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SINGAPORE MANAGEMENT UNIVERSITY
2021

I hereby declare that this PhD dissertation is my original work
and it has been written by me in its entirety.
I have duly acknowledged all the sources of information
which have been used in this dissertation.

This PhD dissertation has also not been submitted for any degree
in any university previously.

WANG Guangyu
30 September 2021

ABSTRACT

DYNAMIC ANALYSIS OF MONEY SUPPLY, UNEMPLOYMENT AND INFLATION RATE IN THE US

WANG Guangyu

Price stability is not only an important indicator of the healthy and stability of macro-economy, but also one of the goals of macroeconomic policy. There are many factors affecting inflation. Different monetary policy instruments, such as money supply, liquidity and market expectations, have different effects on inflation. Meanwhile, monetary policy goals, such as inflation rate, employment rate and economic growth rate, also affect each other.

This paper provides an empirical study of money supply, inflation and unemployment in the US economy. Based on the existing theoretical and empirical analysis, this paper selects different research models and new data dimensions to study the relationship between money supply, unemployment and inflation from different angles for both theoretical and empirical aspects. This paper analyzes and defines the historical impact based on three-dimensional VAR model. In order to construct a multi-dimensional VAR model for analysis, this paper chooses the money supply in the monetary policy instruments and the unemployment rate in the monetary policy goals as the endogenous variables affecting inflation, and chooses the import price stably related to the growth of money supply as the exogenous variable. This paper uses the consumer price index (CPI) to represent the inflation rate and M1 money supply to represent the monetary aggregate. Finally, through the comparative analysis of inflation between China and the US, the paper puts forward some thoughts and suggestions on the monetary policies.

Through the research, it proves that the choice of money supply as an intermediary target is effective, but there is a certain lag in regulating consumption inflation. Meanwhile, it shows that there is a policy contradiction between the employment rate and the inflation rate.

Contents

1. Introduction

1.1 Background

Inflation is one of the most fundamental economic indexes that many economists have tried their best to define and analyze. It is commonly accepted that inflation can be defined as a sustainable increase in the price of goods and services in an economy over a certain period. In the 1920s, inflation was generally defined as an economic phenomenon where the purchasing power of unit currency fell while the price level rose, due to the excess issuance of currency. At that time, the quantity theory of money had a great influence, which partially explains why inflation was defined in this approach. During the time, the economy of the United States (the US) seemed to be booming, but in fact, it had been in inflation. Then came the Great Depression of the 1930s, when the money supply increased by US $28 billion, an increase of 61.8% over the past eight years, with an average of 7.7% (Rothbard M.N., 2003). This was a huge increase, however, gold increased by only $1.66 billion between 1921 and 1929, indicating that the inflation was not caused by gold.

Throughout the history of the US, two serious inflations have occurred: the first in 1930s, during the global economic recession; and the other in 1970s, following the breakdown of the Bretton Woods System, the excessive money supply intensified inflation and caused economic stagnation. From 1974 to 1975, the inflation rate exceeded 11% for the two consecutive years. From 1930s to 1960s, with the prevailing of Keynesianism, the traditional quantity theory of money was criticized, since Keynes believes that the increase of money quantity will at most lead to semi-inflation, as long

as there are still unemployed resources in the economy. In the 1970s, the growth rate of GDP began to decline, and the unemployment rate reached a top point, meanwhile, the inflation rate remained high, and the economic recession continued. In these circumstances, the direct relationship between the increase of money supply and the rise of price level was generally accepted.

Hanson, J. A. (1985) pointed that the consequence of inflation is the reduction of the purchasing power per unit of money - a loss of real value of the medium of exchange within the economy. The high inflation rate has always been a crucial problem for many countries, since it makes people's living much harder as the goods and services become more and more expensive. Moreover, for companies, the high inflation rate makes it difficult to budget or plan in a long-term approach, which is harmful to the national productivity. Central banks may find ways to control the inflation rate by introducing different monetary policies, however, the relationship between inflation and money supply/demand remains complicated, even if many relevant organizations have long studied it. Indeed, it is suggested that higher money supply can be a good solution to problems caused by shocks in financial markets, and hence governments increasingly print money to repay the huge debt and to help people who went bankrupt during the shocks (Zandi, 2009). In the US, the Federal Reserve Committee and FOMC have set series of monetary policies during the 1990s to control the domestic inflation. Unfortunately, the monetary policies did not solve the problem well. (Temesvary, et. al., 2018). In both of the asset market and the production market, the price of US dollar reacts to the money supply change and the inflation rate in the same manner; Also, the

oil price reacts to the growth of money supply and the inflation in the same manner (Azar, 2013).

We are interested in whether excess supply of money is the main cause of inflation, and whether inflation can be stabilized by controlling money supply. Research on money supply and inflation has always attracted the attention of scholars worldwide. The paper by Manera and Cologni (2005) explored in depth the possible statistical models for a country and the relationship between monetary policy and inflation. Woodford (2009) found that in a low-inflation environment, it is possible for central banks to change monetary policies in order to induce inflation and maximize social welfare.

Although the relationship between money supply and inflation has been extensively studied, scholars have different views on it. For decades, Milton - Friedman (Milton Friedman, 1971a) and other economists have always believed that the money supply will increasingly lead to discussions and arguments on inflation in the economy. Scholars have shown that there is a high correlation between the money supply growth rate and the inflation rate through empirical research. Some have pointed out that in the long run, there is a strong positive correlation between money supply and inflation, while others have pointed out that there is no necessary correlation between the two, and the increase in money supply will not lead to currency devaluation. Xie (2012) stated that rising prices in China are not driven by the high liquidity caused by excess money supply. Instead, endogenous money supply will decrease velocity of money, and other factors, the virtual economy as an example, may result in excess supply of money,

which consequently leads to rising prices of transmission channels, but this does not necessarily indicate a correspondence between money growth and inflation (Bland, Georgia Desmail and Rophia, 2002).

However, according to reports in today's mainstream journals, in the past 40 years, along with the extensive development of academia, total money supply is less prioritized in discussions of fundamental monetary theories. Indeed, in analysis of monetary policies, explanations on monetary aggregates are much weaker. Also, the current policy model is intended to explain the performances of inflation and interest rates, while ignoring the role of the total amount of money.

Nevertheless, this does not indicate that discussions on total money supply are less meaningful. It can be seen that the Fed's policy reflects the adjustment of interest rates, but not the adjustment of the total amount of money. In macroeconomics, one of the main responsibilities of the central government is to carefully control the total amount of market money by printing and engraving money. Therefore, the main purpose of the adjustment is to ensure that the money supply is not excessive or inefficient, thereby not weakening economic growth. For example, once an economy’s central bank prints more money than the market needs, excessive monetary aggregates may lead to unnecessary inflation in the economy. The paper by Manera and Cologni (2005) and the paper by Woodford (2009) mentioned above profoundly addressed the academic significance of total money supply, which points out the direction for future research.

1.2 Significance

This article provides a reference for empirical research of the United States economy. Price stability is not only an important indicator of the healthy and stability of macro-economy, but also one of the goals of macroeconomic policy. The research on the relationship between money supply and inflation has always been a hot issue in the field of macroeconomics, which is of great significance for macro-control. Central banks are trying to control inflation by setting different monetary policies, inflation and money supply and demand are intertwined.

After the 2008 financial crisis, the US launched several rounds of QE to create money and expand credit with quantitative tools, so as to reduce the liquidity pressure of banks and other financial institutions, guide the decline of real interest rates, stimulate residents to increase consumption and enterprises to increase investment, and drive the American economy to recover from the recession. By October 2017, before the Fed began to shrink its balance sheet, the Total assets of the Federal Reserve increased from 876.7 billion dollars in August 2007 to 4.4 trillion dollars in October 2017, a four-fold increase in 10 years. In the face of COVID-19 in March 2020, the Federal Reserve relaunched unlimited QE and issued more than 5 trillion financial subsidies. The large-scale money supply and unemployment subsidies have brought serious inflation problems to the United States. It is more and more important to effectively solve the existing inflation problem, achieve a more reasonable economic growth goal, and clarify the interactive relationship between inflation, money supply and unemployment under the new situation.

Moreover, beyond existing research in the field of money supply and inflation, this article will provide more possibilities for future study, from one more dimension--unemployment. The literature review as follows will focus more on the influence of monetary aggregates on economic growth, from a perspective of the central bank, and it will also address the existing literature about unemployment and other factors that have significant impacts on inflation.

1.3 Thoughts

Our research is based on the AS-AD model, with analysis of how AS-AD curve will change, given that the monetary policy changes. In this sense, we further explore the effects of monetary policy on inflation. By theoretical derivation, we observed that:

A) While increasing the money supply will give people more purchasing power, which is a common economic intuition, in fact, it does not lead to increasing of the production capacity.

B) Expansionary monetary policy will eventually lead to price rising but will not bring about any increase in supply and demand. Figure 1 shows that when the government undertakes expansionary monetary policy in the short term, demand will expand, and AD curve will move towards top right. However, due to the fact that demand exceeds supply in the long-term, the economy will be in position Y_2 where there will be excess output. Therefore, in the long run, manufacturers will gradually adjust their scale of production, and the aggregate supply curve will correspondently move to the upper left and eventually return to the long-term equilibrium output Y_1. With the process repeating, the price level will gradually increase from the beginning

P_1. In this manner, continuous growth in the growth rate of the money supply will lead to a continuous rise in the inflation rate.

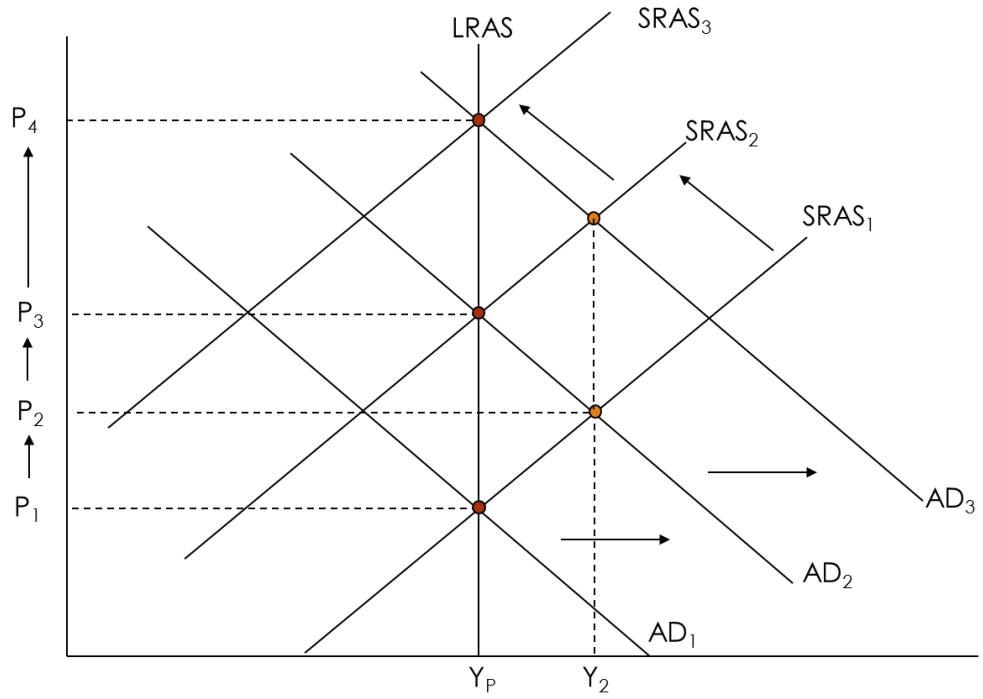


Figure 1 AS-AD Model

In general, scholars commonly believe that modifying monetary policy presents a good way to control a country's inflation rate. In this sense, we try to build a model concerning money supply growth, unemployment rate, and inflation rate, in accordance with Barro's theory, to explore the relationship among supply, unemployment and inflation, in order to consequently find out the actual impact of US monetary policy on the country's inflation rate. Generally, according to the research of McCallum and Nelson (2010), any research on money supply inevitably starts with the traditional quantity theory of money (Friedman, 1956), as the quantity theory of money (QTM) states that the total price level of goods and services is directly proportional to the quantity of money in circulation, i.e., the money supply.

