.5e-11*	-16.4088*	-15.98	-15.3468
5	807.788	11.553	9	0.240	1.6e-11	-16.3395	-15.8117	-15.0324
6	813.317	11.058	9	0.272	1.8e-11	-16.2649	-15.6381	-14.7126
7	818.759	10.885	9	0.284	1.9e-11	-16.1884	-15.4627	-14.391
8	831.874	26.231	9	0.002	1.8e-11	-16.2769	-15.4522	-14.2345
9	836.178	8.6068	9	0.474	2.0e-11	-16.1759	-15.2522	-13.8884
10	839.5	6.6452	9	0.674	2.3e-11	-16.0538	-15.0312	-13.5212
11	853.415	27.829*	9	0.001	2.1e-11	-16.1595	-15.0379	-13.3818

From the Table 5, it can be seen that according to the HQIC criterion and the SBIC criterion, the model should be selected with lag order 2, and according to the FPE criterion and the AIC criterion, the model should be selected with lag order 4. At this point, the selection is based on the AIC criterion, so lag order 4 is selected.

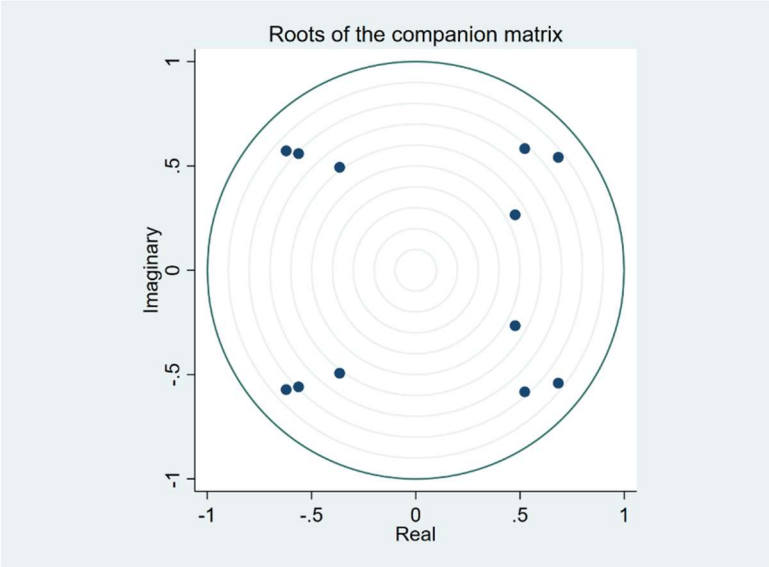

Figure 2. AR Root Plot for VAR1

Continuing with the stability test of the VAR model after the optimal lag has been determined by the AR root test (Figure 2), a sufficient condition for the model to be stable is that the modes of all the characteristic roots are within the unit circle (less than 1). As seen in Table 6, the model is very stable.

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Table 6. Unit root test for VAR1

Eigenvalue	Modulus
.6836029 + .5410413i	.871802
.6836029 - .5410413i	.871802
-.6216526 + .5721532i	.844873
-.6216526 - .5721532i	.844873
-.5623788 + .5589242i	.792885
-.5623788 - .5589242i	.792885
.5227952 + .5828143i	.782935
.5227952 - .5828143i	.782935
-.3651649 + .4934104i	.61384
-.3651649 - .4934104i	.61384
.4766597 + .2657963i	.545758
.4766597 - .2657963i	.545758

4.1.3. Cointegration Tests

Table 7. VAR1 cointegration test results

		Interpolated Dickey-Fuller		
	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-7.890	-3.509	-2.890	-2.580

MacKinnon approximate p-value for Z(t) = **0.0000**

The residual series of VAR1 is tested and found to be smooth and optimal model. As can be seen from Table 7, the results of its cointegration test reject the null hypothesis that there is a long-run equilibrium relationship between the three variables at a significance level of 1%.

4.1.4. Impulse Response

On the basis of VAR, in order to way the sensitivity brought by the change of the order of the dependent variable of the VAR model to the shock response function, this paper adopts the test of the general shock of the relationship between the two variables as a way to avoid the orthogonalization of the response variable order dependence, and adopts the base of the Cholesky decomposition, and further analyzes the shock relationship between the two of the three variables over the long-term full-sample period by means of the impulse response function.

As can be seen from the figure, when the price growth rate is an impulse variable, its positive shock is conducive to its own improvement, and gradually converge, which indicates that the price has rigidity, the price continues to rise will return to equilibrium because of inflation; price growth rate of the positive impact on economic growth in the beginning of the positive effect, and in the 3rd period from positive to negative, and then also in has been in the positive and negative fluctuations, indicating that the impact of the rise in prices on the economy is sustained; prices The positive shock of the growth rate of prices has a negative effect on the growth rate of money supply and turns from negative to positive in the 4th period, indicating that the price increase will have a certain inhibiting effect on the growth of money supply at the

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beginning, and after a certain period of time, it has a promoting effect on the growth of money supply.

