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Exchange Rate Fluctuation、Money Supply and GDP

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Abstract: In order to reflect the time-varying and non-linear characteristics of the exchange rate fluctuation and the effect of money supply on GDP, this paper constructs the stochastic fluctuation model and time-varying parameters based on the analysis of exchange rate fluctuation and money supply to the GDP mechanism and path Vector auto-regressive model. The empirical study shows that there are obvious shortcomings in the traditional parameters model, the exchange rate fluctuation and the influence of the money supply on the GDP are obviously time-varying. The impact size has obvious difference and the lag longer the duration, the weaker the effect, the more flexible and more efficient the transmission mechanism of exchange rate fluctuations and the effect of money supply on GDP.

Keyword: Exchange Rate Fluctuation; Money Supply; GDP; SV-TVP-VAR Model

1. Introduction

After the subprime mortgage crisis, the world's major economies in order to save their own or the region from the recession, competing to launch a variety of "quantitative easing" monetary policy, trying to increase the money supply to stimulate the economy. As an effective means of government regulation and control of the economy, loose monetary policy on the national economic recovery has played a positive role in promoting [1]. In-depth study of monetary policy under the impact of monetary policy endogenous conduction mechanism and the specific transmission path, is conducive to the monetary authorities to develop a forward-looking, consistent and consistent monetary policy, reduce social welfare losses and contain some of the instability in the economic operation Factors and ironically cyclical fluctuations in the economy.

Due to the late start of the financial market in China, the slow process of marketization and the frequent intermission of non-market behavior, the lack of strong continuity and consistency between the different development stages of China's monetary policy in the transition process, showing obvious non-linear characteristics , Which makes the credibility decline of China's money transmission mechanism based on the VAR family model which describes the linear relationship [2]. In order to make up for this defect, scholars use a large number of non-linear model to continue to explore and research [3-5].

The above research proves the non-linearity of the non-continuous, non-uniformity and output fluctuation of the monetary policy transmission mechanism in China's monetary policy from different perspectives. But they can not describe the conditional heteroscedasticity of the sequence of variables that occur due to the influence of the macroscopic common factor in the monetary policy tool variables. This paper attempts to study the dynamic response of China's output fluctuation to monetary policy rules at different time points by using the time-varying parameter vector autoregressive SV-TVP-VAR model with stochastic volatility.

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2. Model construction

Based on the study of Primiceri (2005) [6], Koop et al. (2009) [7]and Nakajima et al. (2011) [8], the hypothesis of VAR model is relaxed and the stochastic time-varying fluctuation model is applied to VAR model , The parameters are allowed to change with time, and the impulse response function is applied to the analysis of the impact of the shock, and finally the SV-TVP-VAR model is constructed. The model is constructed as follows: First, build a basic structural VAR model:

$$Ay_t = F_1 y_{t-1} + \cdots + F_s y_{s-1} + u_t \quad t = s+1, \ \ldots n \tag{1}$$

Where $y_t =$ $k \times 1$-order observed variables vector matrix, A, F_1, $\ldots F_s$=$k \times k$ - order coefficient matrix, u_t=$k \times 1$-order Structural shock, and $u_t \sim N$（0，$\Sigma\Sigma$）。

$$\Sigma = \begin{pmatrix} \rho_1 & 0 & \ldots & 0 \\ 0 & \ddots & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ 0 & \ldots & 0 & \rho_k \end{pmatrix}, \qquad A = \begin{pmatrix} 1 & 0 & \ldots & 0 \\ a_{21} & \ddots & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ a_{k1} & \ldots & a_{k,\ k-1} & 1 \end{pmatrix}$$

Equation (1) simultaneously on both sides is multiplied by A' inverse matrix , we can obtain:

$$y_t = A^{-1} F_1 y_{t-1} + \cdots + A^{-1} F_s y_{t-s} + A^{-1} u_t \quad t = s+1, \ \ldots n \tag{2}$$

Defining $B_i = A^{-1} F_i$, $i = 1, 2, \ldots s$, then substituting that into Equation (2), thus:

$$y_t = B_1 y_{t-1} + \cdots + B_s y_{t-s} + A^{-1} \Sigma \varepsilon_t \qquad \varepsilon_t \sim N(0, I_K) \tag{3}$$

Equation (3) also can be expressed in matrix form:

$$y_t = X_t \beta + A^{-1} \Sigma \varepsilon_t \tag{4}$$

Where $\beta = (k^2 \times 1)$-order vector, and the order comes from the row of matrix$\beta_i^{'}$ s. $X_t = I_s \otimes (y_{t-1}^{'}, \ \ldots, \ y_{t-s}^{'})$。