On the other hand, from the Phillips curve, we know that the unemployment rate is closely related to inflation. Therefore, this article also incorporates unemployment into the model as an explanatory variable, and uses data concerning the US unemployment rate to measure the variable. Based on that, the dissertation builds a three-dimensional VAR model to fit and forecast the inflation rate. And for the main indicators of inflation, unemployment, and money supply, we select the consumer price index (CPI) as the referential index indicating changes in the price level of consumer goods and services to changes of inflation; we use unemployment rate to reflect the level of employment; and we select a relatively narrower currency measurement, M1, to represent the money supply. Meanwhile, we consider controlling the changing rate of the price index of import goods as an exogenous variable in order to make the model more precise.

In summary, as mentioned above, this article seeks the relationship among money supply, unemployment rate and inflation on the basis of previous academic explorations. In fact, some scholars focus on long-term relationships, while others only focus on short-term effects, therefore there will be different conclusions on the relationship among money supply, unemployment rate and inflation from different perspectives. In addition, by using different intermediate targets of money supply, M0, M1, or M2, the results of analysis can be significantly different. Therefore, on the basis of clarifying our methodology, the main purpose of this article is to describe the specific relationship among the three.

1.4 Innovation Points

Although there are abundant research and discussions on the relationship among money supply, unemployment rate and inflation, this article enriches the research in this area from the following two points:

(1) The selection of different money supply intermediate targets, M0, M1, or M2, for analysis, can significant influence the results obtained, and most of the previous studies have chosen M2 for research. But this article chooses a narrower money supply, M1, to measure money supply. On one hand, the research on money supply and inflation can be broadened; and on the other hand, by studying the relationship between M1 and inflation, the article can be provided as a policy reference for central banks as new perspective in macro-control measures.

(2) Regarding the relationship between money supply and inflation, this article chooses to introduce variables such as unemployment rate and import price, and uses a multi-dimensional VAR model for analysis. The regression results are more reliable than the results of a single VAR model.

1.5 Article Structure

The structure of this article is as follows. Sections 1 and 2 introduce the research background of this article and the literature review of inflation research. The third section introduces the sample data and data analysis, which constitutes the methodology of this article. Section 4 shows the process of testing the relationship among money supply, unemployment and inflation, and gives the statistical results of the study.

Section 5 makes a comparative analysis of inflation in China and the United States. Finally, Section 6 provides the conclusions of the research and lists potential improvements that can be made in future research.

2. Literature Review

Friedman (1971), a representative of monetarism, pointed out that inflation is a monetary phenomenon at anytime, anywhere. According to the quantity equation of money: MV=PY, with the assumption that money is neutral and the velocity of money (V) remains stable, the increase in money supply (M) will cause the price level (P) to rise at a ratio of 1:1. Regarding this equation, different doctrines such as classicism, monetarism, and neoclassicism have proposed different assumptions. Classicism assumes full employment, and thus labor and commodity markets are immediately cleared, wages and prices are completely elastic; monetarists assume a natural unemployment rate; while the rational expectations hypothesis assumes that economy as a whole can reasonably anticipate changes in the money supply, and accordingly adjust its economic behavior. Despite these assumptions, classicism, monetarism, and neoclassicism all believe that money is neutral, and that an increase in money supply can only increase commodity prices in the long run, and has a very limited impact on total social output. Based on this, Friedman has always advocated to make monetary aggregate the primary goal of monetary policy (1971b). However, whether the money supply can effectively explain the inflation phenomenon has aroused heated discussions in the academia. Firstly, it is still questionable for the effectiveness of the classic market liquidation hypothesis, the monetarist natural interest rate hypothesis, and the rational expectations hypothesis of the rational expectations school in actual economic operations. Secondly, many researchers believe that due to the instability of the currency velocity (V), there is no stable relationship between the money supply (M)

and the price level (P), and the impact of currency growth on inflation is relatively limited.

2.1 Research on Impact of Money Supply on Inflation Rates Worldwide

Given the above controversy, many scholars have conducted a large number of empirical analyses, while Friedman's assumption that the amount of money increases in proportion to inflation has been widely supported. Moazzami and Gupta (1995) studied the annual data of Canada, France, Germany, Italy, the UK, and the US from 1953 to 1987; Sola and Peter (2013) illustrated that there is a positive relationship between money supply and inflation in Nigeria, concluding that the Nigerian government should carry out serious reforms to ensure that more circulating funds are used in the production sector. Reynard (2007) studied the data of the US and Europe from 1953 to 2004, and data later on, all of which indicate that there is a significantly positive relationship between money growth rate and inflation rate. Nelson (2008) logically shows that stable inflation is determined by a stable money growth rate. Crowder (1998) used a cointegration analysis to find that there is a significant statistical relationship between the money supply growth rate and inflation in the long run. Through qualitative analysis, Dwyer Jr and Hafer (1999) also found that there is a significant relationship between money supply growth rate and inflation in many countries, in both the short run and long term. Dwyer Jr (2011) used data from the US to find that, in addition to historical inflation, the money supply growth rate is the optimal indicator of future inflation. Christensen (2001) analyzed data of the US and found a 1:1 relationship between monetary growth and inflation in the long run. He

attributed the deviation of this ratio in the short run to the impact of the real global money supply. Grauwe, P.D and M. Polan (2005) found that in countries with high inflation, money supply growth rate and inflation have a positive and significant relationship in the long run, but in low inflation countries, the relationship between the two is not significant. Krugler and Kaufmann (2011) also found a significant co-integration relationship between European money supply growth rate and inflation, and believed that the deviation of real money supply growth rate from its long-term mean may present a good predictor of inflation. Kaufmann (2007) used the VEC model to analyze the quarterly data of Europe between 1980 and 2006 and found that the relationship between money supply growth rate and inflation is not stable, but there is a co-integration relationship between the two. Kulaksizo, T. G. and Kulaksizo, S. G. (2011) used US data to test the relationship between excess money supply growth rate (the difference between money supply growth rate and GDP growth rate) and inflation, and found that the relationship between the two is non-linear, and the growth of excess money supply rate has a positive effect on inflation in the long-term. But even in the high inflation stage, the relationship between the two is not 1:1.

On the other hand, many studies have shown that there is no close relationship between money supply and inflation. Binner, Tino, Tepper, Anderson, Jones and Kendall (2010) analyzed monthly data of the US from 2001 to 2005, and found that the stable relationship between money supply and inflation cannot be confirmed. Nikolic (2000) studied the Russian economy and found that the more stable the economic situation, the weaker the impact of money supply growth on inflation. Gregorio (2011)

analyzed several countries with low inflation and very rapid growth in the money supply, and based on the analysis, he also believed that money growth did not necessarily lead to inflation. Using UK data, Milas (2011) found that inflation pressures caused by monetary growth are not stable in the long run, and that only when the monetary growth rate exceeds the threshold of 10%, will inflation threat emerge. Moreover, even in such circumstances, Milas (2011) still believes that the inflationary effect from monetary growth can be neglected. Through a series of empirical studies, Bachmeier, Leelahanon and Li (2007) rejected the hypothesis that there is a linear relationship between money supply growth rate and inflation. Instead, they forecasted inflation by using the non-parametric model and threshold regression model, and the result shows that, compared with the linear model, the non-linear model is more effective in predicting inflation, and that adding a money supply growth rate to the model cannot significantly improve the predictive ability. Therefore, they argued that the money supply growth rate is not a good predictor of inflation when linear models are used. Roffia and Zaghini (2011) studied the short-term impact of money supply growth rate on inflation based on 15 industrialized countries, and the results were not clear. According to this study, they found that there was a positive relationship between the money supply growth rate and inflation in nearly half of these countries.

Woodford (2009)'s Interest and Prices, foundation of the theory of monetary policy, is a huge and impressive piece of work, which has used both qualitative and quantitative methods to build a framework for analysis of monetary policy. Based on dynamic and general equilibrium analysis, Woodford (2009)'s work has optimized his work in a

stochastic context. This book has made several points that are related to our study. In Chapter 4, Woodford (2009) shows that if central banks are able to keep the actual short-term nominal interest rate equal to a "natural rate of interest", which is the time-varying equilibrant real rate of return that would be obtained if prices were fully flexible, it would not be likely that prices are adjusted upward or downward, and thus inflation could be stabilized at a rate of zero. More specifically, using a log-linear approximation, the book has illustrated that to keep the inflation rate low and equal to a non-zero target rate, central banks need to maintain an interest rate that is equal to the target inflation rate plus the time-varying natural rate of interest. According to the empirical evidence and data during the 1980s and through the mid-1990s, the author has also built time-series models and found that in the low inflation environment, the central banks can change the monetary policies to induce inflation and maximize the social welfare of the countries. At the same time, in the high inflation environment, the central banks can also focus on policy changing to influence inflation, so as to improve the social welfare of the countries.

Roberts (2004) has examined the extent to which how changes in monetary policy are related to the important changes in the relationship between inflation and unemployment. In fact, the conceptual proposal of the relationship between monetary policy and inflation dynamics is not new at all. Friedman (1968) has stated that inflation is always a monetary phenomenon. Lucas (1976) also assessed how changes in monetary policy can affect inflation dynamics, but he only considered monetary policies relatively stylized. By contrast, Roberts (2004), in his work, incorporated the

effects of more realistic changes in monetary policy and considered expectation formation while holding fixed the behavioral relationships in the economy. Roberts (2004) has adopted two macroeconomic models: a simple model comprised of three equations to analyze inflation, federal funds rate and the output gap respectively; and another, Federal Reserve's large-scale FRB/US model. Both of the models are close to the extremes of the range of complexity among all existing models in policy analysis. Results from both the models show that the change of monetary policy can forecast declines in the slope of the reduced-form relationship between the unemployment rate and change in inflation. The analysis of inflation volatility, on the other hand, has shown different results. According to the simple three-equation model, changes in monetary policy may lead to major reductions in the standard deviation of inflation, but the large-scale FRB/US model only shows a weak relationship between the two variables.

George and Warren (1995) examined 110 countries and found that there is a strong correlation between changes in the inflation rate and the money supply. The correlation coefficient was between 0.92 and 0.96, which was almost close to 1. The increase in the money supply will eventually lead to the same degree of inflation. In other words, the change in the supply of money is finally reflected in the change in the price of goods.

The above literature reviews explain the fact that central banks of many countries worldwide introduce monetary policies or adjust their money supply to control domestic inflation. However, the relationship between money supply and inflation seems less marked in some cases.

2.2 Research on Impacts of Money Supply on Inflation Rates in the US

Many studies have provided valuable insights into how the inflation rate responds to the change in money supply, especially those using data of the US. Binner, *et al*. (2010) has provided comprehensive evidence on the effect of monetary aggregates on the inflation rate in the US, by using the data selected range from January 1960 to February 2005. The authors have explored a relatively wider range of definitions of money and inflation, given that measures of inflation are abundantly available in the US, such as the chain-price index for personal consumption expenditures, the chain-price index for gross domestic product, the implicit price deflator for GDP and variants of the consumer price index (CPI) for urban workers and wage earners respectively (CPI-U and CPI-W). The study adopted a monthly year-over-year percentage change in the CPI-U as the inflation measure, considering its public recognition and data availability, and for monetary aggregates, the authors have considered 16 distinct measures, each differentiated from the monetary assets and the method of aggregation, including M1, M2, M3, MZM and so forth. The authors utilized two non-linear models: recurrent neural networks (RNNs) and recursive least squares regression model that is based on the kernel method. The authors compared the two models with each other to forecast the inflation rate that will prevail in the following 6 months. As a result, the kernel recursive least squares regression model was recognized as the winning model. The experiment results, however, appear unexpected, since the findings did not prove an obvious relationship between monetary aggregates and inflation in the US.

Focusing specifically on monetary aggregate variable M2, William (1998) has pointed out in *Historical US Money Growth, Inflation, and Inflation Credibility* that an

increase in M2 money supply is always followed by an increase in inflation; a decrease in M2 money supply is always followed by a decrease in inflation as well, by using the annual data for the period 1959-1997. The examination of the year-over-year changes in the historical series shows that there is a weak relationship between M2 growth and nominal GDP growth (in turn, inflation) in the short term, but there is a strong relationship in the long term.

