The Effectiveness of Monetary Policy in China During COVID-19

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Keywords: Monetary Policy, VAR, Impulse response.

Abstract: In this paper, we apply the Vector Autoregression (VAR) model to analyze the impact of the monetary policy on China's economy. We selected the Unemployment rate and GDP as the representatives of the economy and M1 and interest rate as the indicators of monetary policy. The sample period is from Q1 2010 to Q3 2020. Empirical results show that there exists a mutually causal relationship between unemployment and GDP. Compared with an interest rate, M1 can be an efficient way to improve the unemployment rate, while the interest rate is an effective strategy to improve GDP. For policymakers, a loss of GDP in the interim should be considered.

1. Introduction

Globally, the impact of the epidemic on the economy continues to fester. The International Monetary Fund (IMF) has lowered the 2020 global GDP growth forecast by 6.3%, to -3% from 3.3% in January, the worst recession since the Great Depression.

To hedge against the epidemic's impact, central banks in the United States and Europe quickly cut interest rates to zero, launched massive asset purchase programs, and even implemented unlimited quantitative easing. The Federal Reserve injected approximately 1.6 trillion US dollars of liquidity in Q1, resulting in loan growth of approximately 500 billion US dollars, with one US dollar of liquidity corresponding to 0.3 US dollars of loan growth. In 2020 Q1, the ECB injected nearly 540 billion euros of liquidity to support loan growth of approximately 230 billion euros, with 1 euro of liquidity injected to support 0.4 euro of loan growth, resulting in a tapering effect as 2.5:1. The Federal Reserve has cut interest rates by 1.5 percentage points so far this year, and the average interest rate on loans from four major U.S. banks was 4.96 % in 2020 Q1, down 0.17% from 2019 Q4. In addition, the ECB has implemented negative interest rates, and the interest rate on commercial bank small and micro loans was 2.17%, down 0.11% from the end of 2019.

Since 2020, China's three downgrades have released a total of 1.75 trillion RMB in long-term funds, as well as three batches of 1.8 trillion RMB in refinancing and rediscounting lines, resulting in a large number of funds being released. In terms of lending rate reductions, China's corporate lending rate was 4.82 percent in March, a 0.3 percent decrease from the end of 2019 and a 0.78 percent decrease from 2018 high.

However, how effective is the monetary policy? In this paper, we apply the quantitative method based on the Vector Autoregression (VAR) model. to analyze the impact of quantitative easing policy on China's economy since COVID-19. Unit root test and cointegration test are applied before estimation. Then, Granger causality tests are used to find the transmission. Finally, Impulse-Response Function (IRF) and Variance Decomposition (VD) are calculated to find out the dynamics relation and forecast. The hypotheses we try to test are: 1) whether monetary policy has a positive or negative influence on China's economy; 2) which monetary policy has more profound and longer influence.

This paper is organized as follows. Section 2 presents the literature review on monetary policy in China and VAR model. Section 3 is the model and methodology. Section 4 contains the empirical results. Finally, section 5 is the conclusion and future extension.

2. Literature Review

2.1 Monetary policy in China

Researches on monetary policy in China are mainly conducted with the VAR model and DSGE model, rarely with qualitative method. Recent theoretical developments can be decided into four parts: the impact of monetary policy on a) stock market/real estate, b) international trade, c) the effectiveness or conductivity of monetary policy d) Chinese Yuan related.

For the stock market/real estate, many researchers have applied the VAR model to find the impact of monetary policy on it. For example, Gao and Wang (2009) discovered the conductivity of monetary policy on the real estate market in China. Wang (2021) verified the significant influence of monetary policy on stock price, considering the investor's emotion variable. Qi and Liu (2020) found that different monetary policies have different influences on the stock price.

For international trade, several scholars have used the VAR model and shown the effect of monetary policy on China. For example, Ma and Han (2017) found that the transmission mechanism of monetary policy implemented by the Chinese monetary authority has been effective since the subprime crisis. Jiang and Wei (2019) discovered that from the perspective of the goal of Chinese monetary policy, the improvement of openness to the outside world plays a positive role in increasing output and controlling inflation. While, Xu (2019) found that under the situation of Sino-US trade friction, the effect of money supply on promoting economic growth is not obvious.