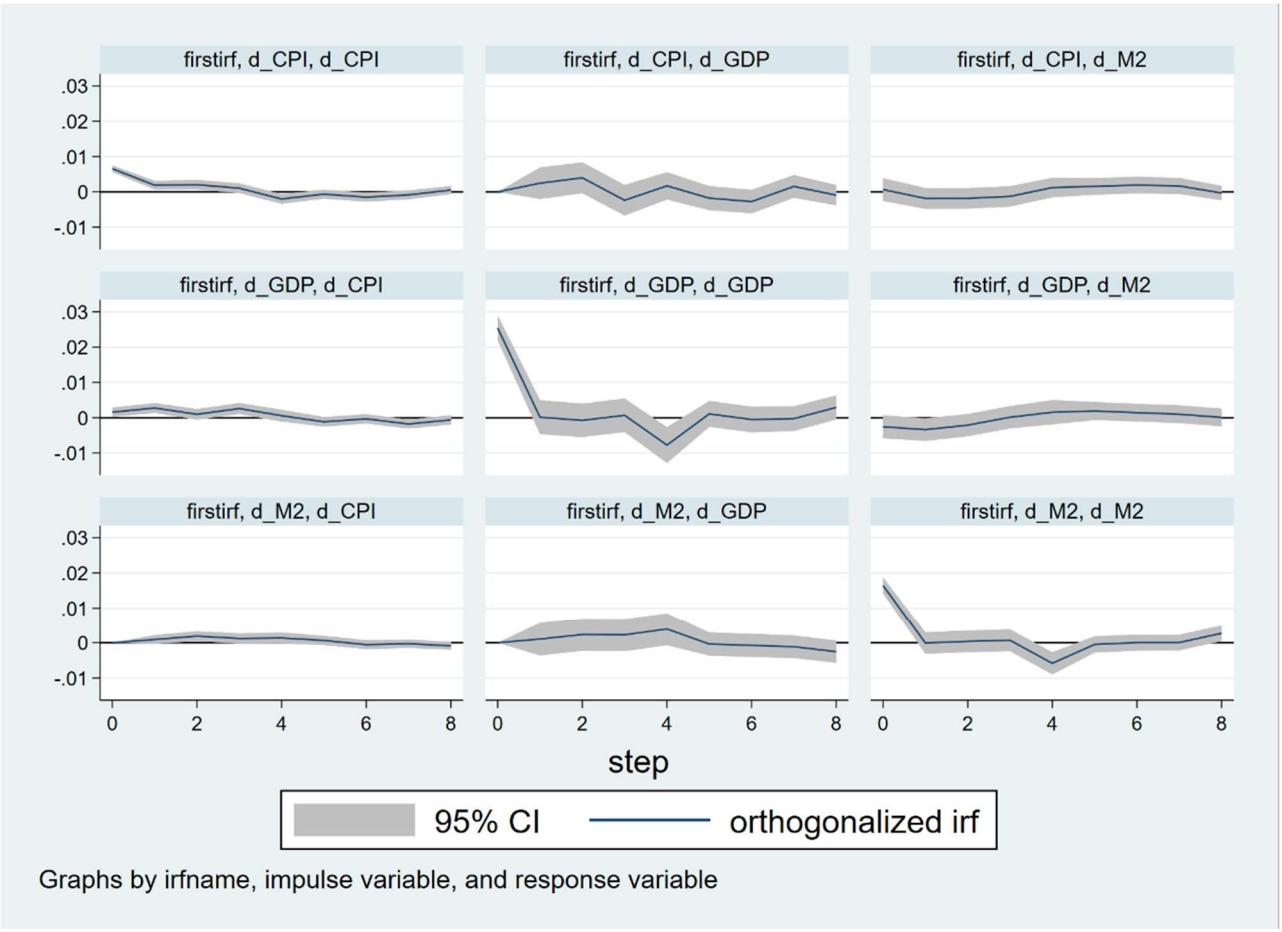

Figure 3. Impulse Response Plot for VAR1

When the economic growth rate is an impulse variable, its positive shock has a significant positive effect on itself only in the 1st period, and turns from positive to negative in the 3rd period; the positive shock of the economic growth rate has a certain promotion effect on the price rise, which indicates that the economic growth will cause the income to rise, the purchasing power of the residents to grow, and the price will rise, but it gradually disappears after the 3rd period; the positive shock of the economic growth rate has a negative effect on the monetary growth rate and fades to zero after period 4, suggesting that economic growth weakens the incentive for monetary authorities to adopt loose monetary policy to sustain economic growth.

When the growth rate of money supply is an impulse variable, its positive shock has a significant improvement on itself and turns from positive to negative in the 4th period; the positive shock of the growth rate of money supply does not have a significant effect on prices; the positive shock of the growth rate of money supply has a positive effect on the economic shocks before the 4th period, and has a negative effect after the 4th period, which indicates that the growth of the money supply in the beginning can expand the demand and promote the economic growth, but in the long run it will have a certain inhibitory effect.

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4.1.5. Variance Decomposition

The variance decomposition can further quantitatively and directly capture the influence relationship between the variables. Variance decomposition was performed for each of the three variables and the results are shown below.