Evidenced from a band-pass filter, Shelley, G. L. and Wallace, F. H. (2011) have found that after 1960, there is a positive relationship between money supply and inflation within the 20-40-year frequency band. The authors have applied the bandpass filter from Christiano and Fitzgerald to their study, which includes three frequency bands (2-8 years as business cycle frequencies, 8-20 years as long-run frequencies, and 20-40 years as very long run frequencies). Inflation was measured by log-differenced growth rates in both the CPI and the GDP deflator, by using the data obtained from the Federal Reserve Bank of St. Louis. The results show that there is no positive relationship between money growth and inflation in the business cycle and long-run frequency bands from 1959 to 2002. However, a strong positive relationship between broadly defined money and inflation was noticed in the very long run frequency band.

In the book *A Monetary History of the United States (1867-1960)*, Goodhart, C., Friedman, M. and Schwartz, A. J. (1964) used the US data to analyze the relationship between the money supply (M2) and inflation (GDP reduction factor) from 1877 to 1960, and found that high money supply led to high inflation, but they have no correlations in the short term.

In another study that focused specifically on monetary aggregate variable M2, Wei, H. Y. (2014) researched on the relationship between money supply and inflation, based on historical data of China and the US, adopting regression analysis of the relationship between money supply and inflation in the US, and has reached two conclusions: 1) in the short term, the relationship between the money supply and the inflation rate is not obvious; 2) in the long run, the effect of the money supply on inflation is obvious. The author selected CPI data to measure the inflation rate and selected M2 data to represent the money supply, sourcing from official websites of Federal Reserve and IMF, resulting that in the 50 years from 1960 to 2010, the growth rate of M2 in the US did not show a clear impact on the inflation rate in the short term; however, in the long run, the growth rate of M2 has an impact on the inflation rate. When M2 has a rapid growth rate, there will be a high inflation rate, and vice versa. The effect is sometimes delayed.

Previous studies have observed a stronger relationship between monetary aggregate and inflation in the US, by comparison of data between the US and developing countries such as China. Based on analysis of the progressive relationship between money supply and economic growth in both China and the US, this dissertation makes some comparative attempts to explore the evolution of the relationship between money supply, economic growth and inflation in the process of economic virtualization. With regards to the process of economic virtualization, Lu Zhengwei and Dong Zhengwei (2017) found that the impact of inflation on M2 is always positive in the industrialization stage of economic virtualization, while GDP and CPI are negative in the first stage, but positive in the second stage. The VAR model and the impulse

response functions were used to measure the impact of the standard deviation shock from a random disturbance term of an endogenous variable, on the current and future values of all endogenous variables in the VAR model. The sample interval for the study in the US was from the first quarter of 1991 to the fourth quarter of 2014, taking into account the available data related to the virtual economy (industrialization period, 1991 Q1~2000 Q4; economical virtualization period, 2001 Q1-2014 Q4). The results show that, for the impact of M2, during the industrialization period, GDP and CPI always showed positive responses; during the period of economic virtualization, GDP and CPI responded negatively in the first period, but mainly showed positive values in the second period. The authors explained that during the industrialized period, when the virtual economy is still under-developed, the increased money supply mainly flows into the real economy, which will directly promote economic growth and bring about rising prices. With the deepening of the degree of economic virtualization, one important difference between the virtual economy and the real economy is the widespread use of financial leverage. And therefore, financial innovations continue to create new technologies and methods that use financial leverage, which makes the profitability of the virtual economy often higher than the real economy, especially in the virtual economy-related industries. Since getting income is easier than normal manufacturing, the increased money supply is more attracted to the virtual economy, and correspondently the economic virtualization can well explain the deviation between the growth rate of money supply, the economic growth rate, and the inflation rate during the economic development process.

Meihua Jiang (2014) has found that regarding the standard deviation of the US money supply, the US inflation rate reacts fastest, reaching the extreme value of 0.05% in the third period, and then gradually falling back to zero and stabilized, and that in the long run, the impact of the money supply on the inflation in the US is not great. The author used the Global Vector Autoregressive (GVAR) model, concerning China, Japan, South Korea, and US, with variables such as domestic real GDP, CPI inflation rate, real money supply, short-term interest rate, and bilateral real exchange rate used for national analysis, and with common variables of the system like international crude oil prices. The data selected were quarterly data for the period 1999 Q1~2013 Q2, sourced from official websites of China Economic Net and IMF. To unify the units, the GDP of the four countries and the money supply M2 have been converted into US dollar-denominated; for the CPI index, data of the 2005 were selected as a benchmark; short-term interest rates of banks were used for the three countries except the US, and the federal funds rate were used for analysis of the US; the nominal exchange rates were respectively selected from the quarterly data of the average daily exchange rates of the CNY, JPY and KRW against USD; for the crude oil price, the arithmetic mean of the prices of the three major benchmark crude oils in the international crude oil market, WTI, Brent, and Dubai, were adopted. The international crude oil price was set as endogenous variables in US model, but as exogenous variables in the models of the other three countries; since the nominal exchange rates of the currencies of the three countries, China, Japan, and South Korea were all chosen to refer to the US dollar, the US dollar exchange rate is always equal to 1. The results show that for a standard

deviation of the US currency supply, the US inflation rate has the fastest response rate, reaching an extreme value of 0.05% in the third period, and then gradually falling back to zero and stabilized, and that in the long run, the impact of the money supply on the inflation of the US is not great. Besides, under the quantitative easing monetary policy of the US, Japan and South Korea's inflation rates showed a negative value at the beginning of the period and then increased slowly and only to a slight degree. In the long-term, the inflation rate of Japan rose to a larger degree than that of South Korea, and the US, when faced with the impact of the US money supply. The author explained that the similarities among these three countries can be largely attributed to changes in the price level of their developed financial markets, which can be seen as the combined effects of the base currency and interest rates. The highly market-oriented adjustment of interest rates in developed countries can reduce the pressure of money supply on inflation.

Through the time series in the vector autoregressive (VAR) model, Li, C. and Li, Z. L. (2011) have found that excessive economic growth and excessive money supply are the main causes of inflation. The empirical results indicate that (1) the increase in the total economic output of inflation at the price level does not affect the real growth of the economy; (2) it is significant to explain inflation by using money supply in case of China, but not relatively significant in cases of the US and Japan; (3) in the long run, the rise in price levels in the US and Japan in the previous period has had a significant effect on inflation in the current period, while the effect is not significant in China. The authors used a vector autoregressive (VAR) model to analyze the relationship between

time-series data, and used the impulse response function to describe the response of an endogenous variable to the impact of an error term. In actual operation, a standard deviation shock can be applied to the error term to observe the current and future values of the endogenous variable under the impact. In purpose of solving the problem possibly caused by strict description of dynamic relationships among multiple variables, the authors selected M2, GDP and CPI data published by the World Bank as the data source for money supply, economic growth and inflation respectively. For China, the authors used the annual data from 1978 to 2008; For the US and Japan, the annual data from 1961 to 2008 were used. The authors concluded that in general, inflation is affected by money supply: in the short term, money supply is one of the main causes of inflation in China and Japan, but not in the US; in the long term, money supply will only affect inflation in China, but not in the US and Japan. This is because CNY plays the role of the national currency, and the scope of circulation is mainly confined to the domestic and surrounding areas, while USD and JPY, as international means of payment and international reserve assets, are widely used worldwide. In particular, as the supply of USD not only satisfies the domestic demand but also meets the international liquidity demand, there is no significant correlation between the USD supply and the domestic inflation rate in US.

In the article *Study on the Relationship between Monetary Supply, Velocity and Inflation: Based on the Comparison among US, Japan, UK, and China*, Li Jun (2011) has found that inflation has not changed with the money supply fluctuations. The author selected M1, which has a large impact on inflation, as the money supply variable. The

money circulation rate (V1) is also calculated based on M1. The analysis shows that in 2009, China's money supply accounted for 64% of GDP, lower than Japan's to 103% and the UK's to 76%. From 1990 to 2009, China's money supply as a percentage of GDP increased by 28%, while Japan and the United Kingdom increased by 69% and 45% respectively. Therefore, through the "horizontal" comparison, it can be concluded that the ratio of China's money supply to GDP is neither the absolute value nor the growth rate. The only exception is the US. In 2009, the country's money supply as a percentage of GDP was only 12%, far below the level of the UK, Japan, and China. From 1990 to 2009, the above-mentioned ratio in the US also dropped by 2%. The main reason for this is that the US money supply is mainly in the form of quasi-currency, not current deposits or cash, and its monetization process has greatly surpassed that of other countries. Compared with the level before the Asian financial crisis, in the past 10 years, the inflation rates of the four countries have been relatively flat. Moreover, from 2000 to 2009, the average inflation rates in the US, the UK, Japan, and China were 2.57%, 1.85%, -0.26%, and 1.87% respectively, and compared to the average of the previous decade (i.e., from 1999 to 2008), inflation rates fell by 0.43%, 1.46%, 1.47%, and 5.9% respectively. It can be seen that among them, China's governance effect on inflation was most pronounced, while Japan was in a state of severe deflation, and the US and UK inflation rates remained relatively stable. By contrast to this, the ratios of the money supply to nominal GDP in the UK, Japan, and China have all risen steadily, while that of the US has seen a drop, which shows that inflation has not changed with the money supply fluctuations.

From the quantitative studies based on worldwide data, it can be concluded that money supply may have an impact on inflation. Many economists and scholars have collected rich data and built all kinds of models to explain this correlation. These studies illustrate this correlation in a more precise approach, concluding that money supply or namely monetary policy would influence inflation in the long term obviously, while the correlation is relatively weak in the short term.

From the aspect of qualitative studies, Barro and Gordon (1983) have provided an example as a reputational equilibrium for monetary policy, they believed that under a discretionary monetary regime, central banks can create more inflation than people expect by printing more money but may fail to generate inflation surprises if people figure out policymakers' incentives and adapt to them accordingly. The example shows that an increase in the money supply will lead to an increment in the inflation rate.

On the other hand, Gerlach (1990) has studied the dynamics of inflation using a purely qualitative method, and the results indicate that in economies where there is a positive relationship between the level and volatility of money growth rate, the inflation rate will always overreact to changes in the money growth rate. From the book *The Purchasing Power of Money*, Irving Fisher (1911) has proposed an explanation for the relationship between the money supply, the currency circulation rate, and inflation, i.e., the income-based Fisher equation: $M \times v = P \times y$ (M= money supply; v= currency circulation rate; P=inflation; y= real GDP). According to this equation, the money supply and currency circulation rate affect the price level, i.e., the inflation rate. With real GDP remaining unchanged, if the currency circulation rate declines, even if the

central bank increases the money supply, inflation may also occur in two situations: either rise or decline.

Keynes (1936) has held the view that inflation can be affected by both money demand and money supply, according to his theory of money demand, i.e., $\frac{M}{P} = L(i, y)$ (M= money supply; L= money demand; i= interest rate; p= inflation; y= real GDP). According to Keynesian theory, when the monetary authorities increase the money supply, if the public's money demand rises, the inflation rate may either increase or decrease. Keynes believes that when the economy is in recession, people often increase the amount of money they hold to hedge their risks, leading to the constant precipitation of money and thus curbing inflation. If we combine Keynesian money demand theory with income-based Fisher equations, we can conclude that the demand for money is in a reverse relationship with the velocity of currency circulation. Therefore, when the economy is in a recession, the currency circulation rate will also decline.

According to the System Theory proposed by Bordo, M. D., and Jonung, L. (1987) in their work *The Stochastic Properties of Velocity: A New Interpretation,* institutional factors such as the degree of monetization, the popularity of banks, and the development of the financial market will affect the currency circulation rate. On one hand, as the degree of monetization rises, people start to use paper money on a larger scale and conduct transactions more through bank deposits. The money demand will thus increase, reducing the currency circulation rate and effectively restraining the increase in inflation rate. On the other hand, the rise in the degree of transformation will also bring about the development of the financial market. The appearance of currency substitutes

money market instruments such as bonds, stocks, that will reduce the money demand, thereby increasing the currency circulation rate and boosting the inflation rate. Beside the above two viewpoints, experience also present us with a U-shaped development trend for the correlation of currency circulation rate to the degree of monetization of a country.