The effectiveness or conductivity of monetary policy was researched the most, which can be divided into two opposite aspects in accordance with the conclusions. First, some scholars concluded the ineffectiveness of monetary policy in China, including researches conducted by Xu et al. (2003), Fang et al. (2005), Pei et al. (2006), and Sun (2006). Second, however, other researchers found the positive effects of monetary policy in China, examples involving Wu (2008), Wang and Li (2010), Diao and Zhang (2012), Lin and Yang (2014), and Dai and Liu (2016).

Other related articles focused on the Chinese currency. For example, Wu et al. found that the reform of the RMB exchange rate system has enhanced the effectiveness of China's monetary policy. Yin and Pei (2015) explored the positive impact of electronic currency on monetary policy in China. And Dent and Xie (2021) evaluated the effectiveness of the quantitative monetary policy.

As a result, there were only two related articles on Chinese monetary policy during the crisis: the China-United States trade war and the subprime crisis. Therefore, there is still no evaluation of Chinese monetary policy under the epidemic, so this paper will fill in the gap.

2.2 Application of VAR

The application of the VAR model on monetary and fiscal policy research has a long history. Monticelli et al. first used the VAR model and conducted the first research on the macroeconomic consequences of monetary policy in 1999. Recent theoretical advances can be categorized into three categories: Monetary policy, a) Fiscal policy, b) Monetary and fiscal policy c) Monetary and fiscal policy.

For monetary policy, numerous studies have used the VAR model to analyze the effect of monetary policy. For example, Djivre and Ribon (2003) examined Israel and discovered the macroeconomic effects of monetary policy. Giacinto (2003) discovered regional macroeconomic effects of monetary policy in the United States. Mirdala (2009) took the EMU as a sample and found the macroeconomic effects of monetary policy on interest rates. For fiscal policy, various scholars have employed VAR models to demonstrate the fiscal policy's consequences. For example, Bencik (2009) took Slovakia as an example and discovered the correlation between the business cycle and fiscal policy. The most common application of VAR is both monetary and fiscal policy. For example, Bruneau and Bandt (2003) investigated the EU and discovered the effects of fiscal and monetary policy on the EU during the Sovereign Debt Crisis. Ambrogio Cesa-Bianchi (2020) analyzed the United Kingdom and discovered the impact of monetary policy shocks on macroeconomic and financial indicators.

It can be found in these researches that most people use the U.S. and European countries as sample research. In 2009, Jiang (2009) conducted a study on China to ascertain the regional effects of monetary policy on the macroeconomy. Following that, academics began studying China's monetary and fiscal policies. Additionally, we can see that numerous monetary and fiscal policy literatures use data from 1970 to 2010.

As a result, we may conclude that the var model is frequently used to analyze and examine fiscal and monetary policy consequences. Thus, it is also practical and beneficial for our posts.

3. Methodology

The Vector Autoregressive Model (VAR), which Sims (1980) proposed, is a linear model that can capture the rich dynamics in multiple time series. As the VAR model is easily implemented and interpreted, it has long been a standard part of econometricians' toolkit. At present, most of the literature on monetary policy shocks use the VAR model.

A set of K time series variables can capture the dynamic interaction via the VAR model $y_t = (y_{1t}, \dots, y_{Kt})'$. There is a form for the basic model of order p (VAR (p))

$$y_t = A_1 y_{t-1} + \cdots + A_p y_{t-p} + u_t \tag{1}$$

Where $u_t = (u_{1t}, \dots, u_{Kt})'$ is an unobservable error term, and the A's are$(K \times K)$ coefficients matrices. Usually, it is assumed to be a zero-mean independent white noise process with time-invariant, and the positive definite covariance matrix $E(u_t u_t') = \sum_u$. Otherwise, the u_t's are independent stochastic vectors with$u_t = (0, \dots, \sum_u)'$.

4. Empirical Application

4.1 Data

It is important to recall that economic theory predicts that the monetary policy will influence GDP and the unemployment rate during a crisis. Hence, we will consider a system with four variables: Real GDP, unemployment rate, M1 and a nominal interest rate. Because the quantity theory suggests a log-linear relationship, we study the four-dimensional system (M1, Unem, GDP, R), where M is the log of real M1, GDP is the log of real GDP. R is the nominal long-term interest rate. Note that GDP data for China are only accessible quarterly. Therefore, we use quarterly data. All the numerical computations are performed in Eviews.