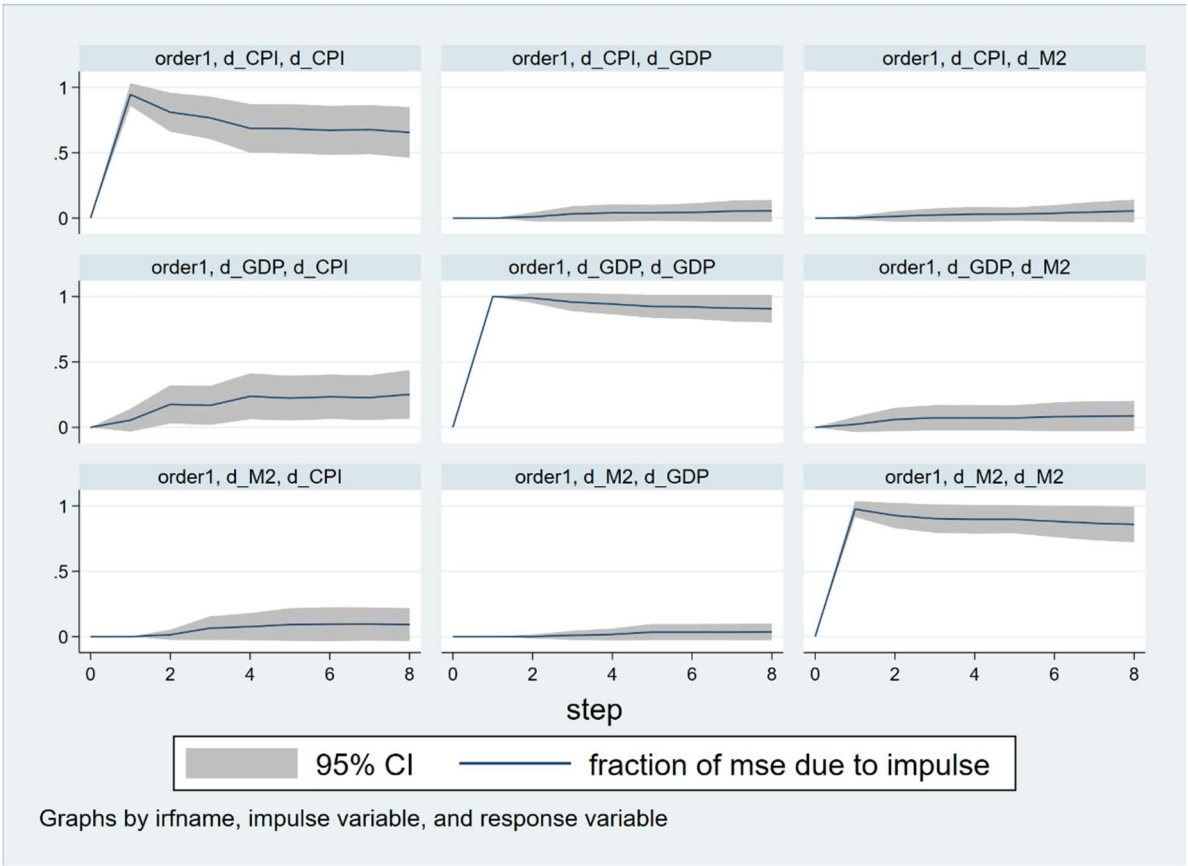

Figure 4. Variance Decomposition of VAR1

According to the results of the data, in terms of the level of price growth, after eight periods of forecasting, 65.55% of its forecasting variance comes from itself, 25.20% from economic growth, and 9.24% from money supply growth.

As can be seen from the figure, the rate of price change has a greater impact on its own curve changes, which is more unstable, the economic growth rate curve also has some fluctuations, and the money supply growth rate curve has less fluctuations, which indicates that the explanatory variables of the rate of price change are less stable except for the money supply growth rate.

In terms of the level of economic growth, after eight periods of forecasting, 90.75% of its forecast variance comes from itself, 5.57% from price changes, and 3.67% from money supply changes. This shows that the factors affecting the growth of the economic level mainly come from itself.

The economic growth rate has a greater impact on the movement of its own curve and a more stable impact on the other explanatory variables.

In terms of the level of money supply, after 8 periods of forecasting, 85.81% of its forecast variance comes from itself, 8.77% from economic growth, and 8.58% from price changes, which suggests that the main influence of the growth rate of money supply comes from itself.

The growth rate of the money supply has a large effect on the movement of its own curve and a more stable effect on the other explanatory variables.

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4.2. 1996-2007

4.2.1. Unit Root Test

Table 8. ADF test results for VAR2

variable name	Type of test	ADF test value	1% threshold	smoothness
GDP	(C,T,9)	-2.501	-4.260	uneven
d_GDP	(C,T,0)	-6.293	-4.187	smoothly
CPI	(C,0,2)	-2.582	-3.641	uneven
d_CPI	(C,0,0)	-4.123	-3.607	smoothly
M2	(C,T,9)	-2.019	-4.260	uneven
d_M2	(C,T,3)	-4.855	-4.214	smoothly

From the above table, it can be observed that all the data series are not all smooth time series at 1% level of significance, but their first order differences (D) are all smooth time series. Therefore, all the variables are first order single integer, i.e., they are I(1).