In this part, it is shown that different scholars hold different opinions about the correlation between monetary policy and inflation, and some statements are even opposite to each other. By adopting various independent variables, these scholars have built their models in their ways, which correspondently result in great differences, which strengthens my determination to uncover more issues related to ensure the effectiveness of the study.

2.3 Research on Impacts of the US Unemployment Rate on Inflation

The first economist who systematically studied the correlation between inflation and unemployment possibly is Phillips, a New Zealand economist based in the UK. He published *The Relationship Between Unemployment and The Rate of Change of Money Wage Rates, in The United Kingdom, 1861-1957* in 1958, depending on data through nearly 100 years to verify the negative correlation between the unemployment and money wage rate of change. In 1960, two American economists, Solow and Samuelson, has verified the proposal of Phillips (known as the Philips Curve) by using data in US. Samuelson, the representative neoclassical synthesizer, then transformed the Phillips Curve into relationship between unemployment and inflation. It is used as a component of the neoclassical comprehensive theory to explain inflation. They proposed the

reverse relationship between the unemployment rate and the price increase rate. In an economic cycle, when prices rise, the unemployment rate falls, and when prices fall, the unemployment rate rises. However, in 1962, the American economist Okun proposed a reverse relationship between the unemployment rate and the economic growth rate.

Roberts (2004) studied the correlation among monetary policy changes, inflation rate and unemployment changes. This is not the first time that the relationship among monetary policy, unemployment and inflation dynamics is conceptualized proposed. Friedman (1968) has pointed out that inflation is a monetary phenomenon. Lucas (1976) has assessed how currency changes affect inflation dynamics, but he only considered those monetary policies relatively stylized. By contrast, Roberts (2004) incorporated the impact of more practical changes in monetary policy into his research, considering the formation of expectations and fixing the relationship regarding economic behaviors. Roberts (2004) used two macroeconomic models: a simple model consisting of three equations to analyze inflation, federal funds rate, and output gap respectively; and the Federal Reserve's large-scale FRB/US model (the two models are perceived as the most complicated ones of all existing models for policy analysis). The results of the two models both show that changes in monetary policy can predict the slope of the decreasing relationship between the unemployment rate and the inflation rate. However, the results of the two models are different regarding the analysis of inflation volatility. According to the simple three-equation model, changes in monetary policy have led to

most of the reduction in the standard deviation of inflation, but the large-scale FRB/US model only shows a weak relationship between these two variables.

This article will analyze and define historical shocks based on three-dimensional VAR model and impulse response functions. With M1 money supply and unemployment rate as factors, CPI as the inflation measure, and by using monthly data from January in 1982 to December in 2019, we analyze the relationships among money supply, unemployment rate and inflation indicators. And by using impulse response function and variance decomposition method, we try to quantify the contribution of M1 money supply and the unemployment rate to CPI rate index.

3. Methodology

3.1 Modelling

The vector autoregressive (VAR) model was first proposed by Sims (1980), which is constructed by taking each endogenous variable in the system as a function of the lag value of all endogenous variables in the system, thereby extending the univariate autoregressive model to a "vector" autoregressive model composed of multiple time series variables. By using VAR model, it is easy to test whether there is a long-term stable relationship among variables without taking the assumption about the endogeneity and exogeneity of the variables. The mathematical expression of VAR model is

$$Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + \cdots + A_p Y_{t-p} + BX_t + \varepsilon_t \quad t = 1,2,3 \ldots T$$

In equation above, Y_t is a k-dimensional endogenous variable; X_t is a d-dimensional endogenous variable; A_p and B are coefficient; ε_t is disturbance term; P is lag order; and T represents the number of samples. And the matrix form of the model is

$$\begin{pmatrix} Y_{1t} \\ Y_{2t} \\ \cdots \\ Y_{kt} \end{pmatrix} = A_1 \begin{pmatrix} Y_{1t-1} \\ Y_{2t-1} \\ \cdots \\ Y_{kt-1} \end{pmatrix} + A_2 \begin{pmatrix} Y_{1t-2} \\ Y_{2t-2} \\ \cdots \\ Y_{kt-2} \end{pmatrix} + \cdots + B_p \begin{pmatrix} X_{1t} \\ X_{2t} \\ \cdots \\ X_{kt} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \cdots \\ \varepsilon_{kt} \end{pmatrix} \quad t = 1,2,3 \ldots T$$

3.2 Data Collection

Central banks use different monetary instruments such as money supply, interest rate or other instruments to achieve the objectives of controlling inflation rate, full employment and economic growth. There are many factors affecting inflation. Different

monetary policy instruments, such as money supply, liquidity and market expectations, have different effects on inflation. Meanwhile, monetary policy goals, such as inflation rate, employment rate and economic growth rate, also affect each other.

Based on theories and literatures we mentioned above, we use the VAR model for further analysis. In order to construct a multi-dimensional VAR model for analysis, we choose the money supply in the monetary policy instruments and the unemployment rate in the monetary policy goals as the endogenous variables affecting inflation.

In addition, in order to make the model more precise and also reduce regression biases, this article also adds exogenous variables. For exogenous variables, we start from understanding of the main causes of inflation, and try to analyze targeting means to control inflation. Based on our analysis, if the main cause of inflation is excess liquidity and excessive demand caused by excessive credit scale and excessive money supply growth, then the tight monetary policy is an effective means to control inflation; And when the main factor causing inflation is excessively high import prices or excessively rapid growth in labor wages, then the tight monetary policy will not only fail to receive significant results, but may also cause damages to the growth of the real economy, leading to supply reductions, and further price rising (Wang Guogang, 2011). Since the import price can be seen as stable in time series, and there is no unit root for it, and it is not related to the growth of the money supply, we consider controlling the changing rate of the price index of import goods as an exogenous variable, in order to study the influence of money supply and unemployment rate on inflation while controlling the import price growth rate as stable.

This paper analyzes the non-stationary time series of inflation, money supply and unemployment. The statistical test analysis results of three optimal estimation models, Linear Models, Quadratic Models and Log-Linear Models, are as follows: Firstly, the money supply change curve is not suitable for linear regression analysis, and the inflation curve is suitable for linear regression analysis. Secondly, the Quadratic Models is very suitable for the analysis of inflation, but not for the analysis of money supply, so this method is not adopted. Thirdly, log-Linear Models are more suitable for analyzing variables that are affected by sudden events. Although they are still inadequate for the growth rate of money supply, they better describe the rate of inflation.

Therefore, the VAR model established in this article contains four variables, among which three are endogenous variables and the other is exogenous variable. The endogenous variables are as follows: **the inflation rate, which is the log difference of the monthly CPI in the US; the percentage change in the money supply, which is the log difference of the monthly M1 in the US; and the change in the unemployment rate, which is represented by the difference of the monthly unemployment rate in the US.** The exogenous variable is the inflation rate of import goods, which is represented by the log difference of the monthly import prices index in the US.

The variable M1 contains the following components:

(1) Currency other than the treasury of the US Treasury, Federal Reserve Bank and depository institutions;

(2) Traveler's cheques from non-bank issuers;

(3) Demand deposit;

(4) Other checking deposits (OCD), mainly including transferable withdrawal order accounts of depository institutions and credit union stock draft accounts (Board of Federal Reserve System, 2015).

Data concerning CPI, M1 and unemployment are all collected from Federal Reserve Economic Database (FRED) and data concerning the import price index is collected from International Monetary Fund. The sample period we use in this dissertation is from January 1982 to December 2019 covering over 37 years. In order to observe the data more intuitively, this article draws a line chart for 4 variables, so as to observe their trends. (As shown in Figure 3-1, Figure 3-2, Figure 3-3, Figure 3-4)

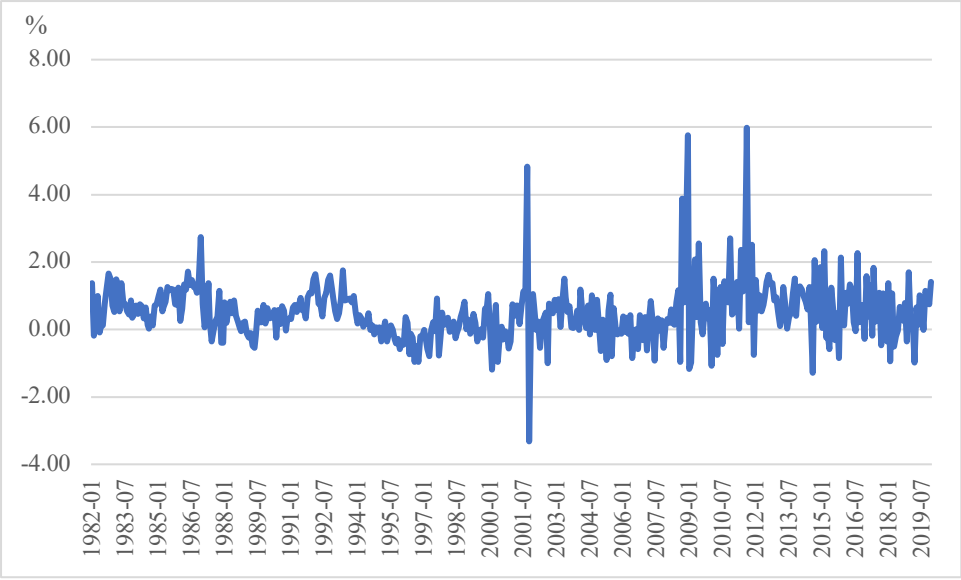


Figure3-1 M1 Monthly growth rate of stock

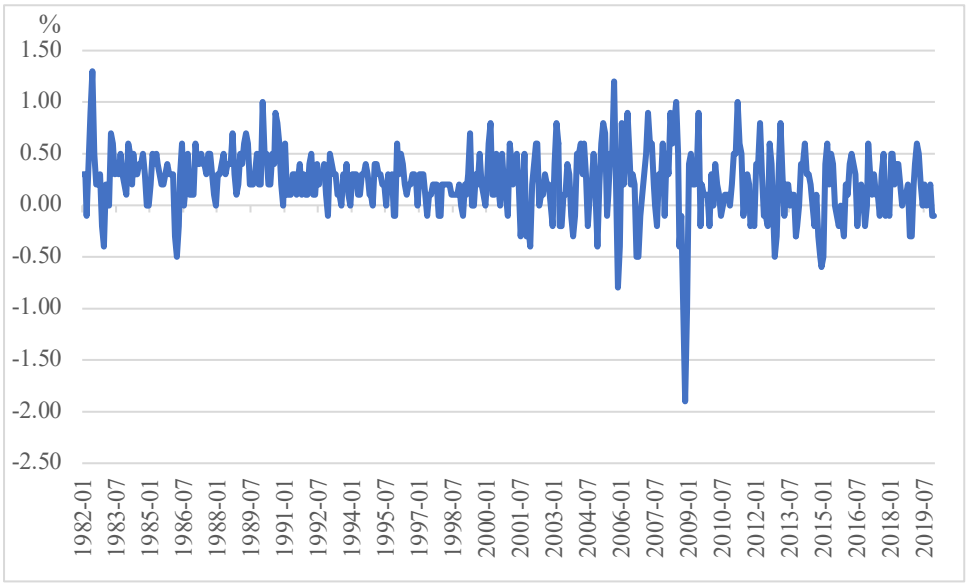
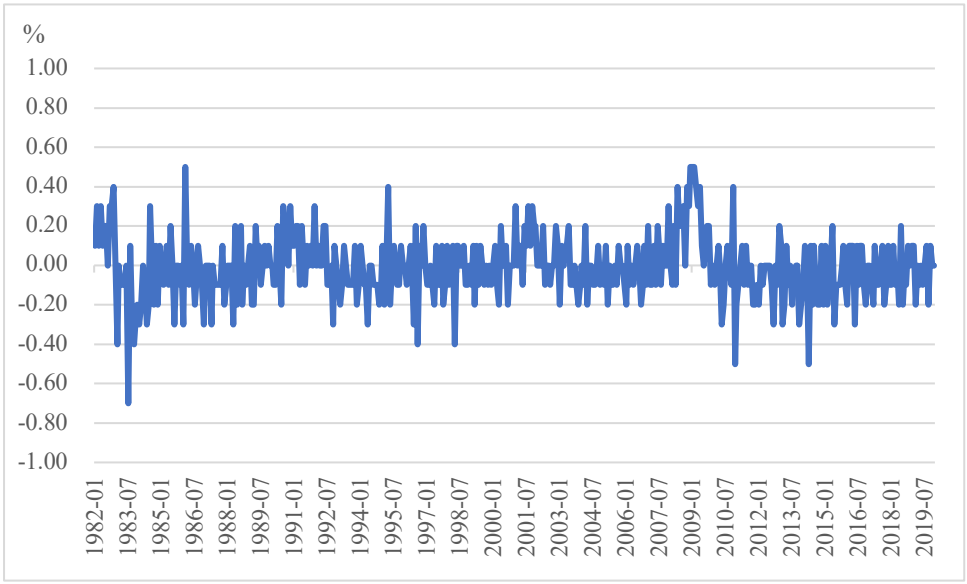


Figure3-2 CPI Monthly growth rate



Note: Change of Unemployment Rate = Ue_{t+1} - Ue_t .