4.2 Unit Root Test

We start by investigating the unit root and univariate time series properties of the four series, noting that all series are well modeled by allowing for a unit root. The appropriate tests support the conclusion that the series may be treated as I (1). Table 1 displays the test results of Unit Root.

Table 1. Unit Root Test

Variable	T-Statistic	P-Value
D(Interest)	-4.4964	0.0008
D(M1)	-10.6446	0.0000
D(GDP)	-16.5113	0.0000
D(Unem)	-5.5483	0.0000

4.3 Model Specification

The first decision to be made is the number of lagged differences to include in the models on which the cointegrating rank tests are based. As a result, a new choice is required for each of the systems considered. An easy way to make this choice is to ask the model selection criteria for suggestions. The number of lagged differences is shown in Table 2.

Based on AIC, a maximum lag order of 4 was considered, while the results of SC and HQ indicate VAR (3) has the best fitness. Because the larger number is the proposal of the AIC criterion and selecting too large an order may imply reductions in power, we examined the VAR model of orders 3 was fitted without any cointegration limitations imposed.

Table 2. VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	121.3428	NA	2.44e-08	-6.1759	-6.0035	-6.1146
1	154.6629	57.8717	9.88e-09	-7.0875	-6.2256	-6.7809
2	177.3324	34.6008	7.17e-09	-7.4385	-5.8871	-6.8865
3	276.8915	130.9987*	9.54e-11	-11.8369	-9.5954*	-11.0391*
4	293.9959	18.9048	1.05e-10	-11.8945*	-8.9641	-10.8519
5	307.3724	11.9684	1.61e-10	-11.7564	-8.1365	-10.4685

4.4 Cointegration Test

We perform Johansen-Juselius cointegration tests on the four-dimensional system. In this case, we examined a maximum lag order of 3, considering the data frequency and number of observations. Then VAR model of order 3 was fitted without any cointegration constraints imposed. Table 3 contains the results of all cointegration test results

There is very strong evidence for the four-dimensional system for two cointegrations with both linear and quadratic trends. In total, we regard this piece of evidence can outweighing the evidence in favour of no cointegration. Thus, it is reassuring that the test results for this system point to a cointegrating rank of 2.

The next step in our analysis is then to search for an adequate model for the four-dimensional system. Based on our cointegration analysis results, we start out from a VAR with cointegrating rank 2 and three lagged differences.

Table 3. Cointegration Test Results

Data Trend	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	4	4	4	2	4
Max-Eig	4	1	1	1	1

4.5 Estimated Results

We now apply the cointegration relation to performing a model reduction where the final estimation was done by feasible GLS (EGLS). The results of R2 are shown in Table 4. With all results of R2 ranging from 0.31 to 0.57, we believe that our model performs well in terms of fitness, and there exists no autoregression among the four variables.

Table 4. The Results of R2

Variable	D(R)	D(M)	D(Unem)	D(Inf)
R-squared	0.3122	0.5687	0.3213	0.6649

4.6 Stability Test

The stability test determines if the shock will disappear when a pulse is imposed on the innovation in the VAR model. If, in this case, the VAR system is stable, otherwise, it is unstable. We can deduct from the estimated findings that the absolute value of all the model's characteristic roots is less than 1. This demonstrates that the model is a stable system that may be further analyzed.

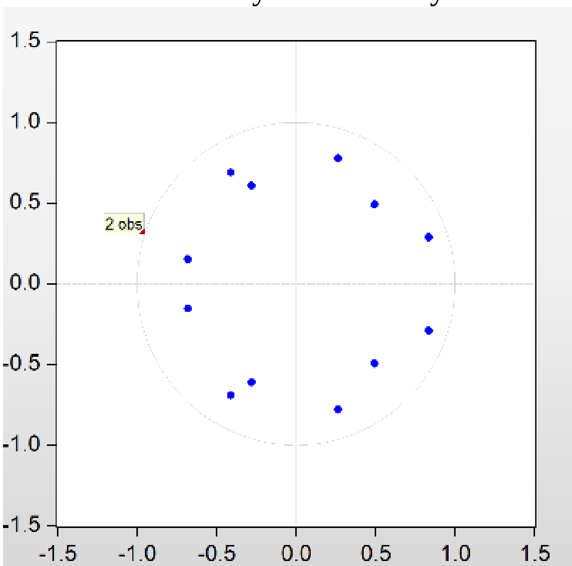

Figure 1. Inverse Roots of AR Characteristic Polynomial

4.7 Granger Causality Tests

Table 4 contains the test results for the Granger causality test based on VAR (3) model. These tests are actually based on a VAR (3) model but only on the first four coefficient matrices. Since the residuals are non-Normal, the linear restrictions in Granger Causality by LR are tested. The result of T2 and T5 reject the null hypothesis while the null hypothesis of other tests is accepted. That means the history information of unemployment helps improve the forecasts of GDP, and the past values of GDP play an important role in the forecast unemployment. Judging from the above results, it appears that there exists a mutually causal relationship between GDP and the unemployment rate.