4.2.2. Stability Tests

Table 9. Optimal Lag Selection for VAR1

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	339.676				4.0e-12	-17.7198	-17.6738*	-17.5905*
1	346.16	12.967	9	0.164	4.6e-12	-17.5874	-17.4034	-17.0702
2	349.973	7.6271	9	0.572	6.1e-12	-17.3144	-16.9924	-16.4094
3	362.172	24.397	9	0.004	5.3e-12	-17.4827	-17.0227	-16.1899
4	383.255	42.167	9	0.000	3.0e-12*	-18.1187	-17.5207	-16.438
5	388.758	11.005	9	0.275	3.9e-12	-17.9346	-17.1987	-15.8661
6	400.998	24.48	9	0.004	3.7e-12	-18.1051	-17.2312	-15.6488
7	409.095	16.194	9	0.063	4.7e-12	-18.0576	-17.0457	-15.2134
8	419.288	20.386	9	0.016	6.0e-12	-18.1204	-16.9705	-14.8883
9	441.43	44.285*	9	0.000	4.7e-12	-18.8121*	-17.5242	-15.1922

From the Table 9, it can be seen that according to the HQIC criterion and SBIC criterion, the model should choose lag order 1; according to the LR criterion and AIC criterion, the model should choose lag order 9. Because of the small sample capacity, lagging the 9th order will lose more sample size, so lagging the 1st order is chosen.

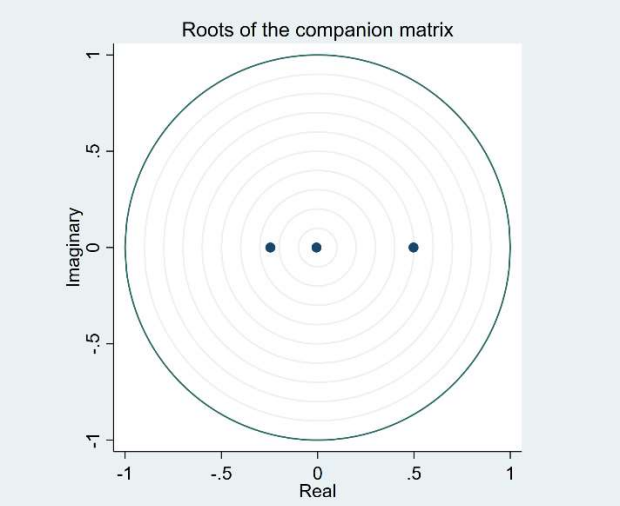

Figure 5. AR Root Plot for VAR2

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Continuing with the stability test of the VAR model after the optimal lag has been determined by the AR root test (Figure 5), a sufficient condition for the model to be stable is that the modes of all the characteristic roots are within the unit circle (less than 1). As seen in Table 10, the model is very stable.

Table 10. Unit root test for VAR2

Eigenvalue	Modulus
.4975569	.497557
-.2456863	.245686
-.00615372	.006154

4.2.3. Impulse Response

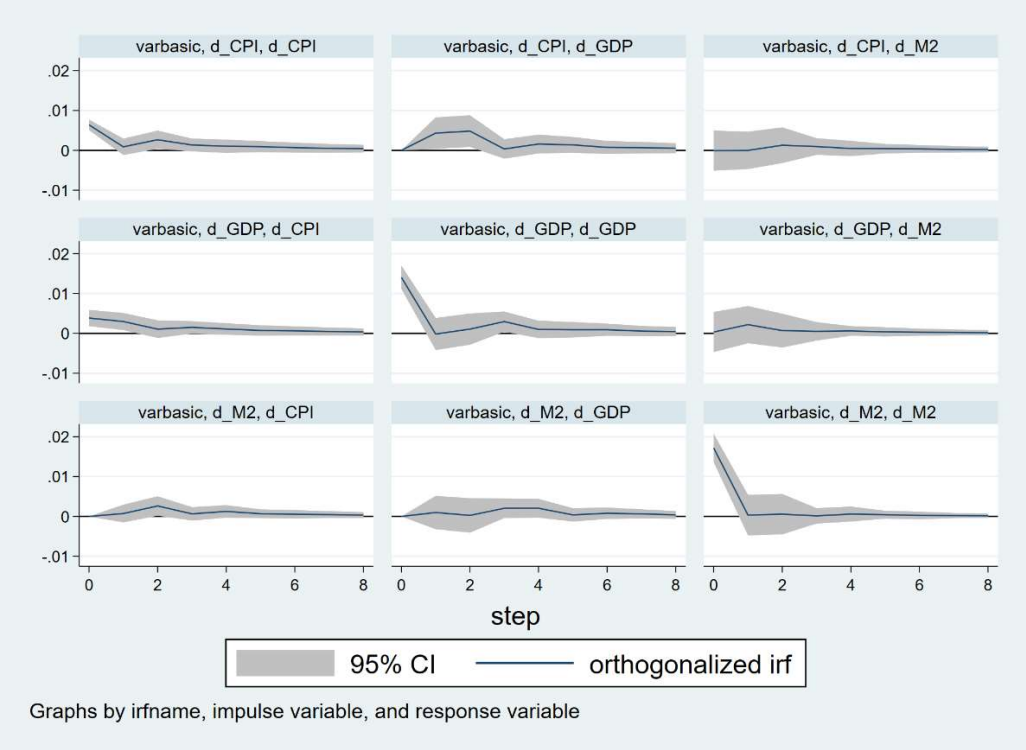

Figure 6. Impulse Response Plot for VAR2

As can be seen from the figure, when the rate of price change is the shock variable, there is a certain positive shock to itself and gradually disappears after the 3rd period; the positive shock to the price growth rate will have a certain role in promoting economic growth, indicating that short-term increase in prices will stimulate the economic production and increase productivity; the shock to the price growth rate does not have a significant effect on the growth rate of money supply.