Figure3-3 Change of Unemployment Rate

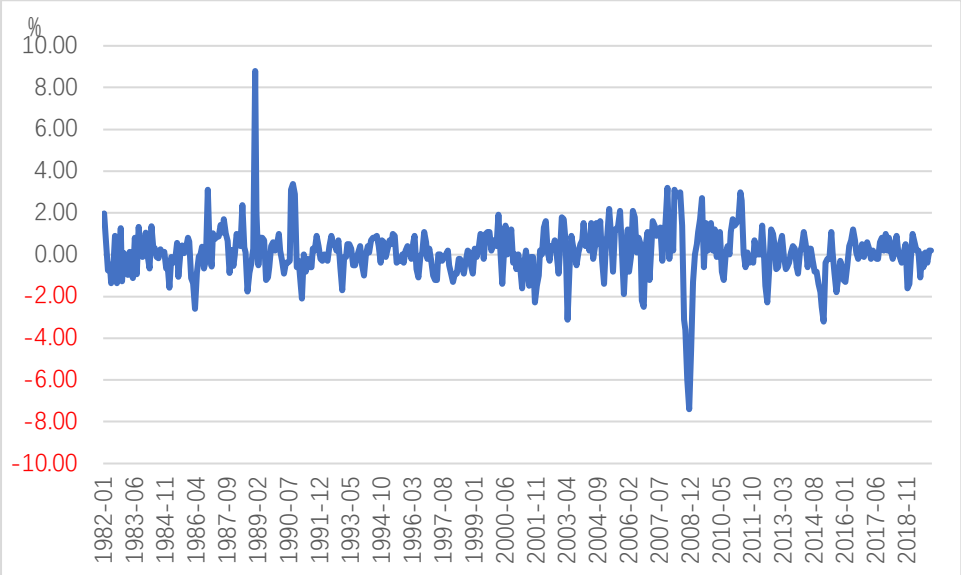


Figure3-4 Import Price index growth rate

4. Establishment of the VAR model and Data Analysis

Many time-series analysis concerning economic data to testify certain economic phenomena are non-stationary. However, if we still use the traditional method of ordinary least squares regression, the result of regression analysis can be spurious. Therefore, to avoid pseudo regression, we hereby use the unit root of the related data to test the stationarity of time series.

4.1 Stationarity Test of the Variables

As mentioned above, we should take unit root test on each of the variables in the VAR model established. After reading related literature about unit root test, Augmented Dickey-Fuller method (ADF) is used to test the sequence unit root in this dissertation. The test is based on the following three regression equations:

$$\Delta y_t = \delta y_{t-1} + \sum_{i=1}^{p} U_i \Delta y_{t-i} + \varepsilon_t$$

$$\Delta y_t = \alpha + \delta y_{t-1} + \sum_{i=1}^{p} U_i \Delta y_{t-i} + \varepsilon_t$$

$$\Delta y_t = \alpha + \beta t + \delta y_{t-1} + \sum_{i=1}^{p} U_i \Delta y_{t-i} + \varepsilon_t$$

In the above three equations, the null hypothesis is $H_0: \delta = 0$, i.e., there is a unit root. According to the calculation, we get the results in the following tables:

Table 4-1 Unit root test results

variable	t-Statistic	Prob.*
D.Log(CPI)	-6.485	0.0000***
D.Log(M1)	-18.867	0.0000**
D.unemployment	-19.233	0.0000***
D.Log(import price index)	-9.675	0.0000***

*** means Significant at 1% level

It can be seen from the tables above that for all the series, the null hypothesis of unit root can be rejected at the 1% significance level (-3.45), i.e., all series are stationary series. This means that the data in this article meets the basic requirements for building a VAR model.

4.2 Selection of Lag Order

In addition to unit root test, one of the key parts to establishing our three-dimensional VAR model is to determine the optimal lag order. In this dissertation, we use Lag Length Criteria function in Circled ARIMA Model to select the best lag order. We need to consider AIC information criterion and HQ information criterion synthetically to decide the optimal lag order of our three-dimensional VAR model. The output of the test is shown below:

Table 4-2 Lag Length Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	4258.328	NA	6.24e-12	-17.286	-17.235	-17.266
1	4376.310	233.566	4.01e-12	-17.729	-17.600	-17.679
2	4421.368	88.650	3.46e-12	-17.875	-17.671	-17.795
3	4509.734	172.780	2.51e-12	-18.198	-17.917	-18.088

4	4555.433	88.798	2.16e-12	-18.347	-17.989	-18.207
5	4607.923	101.352	1.81e-12	-18.524	-18.089	-18.353
6	4645.295	71.706	1.61e-12	-18.639	-18.127	-18.438
7	4679.254	64.743	1.46e-12	-18.741	-18.152	-18.510
8	4755.872	145.139	1.11e-12	-19.016	-18.350	-18.754
9	4811.746	105.161	9.15e-13	-19.206	-18.464	-18.915
10	4837.290	47.765	8.56e-13	-19.274	-18.454	-18.952
11	4864.469	50.491	7.95e-13	-19.347	-18.451	-18.996
12	5039.415	322.868*	4.05e-13*	-20.022*	-19.049*	-19.640*

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

According to the regression results in the table above, when the lag period is 12, the detection results of Schwarz Information Criterion and Akaike Information Criterion are significant, which means that the lag of 12 periods is the optimal lag order, i.e., the lag order of the three-dimensional VAR model is 12 periods.

Based on the results above, it can be seen that the variables selected in this dissertation (inflation, money supply, unemployment and import price), are all stationary series and they can all pass the unit root test. Meanwhile, with the exogenous variable, import price, under control, the above variables still have a relatively stable cointegration relationship in the long run. Also, in order to ensure the robustness and accuracy of the three-dimensional VAR model, different information criteria were considered, to determine the optimal interval. Based on the efforts above, we

established a VAR model considering money supply, unemployment and inflation as follows:

$$CPI_t = \sum_{i=1}^{12} \alpha_{1i} CPI_{t-i} + \sum_{i=1}^{12} \beta_{1i} M1_{t-i} + \sum_{i=1}^{12} \gamma_{1i} U_{t-i} + \lambda_1 Price + c_1 \quad (1)$$

$$M1_t = \sum_{i=1}^{12} \alpha_{2i} CPI_{t-i} + \sum_{i=1}^{12} \beta_{2i} M1_{t-i} + \sum_{i=1}^{12} \gamma_{2i} U_{t-i} + \lambda_2 Price + c_2 \quad (2)$$

$$U_t = \sum_{i=1}^{12} \alpha_{3i} CPI_{t-i} + \sum_{i=1}^{12} \beta_{3i} M1_{t-i} + \sum_{i=1}^{12} \gamma_{3i} U_{t-i} + \lambda_3 Price + c_3 \quad (3)$$

The above equations 1-3 present as the VAR model constructed in this dissertation. $c_i (i = 1,2,3)$ is the constant term of the equation. However, before estimating the three-dimensional VAR regression, to ensure the stability of the VAR model, lag structure test is necessary. In this dissertation, AR root graph is used to justify the results of the test. If the reciprocals of all root modules of the estimated three-dimensional VAR model are less than 1, i.e., in the unit circle, then the model is proved to be stable. The output is shown in Figure 4-5.

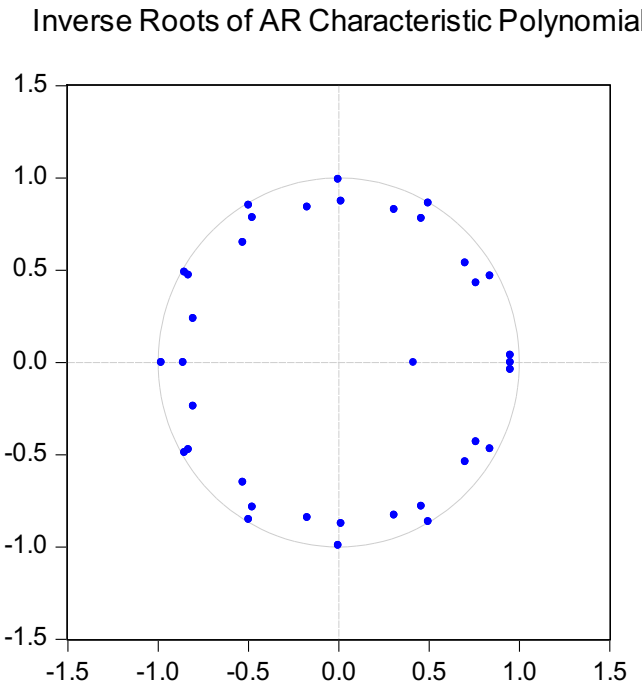


Figure 4-5 Inverse Roots of AR Characteristic Polynomial

According to the AR root graph, all the results are in the unit circle, indicating that the VAR model is stable and effective. To sum up, results of the three-dimensional VAR obtained in this dissertation are shown in Table 4-3 below:

Table 4-3 Output of Three-Dimensional VAR model

Variables	CPI	Variables	CPI
CPI (-1)	0.360707*** (0.03979)	CPI (-7)	0.034168* (0.04403)
CPI (-2)	-0.126124*** (0.04363)	CPI (-8)	0.013829 (0.04414)
CPI (-3)	0.092158** (0.04372)	CPI (-9)	0.106065*** (0.04410)
CPI (-4)	0.004965 (0.04389)	CPI (-10)	0.084135* (0.04379)
CPI (-5)	0.005474 (0.04397)	CPI (-11)	0.155409*** (0.04370)
CPI (-6)	0.091201*** (0.04399)	CPI (-12)	-0.100725** (0.03917)

Variables	CPI	Variables	CPI
M1(-1)	-0.010958* (0.00840)	M1 (-7)	0.000183 (0.00838)
M1 (-2)	0.010950* (0.00837)	M1 (-8)	-0.009065 (0.00828)
M1 (-3)	-0.001367 (0.00828)	M1 (-9)	0.010201* (0.00841)
M1 (-4)	-0.002484 (0.00849)	M1 (-10)	0.018094** (0.00840)
M1 (-5)	-0.003841 (0.00843)	M1 (-11)	0.000358 (0.00838)
M1 (-6)	0.009422* (0.00849)	M1 (-12)	-0.012160* (0.00831)

Variables	CPI	Variables	CPI
JOB (-1)	-0.003520 (0.00212)	JOB (-7)	0.001519 (0.00208)

JOB (-2)	-0.001119 (0.00211)	JOB (-8)	-0.000409 (0.00207)
JOB (-3)	-0.000315 (0.00211)	JOB (-9)	-0.001407 (0.00205)
JOB (-4)	-0.003912* (0.00212)	JOB (-10)	0.003407* (0.00208)
JOB (-5)	0.000307 (0.00204)	JOB (-11)	-0.002963* (0.00207)
JOB (-6)	0.003819* (0.00207)	JOB (-12)	-0.000964 (0.00206)

Constant	0.000473*** (0.00018)	Price	0.113585*** (0.00752)
R-squared	0.677629	Akaike AIC	-9.677198
Adj. R-squared	0.651357	Schwarz SC	-9.352925
F-statistic	25.79231		

Note: Standard errors in ( )

4.3 Impulse Response Function Analysis

The results above show that there is a significant long-term equilibrium relationship among the three endogenous variables of the VAR model in this dissertation. However, due to the influence of random interference, variables may temporarily deviate from the equilibrium value in the short term. In addition, the impact of a variable is transmitted through the VAR model. Thus, in order to further reflect the dynamic interactions between the variables in the research and figure out the influence of the variable, Money Supply, which is represented by M1 growth rate and the variable, Unemployment, which is represented by the change rate of unemployment rate on the degree of inflation, we use the impulse response function (IRF) to analyze theses effects. The basic idea of this method is to consider the influence of the disturbance term and figure out how it is passed to each variable. Also, the dynamic analysis of the VAR

model is generally realized by the "orthogonal" impulse response function, and the orthogonalization is usually completed by the Cholesky decomposition. Therefore, the impulse response function, decomposed by Cholesky orthogonal decomposition, is suitable to analyze the interactions of the two variables with inflation. Figure 4-6 and Figure 4-7 respectively show the impact of the short-term shocks of the money supply and unemployment rate on inflation.