However, we can't find a solid influence of interest or M1 on GDP and the unemployment rate. This may indicate that we need to find a new variable in this model, as the influence of interest or M1 may be indirect. But, overall, we can see that if we merely want to improve GDP, using monetary policies to reduce the unemployment rate would be a reasonable choice.

Table 5. Dependent Variable: D(GDP)

Excluded	Chi-sq	df	Prob.
D(M1)	0.689569	3	0.8757
D(Unem)	6.906302	3	0.0749
D(Interest)	3.038221	3	0.3858
All	13.74043	9	0.1319

H0 of Test 1: M1 is not the Granger Cause for GDP. H0 of Test 2: Unemployment is not the Granger Cause for GDP. H0 of Test 3: The interest rate is not the Granger Cause for GDP.

Table 6. Dependent Variable: D(Unem)

Excluded	Chi-sq	df	Prob.
D(M1)	1.511991	3	0.6795
D(GDP)	7.574332	3	0.0557
D(Interest)	0.863113	3	0.8343
All	10.01248	9	0.3495

H0 of Test 4: M1 is not the Granger Cause for Unemployment. H0 of Test 5: GDP is not the Granger Cause for unemployment. H0 of Test 6: The interest rate is not the Granger Cause for unemployment.

4.8 Impulse Response

To investigate the long-term effect of various variables on GDP, we apply impulse response analysis to further explore the relationship between variables. Using Monte Carlo stochastic simulation method to calculate the dynamic response to monetary policy shocks and setting the inspection period as 10 periods, we can get the impulse response function diagram of interest rate and M1 to other variables representing monetary policy.

In Fig 2-a, we can see that when M1 increase by 1% in Period 0, the unemployment rate would continue to decrease till Period 4 by 1%, after which it remains stable. Thus, it indicates that changing M1 is an effective method to influence the unemployment rate in the short term. But it won't be useful in the long run.

In Fig 2-b, when M1 increases by 1% in Period 0, GDP first decreases by 0.5% in Period 2, then rises by 0.5% in Period 4 and continues to rise steadily. The initial decline may be caused by the rise of inflation and the decrease of consumption followed by the increase in the money supply. However, inflation would also give an incentive to invest, increasing GDP. This indicates that expansionary monetary policy can be an efficient way to improve GDP, but a loss of GDP in the interim should be considered.