When the economic growth rate is a shock variable, it has a significant improvement on its own and gradually to 0 after the 4th period; the positive shock of the economic growth rate in the 1st period has a promoting effect on price changes, indicating that after the economic growth, the income rises together, the purchasing power of the residents is enhanced, and the prices will rise accordingly, but in the long run the economic growth has no influence on the price level; the positive shock of the economic growth rate has no The positive impact of economic growth rate has no significant effect on the growth rate of money supply.

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When the money supply growth rate is a shock variable, it favors its own improvement, but has no effect in the long run; when there is a positive shock to the money supply growth rate, it has a certain role in promoting price growth; when the money supply growth rate has no significant effect on economic growth.

4.2.4. Variance Decomposition

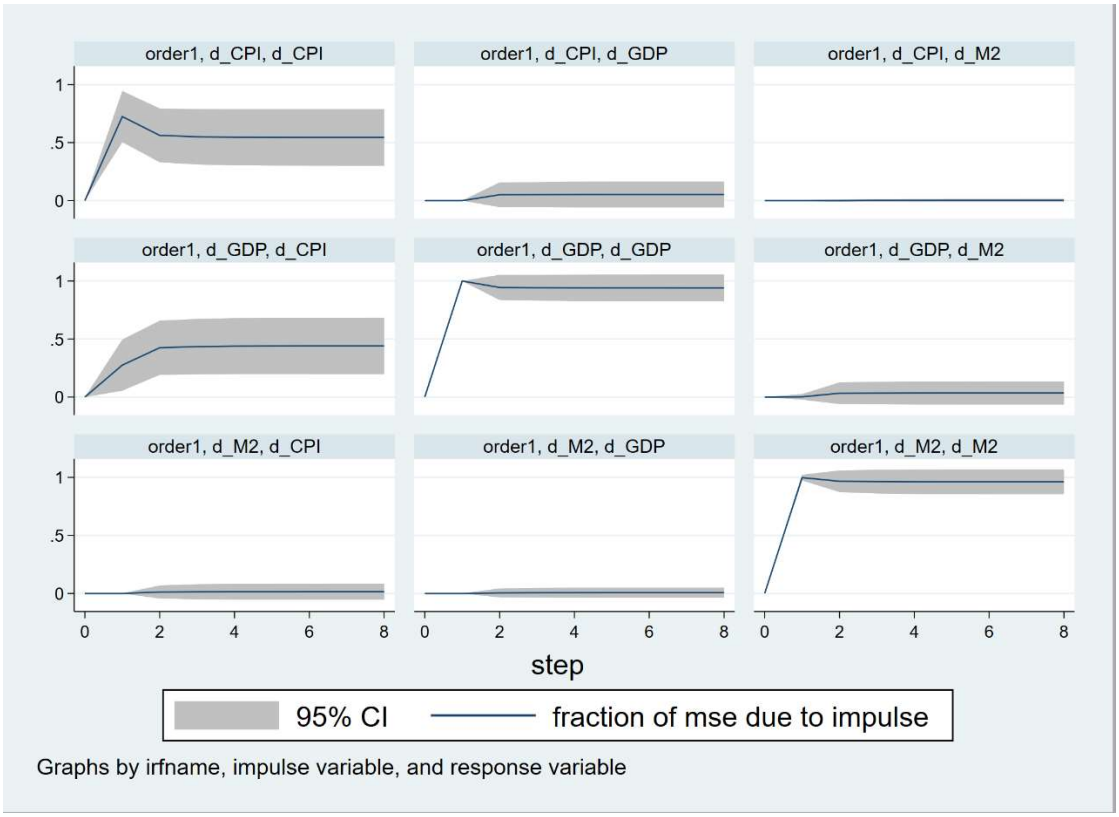

Figure 7. Variance Decomposition of VAR2

The results of the data show that in terms of the price growth level, after eight periods of forecasting, 54.45% of its forecasting variance comes from itself, 44.02% from economic growth, and 1.53% from money supply growth. It shows that the growth of price level is mainly influenced by itself and economic growth.

As can be seen from the figure, the rate of price change has a greater impact on the movement of its own curve, which is more unstable, and the economic growth rate curve is more volatile and unstable. The money supply growth rate curve is basically non-volatile, indicating that the explanatory variables of the rate of price change are not stable and the explanatory variables are more volatile.

In terms of the level of economic growth, after eight periods of forecasting, 94.04% of its forecast variance comes from itself, 5.32% from the price growth rate, and 6.35% from the growth rate of the money supply, indicating that the growth of the economic level is mainly influenced by itself.

The economic growth rate has a large and more unstable effect on its own curve movement, while the other two explanatory variables have a more stable effect on it.

In terms of money supply growth, after eight periods of forecasting, 96.21% of its forecast variance comes from itself, 3.56% from economic growth, and 2.25% from price growth, indicating that the growth rate of money supply is mainly influenced by itself.

The money supply growth rate has a large and more volatile effect on its own curve movement, while the other two explanatory variables have a more stable effect on it.