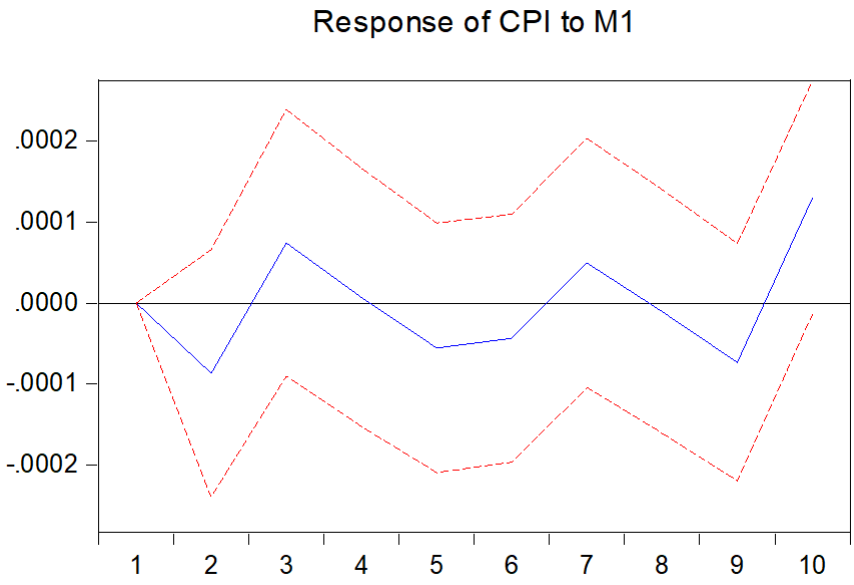


Figure 4-6 Impulse Response Function of CPI to M1

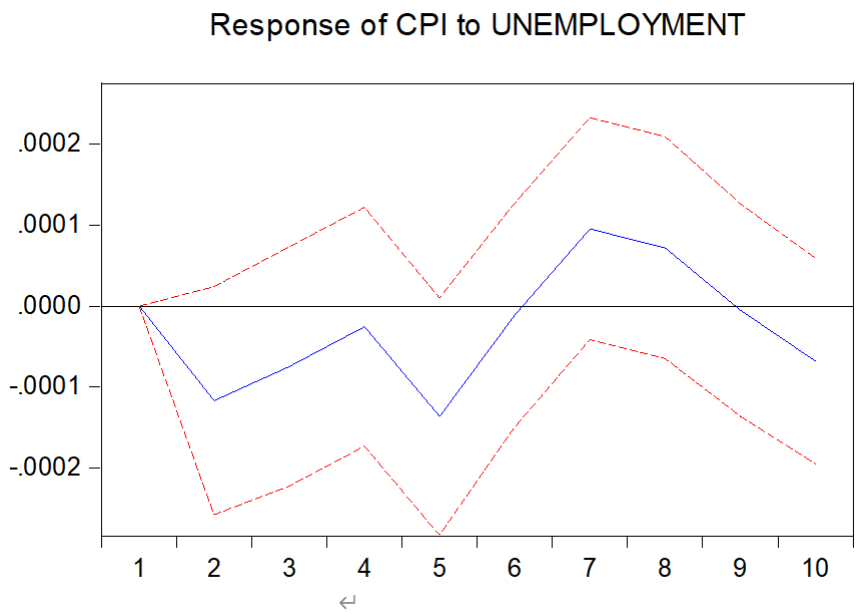


Figure 4-7 Impulse Response Function of CPI to Unemployment

According to the Figure 4-6, we can see that when a positive shock of standard deviation is applied to the money supply M1, the response of inflation (CPI) to the shock is relatively stable. At the beginning of the shock, CPI will have a negative response to the shock, which means that the positive shock of M1 will lower the price level and eventually lead to an extremely short-term inflation reduction. However, as the shock continues, just like the theoretical derivation we said above, a positive shock derived from increasing in money supply possibly caused by macroeconomic control measures such as expansionary monetary policy, can bring about a continuous increase in CPI, which in turn leads to the price level rising, resulting in a more serious inflation.

According to the results of the impulse response graph in Figure 4-7, when a positive shock of standard deviation is applied to the unemployment rate, i.e., the unemployment rate increases, CPI will have a relatively smooth negative response to

the shock, which is consistent with the theoretical mechanism deduced in the previous part of this dissertation. Specifically, during the initial period of the shock, CPI is very sensitive to the shock, but as the unemployment rate rises, CPI will drop significantly, and consequently the price level will drop sharply. In other words, when inflation decreases at initial stage, the economy will notably "cool down"; but when it is in mid or long term, the impact of unemployment on inflation will gradually get weaker. this phenomenon can be explained by the fact that the unemployment structure may change over time, and therefore, the equilibrium between inflation and the natural unemployment rate will gradually change, leading to the weakening of the impact. However, in general, the unemployment rate still has a strong negative impact on inflation.

Overall, the results of impulse response function analysis based on the influence of money supply and unemployment rate on inflation are consistent with the theoretical analysis of this dissertation. Specifically, for the money supply, the impact of M1 growth on inflation is the same as the deduced result in the AD-AS model, i.e., leading to a rise in price levels and an increase in inflation in long term. The impact of unemployment rate on inflation is also the same as the result of theoretical analysis. From our analysis above, we conclude that the increase in the unemployment rate usually represents economic recession and slowdown in economic growth, during which the consumption capacity and output capacity of the society will be negatively affected, which will further lead to a decline in the price level and ultimately cause decrease in inflation.

4.4 Variance Decomposition

Through the analysis of the VAR model and the impulse response function above, we can preliminarily confirm our forecast on the impacts of different shocks on inflation. Further, in order to explore the influence of different variables in the VAR model on inflation, including the variable inflation itself, and evaluate the impact of money supply and unemployment on inflation in a more precise approach, we chose variance decomposition. The result of variance decomposition is shown in Figure 4-8 as follows:

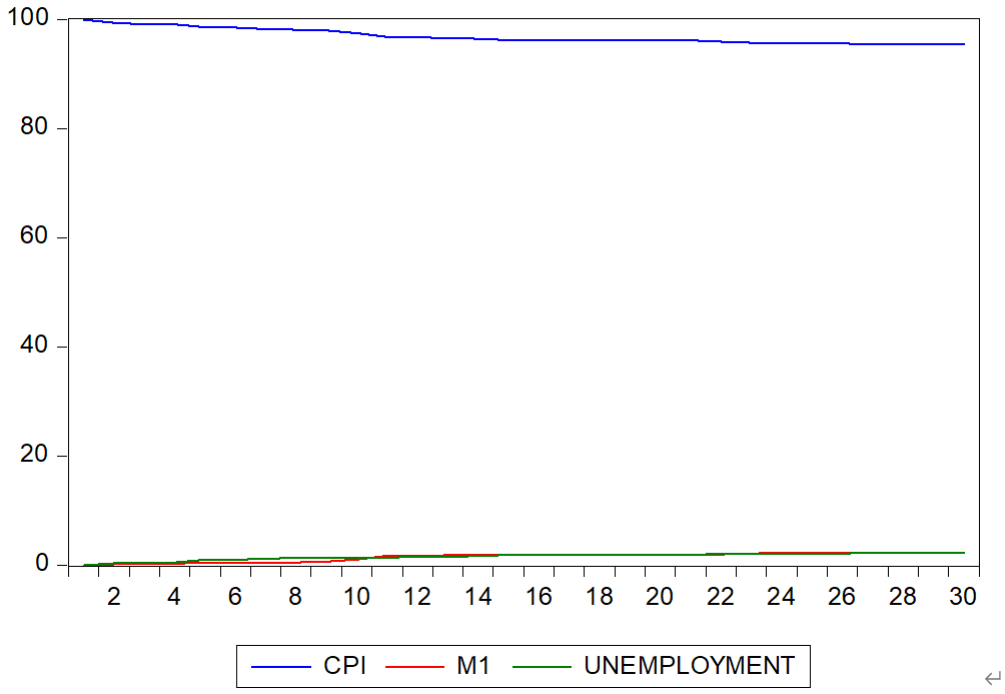


Figure 4-8 Variance Decomposition of CPI by Using Cholesky Factors

As shown in Figure 8, among the three variables which impact inflation (represented by CPI), the contribution of itself is the highest and the relevant proportion in the variance decomposition has remained at more than 90% during all periods, with a slightly decreasing tendency. However, the contribution proportion of the variable Money Supply (represented by M1) and that of the variable Unemployment

(represented by the unemployment rate) both gradually increase and the proportions of them are almost equal.

4.5 Summary of the Results Analysis

We can summarize the results of the above analysis as follows. After confirming that the data used are stable and the variables are strongly cointegrated, we chose the Lag Length Criteria and compared the results derived from different information criteria. We found that the best lag order for the VAR model established in this paper is 12 periods, indicating that the data trend is in line with the 12-year lag. In this sense, we managed to construct a VAR model. According to the estimated coefficient of VAR model, the growth rate of broad M1 money supply is positively correlated with the inflation rate to some extent. Impulse response analysis shows that, for the United States, reducing the growth rate of M1 money supply is helpful to reduce the inflation rate, especially in a lag period. The statistical test results show that American money supply M1 is the influencing factor of CPI. The increase in the growth rate of the M1 money supply would lead to the increase in the inflation rate in the US money market, and the increase in the unemployment rate will bring about a decrease in the inflation rate. On the one hand, it proves that the choice of money supply as an intermediary target is effective, but there is a certain lag in regulating consumption inflation. On the other hand, it shows that there is a policy contradiction between the employment rate and the inflation rate.

From the perspective of the relationship between the M1 money supply and the US inflation rate, it is necessary to comparatively combine our results with relevant previous research.

Christiano and Fitzgerald (2003) found a significant, positive correlation between M2 money growth and CPI inflation in all examined frequency bands for the US before 1961, while However, they found a positive correlation only in the frequency band corresponding to cycles of 20−40 years for the post-1960 period.

Based on the research of Christiano and Fitzgerald, Shelley, G. L., and Wallace, F. H. (2005) verified the results and extended the pre-1961 sample by including the monetary base and inflation calculated from the GDP deflator. Besides the monetary base (MB), they considered the other two money measures, M1and M3. Also, inflation was measured as log differenced growth rates in both the CPI and the GDP deflator. For this analysis, monthly money growth was matched with the monthly growth rate of the CPI. Similarly, the authors matched quarterly money growth with quarterly growth of the GDP deflator. Data are sourced from the Federal Reserve Bank of St. Louis. For the monthly data, results have revealed no apparent positive co-movement between filtered CPI inflation and money growth (either narrow or broad), in frequency bands of 2-8 years or 8-20 years. Thus, the money inflation relationships at the frequencies of 2-8 years and 8-20 years both differ distinctively with that observed in the 1914-1960 period. Beside the results different from the earlier period, negative correlations between the business cycle and long-run components of money growth and inflation were observed. For example, the correlation of M2 growth and inflation measured by

the CPI is -0.68 for the 1959-2002 period, while the correlation of these two variables is 0.44 for the period before 1961. In this very long run (20 to 40 years), there remains a positive relationship between money growth and inflation in this sample for MB, M2, and M3; but, interestingly, for M1, it is not the case, the results of Shelley, G. L., and Wallace, F. H. are in contradiction with the results in this paper. For the quarterly data, similar to findings for the monthly series, there is no apparent positive co-movement between money growth and inflation in either the frequency bands of 2-8 or 8-20-years, and the only strongly positive relationship between the plotted filtered series is for broad money growth and inflation in the 20-40 years' frequency band. As before, these observations are confirmed by the correlations between the filtered series. All of the correlations between money growth and inflation in the frequency's bands of 2-8 and 8-20 years are negative for the 1959-2002 period, except one positive correlation observed, which is relatively small. A strong, positive correlation between money growth and inflation is found only for M2 and M3 and in the very long run, i.e., 20-40 years frequency band. Therefore, this previous study is contradictory to the results in this dissertation in a way that a positive relationship between M1 and inflation rate in the US was not observed. This difference is possibly due to the fact that the data in the two papers were selected from sample periods different from this dissertation and the statistical models also differ.