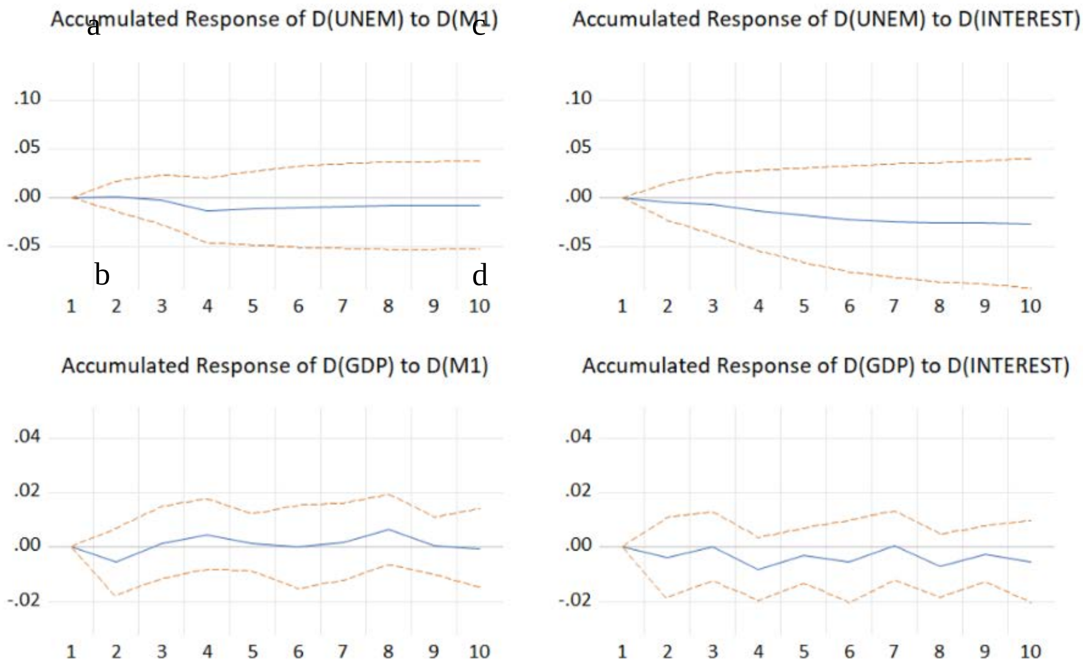

Fig 2. Impulse Response Function

In Fig 2-c, when the interest rate rises by 1%, the unemployment rate continues to decrease slowly. This finding contradicts the popular belief that an increase in interest rate would result in a rise in unemployment. This disparity may be explained as follows: first, the sample data period includes some important economic events, such as the trade war in 2019 and the stock market crash in 2015; second, we may ignore the effect of fiscal policies during the period.

As shown in Fig 2-d, when the interest rate rises by 1%, GDP will decrease with fluctuations afterwards. Therefore, it indicates that it is an effective strategy to improve GDP by reducing the interest rate.

In conclusion, we can deduce that using money supply to influence unemployment and GDP may not achieve the desired effect in the short run. Monetary policies and their influence on GDP and unemployment match the macroeconomic theory. To adjust interest rates would have a relatively quicker impact on GDP, while money supply matters in the long run.

4.9 Variance Decomposition

To better evaluate the influence of four different shocks on China economy, we decompose the forecast error variance of the variables relative to the shocks. The results of Variance Decomposition of GDP are shown in Table 6.

As seen in Table 6, the innovation in interest rate does not seem to be an accurate indicator for GDP. However, unemployment and M1 shocks play an important role in the forecast error variance of GDP for the long run. However, with an increasing forecast horizon, the GDP shocks become less important and finally level out at about 50%. Apart from GDP itself, the unemployment rate and money supply have a significant effect on the non-determinacy of GDP. From the impulse response graph, we know that expansionary monetary policy will result in a desirable rise in GDP. Given the influence of money supply on GDP, as demonstrated by the variance decomposition, we anticipate that changing money supply will have a more preferred direction and greater impact on GDP than changing interest rate.

Table 7. Variance Decomposition of GDP

Period	S.E.	D(M1)	D(GDP)	D(Unem)	D(Interest)
1	0.040381	34.16718	65.83282	0.000000	0.000000
2	0.056249	25.09886	66.32458	8.128622	0.447942
3	0.060822	23.88254	56.73243	18.58545	0.799576
4	0.063199	22.94862	52.88139	21.72161	2.48376
5	0.077085	28.66323	54.53041	14.75766	2.048696
6	0.085449	28.30453	56.45106	13.51584	1.728564
7	0.088795	26.37260	52.27933	19.30880	2.039261
8	0.090651	26.08757	50.43791	20.81422	2.660304
9	0.101681	30.17765	50.86920	16.64352	2.309635
10	0.107808	29.70132	51.97028	16.20402	2.124374

5. Conclusion

This paper uses Vector Autoregression (VAR) method to analyze the impact of monetary policy on China economy from 2010 Q1 to 2020 Q3. First, we apply money supply and interest rate as monetary policy indicators and GDP and unemployment rate as economic indicators. All four series are well modeled by I (1). Then VAR model of orders 3 and cointegrating rank of 1 was fitted without any cointegration restrictions imposed.

There are strong evidences that unemployment and GDP have a mutually causal relationship, which means the history information of unemployment helps improve the forecasts of GDP. However, monetary policy has little influence on the GDP. With an increasing forecast horizon, unemployment shocks and monetary supply play an important role in the forecast error variance of GDP. Based on impulse response function, M1 can be an efficient way to improve GDP, but a loss of GDP in the interim should be considered. For the unemployment rate, changing M1 is an effective method in only the short term. However, it is an effective strategy to improve GDP by reducing the interest rate.

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