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4.3. 2008-2022

4.3.1. Unit Root Test

Table 11. ADF test results for VAR3

variable name	Type of test	ADF test value	1% threshold	smoothness
GDP	(C,T,8)	-1.931	-4.168	uneven
d_GDP	(C,T,7)	-4.279	-4.168	smoothly
CPI	(C,0,8)	-1.449	-3.594	uneven
d_CPI	(C,0,7)	-5.034	-3.594	smoothly
M2	(C,T,8)	-1.232	-4.168	uneven
d_M2	(C,T,7)	-5.898	-4.168	smoothly

From the above table, it can be observed that all the data series are not all smooth time series at 1% level of significance, but their first order differences (D) are all smooth time series. Therefore, all the variables are first order single integer, i.e., they are I(1).

4.3.2. Stability Tests

Table 12. Optimal Lag Selection for VAR3

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	751.223				2.4e-11	-15.9196	-15.8869	-15.8385
1	772.358	42.269	9	0.000	1.9e-11	-16.1778	-16.0467*	-15.8531*
2	777.097	9.4781	9	0.394	2.1e-11	-16.0872	-15.8577	-15.519
3	786.989	19.784	9	0.019	2.0e-11	-16.1061	-15.7783	-15.2945
4	811.286	48.594	9	0.000	1.5e-11*	-16.4316*	-16.0054	-15.3764
5	817.219	11.867	9	0.221	1.6e-11	-16.3664	-15.8418	-15.0677
6	823.371	12.303	9	0.197	1.7e-11	-16.3058	-15.6828	-14.7635
7	828.861	10.981	9	0.277	1.8e-11	-16.2311	-15.5098	-14.4454
8	841.743	25.764*	9	0.002	1.7e-11	-16.3137	-15.494	-14.2845
9	846.207	8.9282	9	0.444	1.9e-11	-16.2172	-15.2992	-13.9444
10	849.789	7.1629	9	0.620	2.2e-11	-16.1019	-15.0855	-13.5856

From the Table 12, it can be seen that according to the HQIC criterion and the SBIC criterion, the model should be chosen to lag order 1; according to the FPE criterion and the AIC criterion, the model should be chosen to lag order 4. At this point the AIC criterion comes to make the selection, so lag order 4 is selected.

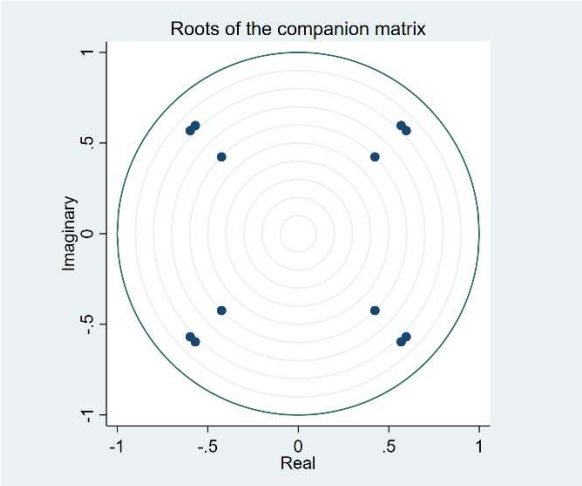

Figure 8. AR Root Plot for VAR3

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Continuing with the stability test of the VAR model after the optimal lag has been determined by the AR root test (Figure 8), a sufficient condition for the model to be stable is that the modes of all the characteristic roots are within the unit circle (less than 1). As seen in Table 13, the model is very stable.

Table 13. Unit root test for VAR2

Eigenvalue	Modulus
-.5685551 + .5967119i	.824209
-.5685551 - .5967119i	.824209
.5967119 + .5685551i	.824209
.5967119 - .5685551i	.824209
.5685551 + .5967119i	.824209
.5685551 - .5967119i	.824209
-.5967119 + .5685551i	.824209
-.5967119 - .5685551i	.824209
-.4235632 + .4235632i	.599009
-.4235632 - .4235632i	.599009
.4235632 + .4235632i	.599009
.4235632 - .4235632i	.599009