Regarding the relationship between unemployment and the inflation rate in the US, many scholars have also studied this issue. Phillips (1958) first proposed and explored the relationship between inflation rate and unemployment rate. By studying British

wage statistics and unemployment data of nearly 100 years, he finally found that the rate of change of nominal wages and the unemployment rate are negatively correlated contributing the rate of change in nominal wages to one of the earliest indicators to measure inflation. Samuelson et al. (1960) replaced the rate of change in currency wages in the Phillips Curve with the rate of price increase, and formally linked the unemployment rate with prices and inflation. Dale M, Pissarides C (1994) explored the relations between inflation and unemployment from the perspective of the labor market. Mazumder (2010) pointed out that the assumption proposed previously on the issue of unemployment is unreasonable, given that the unemployment rate is inelastic in the short term. Gordon (2011) conducted regression of the expected variables in the model to a limited number of inflation lag values, and proposed that the length of sample would affect the accuracy of the results. Also, Okun's law states that for every 2% decrease in GDP relative to potential GDP, the unemployment rate will rise by 1%. Generally speaking, the price level reflected by CPI is positively correlated with GDP. This also provides a theoretical basis for the negative correlation between unemployment rate and inflation.

However, it is important to note that the VAR model hides the structural correlation between variables. Therefore, SVAR model can be introduced for further in-depth analysis, to establish the organic dynamic relationship among M1, CPI and unemployment rate variables, and to further analyze the current impact of other variables on the basis of analyzing the lag effect of each variable.

5. Comparisons with China

At present, with the expanding of the global value chain and the deepening of international cooperation, the development speed of developing countries has increased sharply. Among them, China's economic growth rate has made rapid progress in recent years, and in terms of the total GDP, China has become the world's second largest economy after the United States. Therefore, after a thorough study of the dynamic problems of inflation in the United States, it is very necessary to compare the economic operation between China and the United States, and take the dynamic development path of inflation in the United States as a reference to provide reference for China's future macro-control policies.

5.1 The relationship between the money supply and inflation in China

As shown in Figure 5-1, since 1996, the growth trend of M1 in China has been basically consistent with that of inflation rate, and the time lag of M1 growth rate's impact on inflation is generally 1-2 years or longer. As shown in Figure 5-2, before 2000, changes in M2 growth were sensitive to the contraction and expansion of money, moving in the same direction as inflation. After 2008, money M2 contains more and more factors of income - savings growth, and the causal relationship with inflation rate is significantly weakened.

China's inflation is more influenced by the money supply than America's. Excessive money supply is also at the root of China's demand-led inflation. In addition, China has adopted a monetary policy of light price and heavy quantity tools for a long time in its inflation control, and the control means are relatively single, which makes the total social demand less sensitive to monetary policy.

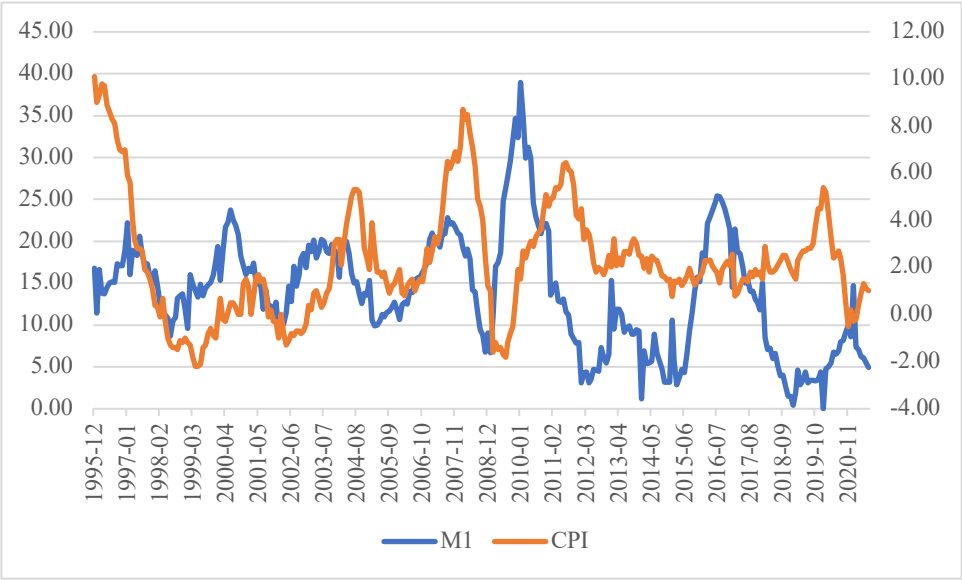


Figure 5-1 Change trend chart of M1 growth rate and CPI growth rate in China

Source: People's Bank of China.

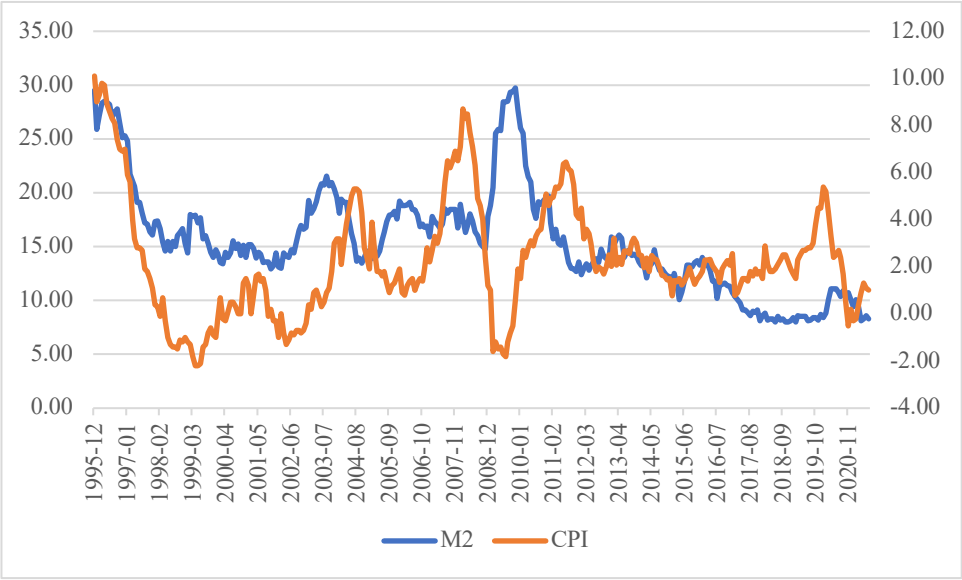


Figure 5-2 Change trend chart of M2 growth rate and CPI growth rate in China

Source: People's Bank of China.

5.2 Policy Recommendations

The Federal Reserve can take money supply as an important means of effective macro-control of the market economy to restrain excess liquidity in the market, which has reference value for the implementation of China's monetary policy.

The goals and priorities of Chinese and American monetary policies are different. After 1982, the United States took the suppression of inflation as the main policy goal, and the monetary policy affected the money supply through the interest rate. However, China mostly uses quantitative policy tools. In addition, China attaches more importance to policy goals such as full employment and social stability, so it has a higher tolerance for inflation.

China's economic growth is accompanied by high inflation. In the long run, liquidity is also one of the factors affecting the inflation rate, which explains the fluctuation of the inflation rate at about 10%. The GDP growth rate, as an indicator of the economic growth, also has impact on the growth rate of money supply, which shows that the fluctuation of China's inflation rate or price level originates from the supply-demand relationship of the real economy. But in recent years, with the internationalization of CNY, the proportion of export-oriented contribution to China’s economy has been increasing, and thus government should pay attention to the impact of world market changes on domestic economy.

USD and CNY play different roles in international payments and reserves. Based on this, the impacts of monetary policy on inflation in the two countries are different. Specifically, USD is used worldwide, and thus the inflationary pressure from the money supply will be diversified. For example, the four rounds of quantitative easing have brought about depreciation of other currencies, which undoubtedly increases the inflationary risk of other countries. Therefore, the relevant data may not be able to show the correlation between the domestic situation and the United States.

Compared with the US, China will be subject to more economic interventions from an authority that reluctant to show market-oriented inflation. Because the Chinese authority always eliminates the risk of inflation in advance, it is less possible to explore the real link between money supply and inflation to some extent.

Above all, we should not only study on the basis of data, but also carry out a more comprehensive study considering practical and local operations.

5.3 Monetization of fiscal deficits

Since the 2008 global financial crisis, the global economic growth has not been returned to pre-crisis levels, the global economy is difficult to thoroughly get rid of the downturn. Moreover, the outbreak of Covid-19 has had a further negative impact on the global economy, global economic shut down, the unemployment rate in the short-term rapid ascent, expected fiscal deficit spending and rapid upward, the benchmark interest rate rapid downward. These problems are difficult to solve quickly under the traditional monetary and fiscal policy framework, but can be easily solved under the MMT framework.

MMT is a development of post-Keynesian economics, focusing on the coordination between fiscal policy and the monetary policy of the central bank. MMT advocates that the financial department decides the scale of fiscal expenditure and deficit, and the fiscal deficit is all purchased by the central bank. In this way, the fiscal policy also determines the release of high-energy money and monetary policy -- the central bank becomes the subsidiary of the Ministry of Finance. MMT theory does not

consider the level of government debt, but only considers employment and inflation to determine the arrangement of fiscal policy (deficit), that is, government deficit has no budget constraint but only inflation constraint. In times of economic recession, effective demand is often insufficient, and expanding fiscal spending can create demand to support the economy. After the economic recovery, if the fiscal deficit cannot be monetized in a timely manner, it may lead to excess demand and easily lead to high inflation.

China does not yet have the preconditions to monetize its fiscal deficit. Firstly, RMB is not the reserve currency, so the risk of currency substitution and exchange rate depreciation always exists. Secondly, soft fiscal constraints are not easily controlled under the current policy framework. Thirdly, China is far from the conventional policy dilemma of low inflation and zero policy interest rates.

6. Conclusions

6.1 Research Conclusion

Based on the data of inflation, money supply, unemployment rate and import price from January 1982 to December 2019 in the US, this dissertation is more didactic in the relationship between money supply and inflation. First of all, this dissertation systematically and comprehensively analyzes the overall changes in the operation of the US economy. Then, the dissertation selects CPI, M1, unemployment rate and other data to build a three-dimensional VAR model to systematically analyze the influencing factors of inflation. Then, based on the VAR model, this dissertation uses impulse

response function and variance decomposition to study the dynamic influence of money supply, unemployment rate and inflation. The conclusion is that the increase of money supply will aggravate inflation, and the increase of unemployment rate will curb inflation. Then, this dissertation briefly discusses and analyzes the empirical results of the above model.

To sum up, this dissertation can conclude that money supply M1 is the influencing factor of CPI, i.e., the change of money supply will be transmitted to the inflation. By adjusting the money supply, we can effectively adjust the inflation. On one hand, it is proved that the choice of money supply as the intermediary target is effective; on the other hand, there is a certain time lag in adjusting the inflation through money supply. As another influencing factor of CPI, unemployment rate affects the inflation level of a country through influencing economic development, wage level, price level and other factors.