4.3.3. Impulse Response

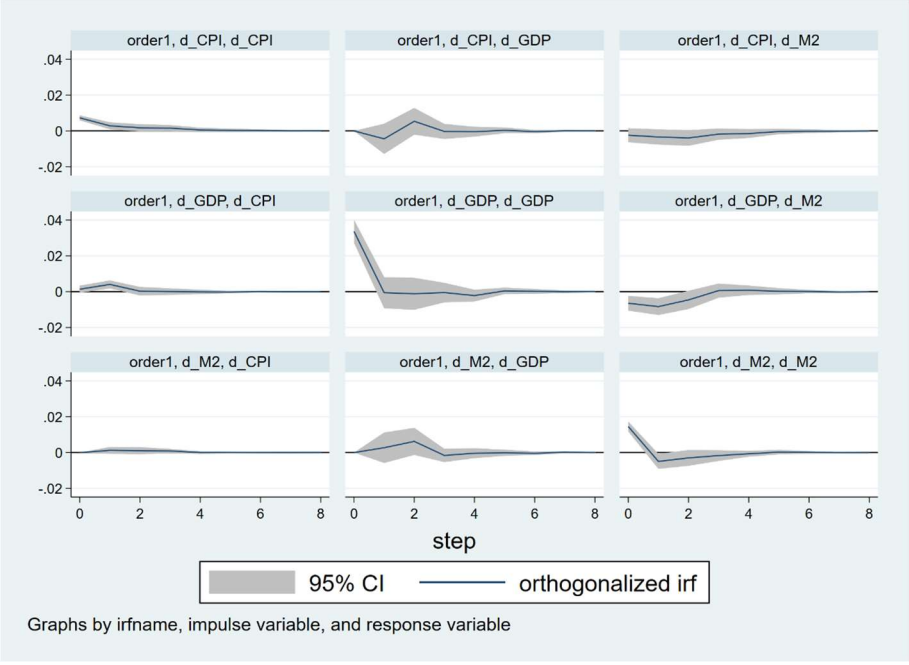

Figure 9. Impulse Response Plot for VAR3

As can be seen from the figure, when the rate of price change is the shock variable, it has a certain positive shock to itself and gradually disappears after the 2nd period; the positive shock of the price growth rate has a negative effect on economic growth in the 1st period and turns from negative to positive in the 2nd period; the shock of the price growth rate in the beginning of the weak negative effect on the money supply, which indicates that price increases will have a dampening effect on the money supply.

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When the economic growth rate is the shock variable, it improves itself significantly in period 1 and disappears after period 1. Positive shocks to the economic growth rate have no significant effect on price growth; positive shocks to the economic growth rate have a dampening effect on the money supply.

When the money supply growth rate is a shock variable, it favors its own improvement, but turns positive to negative at the end of period 1; when there is a positive shock to the money supply growth rate, it has a significant contribution to economic growth until period 3; and the money supply growth rate has no significant effect on price growth.

4.3.4. Variance Decomposition

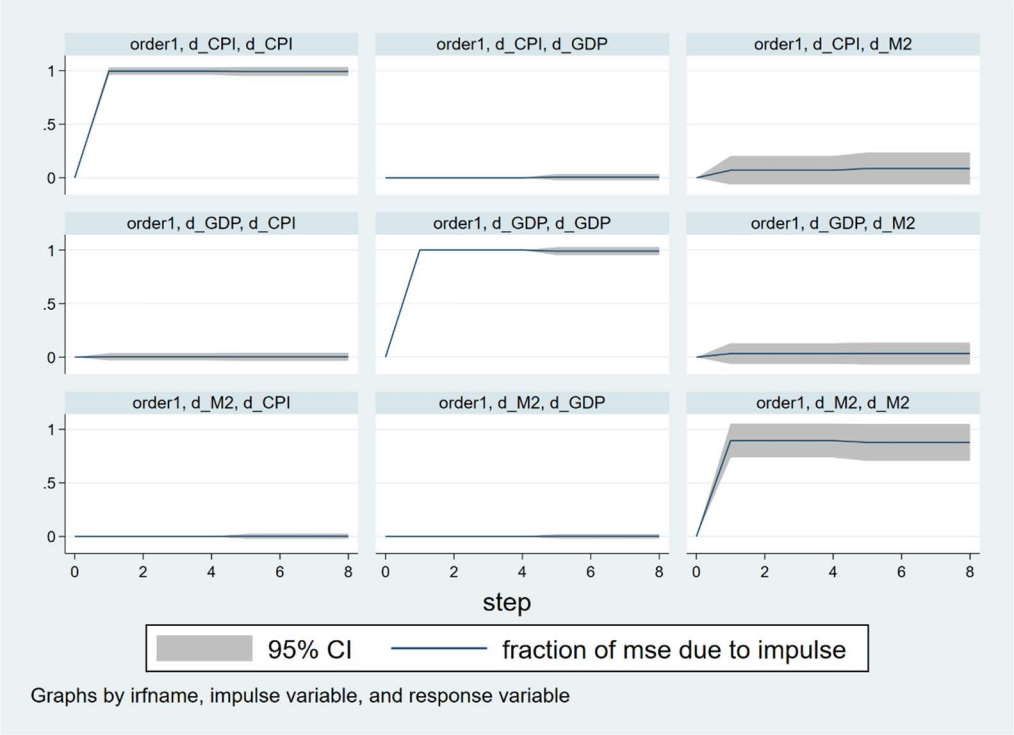

Figure 10. Variance Decomposition of VAR3

The results of the data show that in terms of the price growth level, after eight periods of forecasting, 99.30% of its forecast variance comes from itself, 0.40% from economic growth and 0.29% from money supply growth. This indicates that the growth of the price level is mainly influenced by itself.

As can be seen from the figure, the rate of price change has a greater impact on the movement of its own curve and is more volatile. The money supply growth rate curve and the economic growth curve are basically non-volatile

In terms of the level of economic growth, after eight periods of forecasting, 98.99% of its forecast variance comes from itself, 0.74% from the price growth rate, and 0.27% from the growth rate of the money supply, indicating that the growth of the economic level is mainly influenced by itself.

The economic growth rate has a large and more unstable effect on its own curve movement, while the other two explanatory variables have a more stable effect on it.

In terms of money supply growth, after eight periods of forecasting, 87.86% of its forecast variance comes from itself, 3.42% from economic growth, and 8.72% from price growth, indicating that the growth rate of money supply is mainly influenced by itself.

The money supply growth rate has a large and more volatile effect on its own curve movement, while the other two explanatory variables have a more stable effect on it.