6.2 Policy Recommendations

Through the research on the relationship among money supply, unemployment rate and inflation, we can see that money supply can be used as the intermediary target of monetary policy to control inflation. Specifically, monetary authorities can influence the ultimate goal of monetary policy by adjusting the money supply M1. Price stability is an important indicator to measure whether a country's macroeconomic operation is healthy and stable, which is also one of the long-term goals of macroeconomic policy. The change of money supply in the market will cause the change of the relationship between money supply and demand, and then lead to the change of price level. In the

long run, the change of money supply is the key factor leading to the change of inflation rate. The transmission mechanism of money supply to inflation mainly includes money channel, interest rate channel and exchange rate channel. The transmission relationship between money supply and inflation is directly related to the implementation of monetary policy. If the influence of money supply on price is not stable, the implementation result of monetary policy and the normal operation of macro-economy will be negatively affected.

Most countries rely on expanding money supply to stimulate the real economy for further growth. Through the research, we know that although the increase of money supply can bring economic growth to a certain extent, it will also lead to the rise of commodity prices and inflation. Economic growth is mainly affected by the real economy. The government should attach importance to the development of real economy and promote the transformation of economic structure. The growth of money supply has little contribution to economic growth. Only the continuous upgrading of industries and continuous innovation of real economy and technology are the fundamental driving force to promote economic growth.

Unemployment, it is also a variable that has a great impact on inflation. The government can also adjust the level of unemployment rate through a series of macro-control measures, and finally complete the regulation and control of inflation. Generally, when the systematic risk increases or crisis occurs, the consecutive economic downturn, is usually accompanied by the decline of consumption capacity and the risk of deflation. At this time, a sharp rise in the unemployment rate may occur. Therefore, in the short

term, in order to make the economy recover rapidly, in addition to promoting consumption through introducing appropriate inflation to enable the economy adjusting automatically, the government should also introduce a series of measurements in order to stabilize the employment, and help enterprises through macro-control, further promoting the economy to return to the right track.

6.3 Limitations of the Study

This dissertation analyzes the relationship among money supply, unemployment and inflation from both theoretically and empirically. However, the author can still make further improvements on the dissertation from the aspects as follows:

(1) The internal mechanism of inflation is complex, and there are many influencing factors should be taken into concern. Although the research on inflation began in the 1950s, there is still no unified standard for evaluation in the academia, even till now. For example, the choice of monetary intermediary target is also diverse. In different countries and social backgrounds, the applicable standards are quite different. In the US, it is almost impossible to perfectly integrate all the standards of research on inflation into a comprehensive theoretical framework.

(2) This dissertation only studies the two factors that affect inflation: money supply and unemployment. The results of variance decomposition in this dissertation show that the lag period of CPI has a very high impact on itself, which is consistent with many scholars' studies. However, inflation expectation may be self-realized in some cases, i.e., irrational expectation. Specifically, when residents expect the coming era of high

inflation or hyperinflation, panic consumption will appear, leading to unnecessary demand driven inflation. Similar influencing factors remain to be uncovered.

(3) The statistical samples in this dissertation have some limitations. This dissertation only studies the monthly data of the US from 1982 to 2019, which is not comprehensive, and thus the research on the relationship among money supply, unemployment and inflation is limited in this specific period. Otherwise, multiple dimensions or perspectives can be added.

Reference

1. Azar S. A. (2013). Oil prices, US inflation, US money supply and the US dollar[J]. OPEC Energy Review, 2013, 37(4): 387-415.

2. Barro, R. and Gordon, D. (1983). "Rules, discretion and reputation in a model of monetary policy", Journal of Monetary Economics, 12(1), pp. 101-121. doi: 10.1016/0304-3932(83)90051-x.

3. Bachmeier, L., Leelahanon, S. and Li, Q. (2007). Money Growth and Inflation in the United States, Macroeconomic Dynamics, 2007, (11).

4. Binner, J., Tino, P., Tepper, J., Anderson, R., Jones, B. and Kendall, G. (2010). "Does Money Matter in Inflation Forecasting?", SSRN Electronic Journal. doi: 10.2139/ssrn.1425738.

5. Li, C. and Li, Z. L. (2011). Comparative analysis of Money Supply, Economic Growth and Inflation in China, USA and Japan. Journal of Xi'an Jiaotong University (Social Sciences).

6. Christensen, M. (2001). Real Supply Shocks and the Money Growth inflation Relationship, Economics Letters, (72). 74.

7. Colander D. (1995). The stories we tell: A reconsideration of AS/AD analysis. The Journal of Economic Perspectives, 169-188.

8. Crowder, W. J. (1998). The Long-run Link between Money Growth and Inflation, Economic Inquiry.

9. Bordo, M. D., and Jonung, L. (1987). The stochastic properties of velocity: a new interpretation. NBER Working Papers.

10. Dale M, Pissarides C. Job Creation and Job Destruction in the Theory of Unemployment[J]. Review of Economic Studies, 1994, 61:397-415.

11. Davidson, R. and MacKinnon, J. (1983). Inflation and the savings rate. Applied Economics, 15(6), pp.731-743.

12. Dwyer Jr, G. P. and Hafer, R. W. (1999). Are Money Growth and Inflation Still Related? Economic Review.

13. Dwyer Jr, G. P. (2011). Money Growth and Inflation in the United States, http: / /www. Jerrydwyer.com/pdf/mandp.pdf, 2011-04-10.

14. Fisher, I. (1919). Stabilizing the dollar in purchasing power. New York: E.P. Dutton.

15. Friedman. M, (1956). The quantity theory of money-a restatement studies in the quantity theory of money. Chicago: University of Chicago Press, 1956.

16. Friedman, M., (1971a). A monetary theory of nominal income. Journal of Political Economy 79, 323-337.

17. Firedman, M. (1971b). A Monetary History of the United States, New Jersey: Princeton University Press.

18. Grauwe, P. D. and Polan, M. (2005). Is Inflation Always and Everywhere a Monetary Phenomenon? Scandinavian Journal of Economics, 107 (2).

19. Gregorio, J. D, (2011). Rapid Growth of Monetary Aggregates and Inflation: The International Evidence, http: / /www.bcentralcl/enq/stdpub/ studies/working paper, 2011-04-10.

20. Gerlach, S. (1990). "Money growth and inflation dynamics", Economics Letters, 32(2), pp. 133-135. doi: 10.1016/0165-1765(90)90065-9.

21. Goodhart, C., Friedman, M. and Schwartz, A. (1964). A Monetary History of the United States, 1867-1960. Economica, 31(123), p.314.

22. Gordon R. J. The history of the Phillips curve: Consensus and bifurcation[J]. Economica, 2011, 78(309):10–50.

23. Hanson, J. A. (1985). Inflation and imported input prices in some inflationary Latin American economies, Journal of Development Economics, Volume 18, Issues 2–3, Pages 395-410, ISSN 0304-3878, https://doi.org/10.1016/0304-3878(85)90064-1.

24. Mazumder S. The New Keynesian Phillips curve and the cyclicality of marginal cost[J]. Journal of Macroeconomics, 2010, 32(3):747-765.

25. Wei, H. Y. (2014). Research on the Relationship between Money Supply and Inflation Based on Historical Data of China and the United States, Time Finance.

26. Jun, L. (2011). Study on the Relationship between Monetary Supply, Velocity and Inflation: Based on the Comparison among US, Japan, UK and China. Finance Wuhan.

27. Keynes, J. (1936). General Theory of Employment, Interest, And Money.

28. Krugler, P. and Kaufmann, S. (2011). Does Money Matter for Inflation in the Euro Area? http://www.oenbat/en/img/wp103_tcm16.32 143. pdf.

29. Kaufmann, S. (2007). Capturing the Link between M3 Growth and Inflation in the Euro Area: An Econometric Model to Produce Conditional Inflation Forecasts Monetary Policy and the Economy.

30. Kulaksizo, T. G. and Kulakszo, S. G. (2011). The U. S. Excess Money Growth and Inflation Relation in the Long-run: A Nonlinear Analysis, http://mpraubuni.muenchen.de/23780/.

31. Lucas, R. (1976). "Econometric policy evaluation: A critique", Carnegie-Rochester Conference Series on Public Policy, 1, pp. 19-46. doi: 10.1016/s0167-2231(76)80003-6.

32. Manera, M. and Cologni, A. (2005). "Oil Prices, Inflation and Interest Rates in a Structural Cointegrated VAR Model for the G-7 Countries", SSRN Electronic Journal. doi: 10.2139/ssrn.843505.

33. McCallum, B. T., & Nelson, E. (2010). Money and inflation: some critical issues. Handbook of Monetary Economics, 3(1), 97–153.

34. George, M. and Warren, E. W. (1995). Some Monetary Facts. Quarterly Review. 19. 2-11.

35. Meihua, Jiang. (2014). "Shocks of Economic Growth and Money Supply on Inflation: An Empirical Analysis of the United States and China, Japan and South Korea under the GVAR Model". Contemporary Economy of Japan.

36. Milas, C. (2011). Does High M4 Money Growth Trigger Large Increases in UK Inflation? Evidence from a Regime switching Model, http://hdlhandlenet/ 101093/oep/ gpn013, 2011-06-10.

37. Moazzami, B. and Gupta, K. L. (1995). The quantity theory of money and its long-run implications, Journal of Macroeconomics, Volume 17, Issue 4, Pages 667-682, https://doi.org/10.1016/0164-0704(95)80088-3.

38. Nikolic, M. (2000). Money Growth inflation Relationship in Post-Communist Russia, Journal of Comparative Economics, (28).

39. Phillips A.W. The relationship between unemployment and the rate of change of money wage rates in the United Kingdom, 1861-1957. Economica, 1958, 25(100):283-299

40. Reynard, S. (2007). Maintaining low inflation: Money, interest rates, and policy stance, Journal of Monetary Economics, Volume 54, Issue 5, https://doi.org/10.1016/j.jmoneco.2007.06.018.

41. Roberts, J. (2004). "Monetary Policy and Inflation Dynamics", SSRN Electronic Journal. doi: 10.2139/ssrn.633222.

42. Roffia, B., Zaghini, A., (2011). Excess Money Growth and Inflation Dynamics, http: / / www.ecbint/ pub/pdf/scpwps/ ecbwp749. pdf, 2011-04-10.

43. Rothbard M.N. (2003). “The Great Depression of the United States”, Shanghai: Shanghai People's Publishing House, 2003, pp. 149, 180-182,195.

44. SAMUELSON P A, SOLOW R M. Analytical Aspects of Anti-Inflation Policy[J]. The American Economic Review, 1960, 50(2): 177-192.

45. Shelley, G. L. and Wallace, F. H. (2005). "The relation between US money growth and inflation: evidence from a band−pass filter." Economics Bulletin, Vol. 5, No. 8 pp. 1-13.

46. Shelley, G. L. and Wallace, F. H. (2011). Further evidence regarding nonlinear trend reversion of real GDP and the CPI, Economics Letters, Volume 112, Issue 1, Pages 56-59,ISSN 0165-1765, https://doi.org/10.1016/j.econlet. 03. 014.

47. Temesvary, J., Ongena, S., and Owen, A. L. (2018). A global lending channel unplugged? Does US monetary policy affect cross-border and affiliate lending by global US banks? Journal of International Economics, Volume 112, 2018, Pages 50-69, ISSN 0022-1996, https://doi.org/10.1016/j.jinteco.2018.02.004.

48. William, G. D. (1998). "Historical US Money Growth, Inflation, and Inflation Credibility," Federal Reserve Bank of St. Louis Review, pp. 13-24. https://doi.org/10.20955/r.80.13-24.

49. Woodford, M. (2009). Interest and Prices: Foundations of a Theory of Monetary Policy. Princeton: Princeton University Press.

50. Lu, X. L. and Dong, Z. (2017). The Evolution of the Relationship between Money Supply, Economic Growth and Inflation in the Process of Economic Virtualization - Comparative Analysis Based on US and Chinese Data. Journal of Finance and Economics.

51. Zandi M. (2009). Financial shock. FT Press, Pearson Education, Upper Saddle River, NJ. California boom ending in recession, 139: 86-88.

52. Stam Hurn, Vance L. Martin, Peter C.B, JunYu, Financial Econometric Modeling, Oxford University Press,2020