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4.4. Comparison of Three Periods

4.4.1. Granger Causality Tests

The Granger causality test was used to determine whether there is a long-term causal relationship between the three variables, and the results of the test for the three periods are shown below:

Table 14. Granger Causality Test (p-value)

	1996Q1-2022Q1			1996Q1-2007Q4			2008Q1-2022Q1		
	d_GDP	d_CPI	d_M2	d_GDP	d_CPI	d_M2	d_GDP	d_CPI	d_M2
d_GDP		0.000*	0.363		0.007*	0.285		0.004*	0.064*
d_CPI	0.179		0.262	0.064*		0.914	0.265		0.086*
d_M2	0.530	0.068*		0.624	0.377		0.605	0.490	

Note: Columns indicate independent variables, rows indicate dependent variables, and values indicate the p-value of the hypothesis that the independent variable in the row is not the Granger cause of the dependent variable in the column.

The results of the Granger causality test can be obtained from Table 14 and Table 15.

Table 15. Granger Causality Test Results (10%)

1996Q1-2022Q1	1996Q1-2007Q4	2008Q1-2022Q1
Economic growth rate is the Granger cause of the rate of price change	Economic growth rate is the Granger cause of the rate of price change	Economic growth rate is the Granger cause of the rate of price change
Granger reasons why the rate of economic growth is not the rate of growth of the money supply	Granger reasons why the rate of economic growth is not the rate of growth of the money supply	Economic growth rate as a Granger cause of money supply growth rate
The rate of price change is not a Granger cause of the rate of economic growth	The rate of price change as a Granger cause of the rate of economic growth	The rate of price change is not a Granger cause of the rate of economic growth
The rate of price change is not a Granger cause of the growth rate of the money supply	The rate of price change is not a Granger cause of the growth rate of the money supply	The rate of price change is the Granger cause of the growth rate of the money supply
Granger reasons why money supply growth is not the rate of economic growth	Granger reasons why money supply growth is not the rate of economic growth	Granger reasons why money supply growth is not the rate of economic growth
Money supply growth rate as a Granger cause of the rate of price change	Money supply growth is not a Granger cause of the rate of price change	Money supply growth is not a Granger cause of the rate of price change

From the test results, it can be seen that the economic growth rate has always been the Granger cause of the rate of price change; the growth rate of money supply has never been the Granger cause of economic growth. It indicates that in the long run, economic growth will have an impact on price changes, and the growth rate of money supply has no impact on economic growth, and money is neutral.

After 2008, the rate of price change changed from being a Granger cause of economic growth to not being a Granger cause of economic growth; over the full period, the rate of growth of economic growth money supply was a Granger cause of price changes, but in two sub-periods economic growth was not a Granger cause of the rate of growth of money supply. after 2008,

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the rate of price change changed from being a Granger cause of economic growth to not being a Granger cause of economic growth, and the rate of price change changed from not being a Granger cause of economic growth to being a Granger cause of money growth. After 2008, the rate of price change changed from being a Granger cause of economic growth to not being a Granger cause of economic growth, and the rate of price change changed from not being a Granger cause of money supply growth to being a Granger cause of money growth.

4.4.2. Impulse Response

A comparison of the three periods shows that when the price growth rate is the shock variable, it has always had a significant shock effect on itself, but the duration is short; in the full period and the 2008-2022 period, the impact of the price growth rate shock on the economic growth rate is not significant enough and fluctuates; in the 1996-2007 period, the price growth rate has a significant positive shock effect on the economic growth rate This is consistent with the Granger causality test. This is consistent with the results of the Granger causality test. Only in the period of 2008-2022, the effect of the rate of price change on the growth rate of money supply is significant, while the other two periods are not significant.

For all three periods, when the economic growth rate is the shock variable, there is a significant positive effect on its own, which fades out after the first period; when the rate of economic change is positively shocked, there is some positive effect on the price growth rate in all three periods. When the rate of economic change is subject to a positive shock, there is a certain boost to the money supply only in the period 2008-2022, in line with the results of the Granger causality test.

For all three periods, when the money supply growth rate is the shock variable, it has a significant positive effect on its own; when the money supply growth rate is positively shocked, it has no significant effect on either the rate of price change or the rate of economic growth.

4.4.3. Variance Decomposition

Comparing the results of the variance test for the three periods, it can be seen that only when the price growth rate is used as an explanatory variable, in addition to itself, the economic growth rate shock has a certain degree of contribution to the price growth rate, indicating that the economic growth has a certain impact on inflation; in the case of the economic growth rate and the growth rate of the money supply as an explanatory variable, the shocks are basically from itself.

5. Conclusion

This paper selects China's data from the first quarter of 1996-2022 and empirically analyzes the relationship between price changes, money supply and economic growth in China using the endogenous economic growth model and the measurement method of the VAR model, the results show that, from the long-period perspective, the growth rate of the money supply is the Granger cause of the price changes, indicating that the money supply changes in China are one of the causes of inflation. From a short-period perspective, the change in China's money supply is not a cause of inflation, suggesting that the change in China's money supply is not consistent with the change in prices over the long and short periods.

The economic growth rate is the Granger cause of price changes in both long and short cycles, suggesting that our inflation is primarily demand-pull inflation.

Both from the long and short cycles, the growth rate of money supply is not a Granger cause of economic growth, indicating that China's money is neutral and that monetary policy has no significant contribution to economic growth in the long run.

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