Then the final SV-TVP-VAR model constructed is expressed as follows:

$$y_t = X_t \beta_t + A_t^{-1} \sum_t \varepsilon_t, \quad t = s+1, \ \ldots, \ n \tag{5}$$

In equation (5), $A_t$is a lower triangular matrix, and the parameters follow the following random walk procedure:

$$\begin{cases} \beta_{t+1} = \beta_t + u_{\beta t} \\ a_{t+1} = a_t + u_{at} \\ h_{t+1} = h_t + u_{ht} \end{cases} \tag{6}$$

Where $h_t = (h_{1t}, \ \ldots, \ h_{kt})^{'}$, and $h_{kt} = log\sigma_{jt}^2$, $j = 1, \ \ldots, \ k$, $t = s+1, \ \ldots, \ n$, $\beta_{s+1} \sim N(\mu_{\beta_0}, \ \sum \beta_0)$, $a_{s+1} \sim N(\mu_{a_0}, \ \sum a_0)$, $h_{s+1} \sim N(\mu_{h_0}, \ \sum h_0)$, and

$$\begin{pmatrix} \varepsilon_t \\ u_{\beta t} \\ u_{at} \\ u_{ht} \end{pmatrix} \sim \left(0, \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & \Sigma_\beta & 0 & 0 \\ 0 & 0 & \Sigma_a & 0 \\ 0 & 0 & 0 & \Sigma_h \end{pmatrix} \right) \tag{7}$$

Where Σ_a、Σ_h mean the diagonal matrix.

As the stochastic fluctuation model is introduced into the model, the over-parameterization

problem occurs when the model is estimated. In the paper, MCMC method is mainly based on the following reasons: firstly, the likelihood function of the nonlinear state equation model with other estimation methods are difficult to estimate; secondly, the MCMC method can estimate the state variables of the solution parameters under uncertainty and the impulse response function estimation.

3. Empirical analysis

（1）Source and description of data

Based on the previous theoretical analysis, the paper selects the money supply (M2), the exchange rate (E) and the total output (GDP) as variables to study the mechanism of the money supply and exchange rate on the total output.

Total output (GDP). The article selects gross domestic product (GDP), since only the annual and quarterly GDP data, we use the Eviews software, first of all to a seasonally adjusted quarterly data using the X12, then using the method of frequency conversion for monthly data of GDP.

Money supply (M2). Since the M2 of the broad money supply relatively reflects the changing trend of the real money supply in our country more accurately and timely, the article chooses M2 to measure the money supply.

RMB exchange rate (E). The exchange rate is directly observed in the daily economic is the nominal exchange rate, the real effective exchange rate, it is eliminated the domestic price level changes to influence the purchasing power of the real exchange rate index, it can reflect the level of China's exchange rate.

The research interval is 2000.1-2016.12, and the data is selected monthly data, in addition to exchange rate, other data are selected from the same year index, the data from the big wisdom data terminal.

（2）The stationarity test

In order to test the structural change characteristics of total output affected by macro policy, the article firstly tests the catastrophe point, and the results are as follows:

Table 1 The total output of the structure changes

	breakpoint1	breakpoint2	breakpoint3
Point of structural change	2004M02	2009M01	2012M02
Three breakpoint F value	100.57		
Four breakpoints F value	2.25		
Schwarz	5.75		

As can be seen from the previous table, the F value of the mutation point test shows that there are 3 structural change points. According to the Schwarz information criterion, it is shown that the time-varying structure point 3 is optimal, so the FDI inflow has 3 time-varying structural points. Because of the cyclical influence, the total output of our country shows time varying characteristics, and can be divided into four sections: 2000M01- 2004M02, 2004M03 - 2009M01, 2009M02 - 2012M02, 2012M03 - 2016M12. The ADF test of three time series is also carried out.

The results show that the three sequences are non-stationary, but the first difference is stationary. Therefore, due to the non time-varying nature of the coefficients and the random disturbance term, the conventional VAR model can not capture the feature well. Therefore, it is necessary to introduce the SV-TVP-VAR model with time-varying coefficients and time-varying perturbations.

(3) estimation results based on the SV-TVP-VAR model

According to the AIC and SC information criteria, the optimal lag period of the SV-TVP-VAR model is 1. For the SV-TVP-VAR model, the convergence test of sampling samples is mainly checked by the statistics of the sampling samples. You can see from Figure 1, the sample SV-TVP-VAR model correlation coefficient chart shows that since the correlation coefficient decreased steadily, and finally tends to 0, indicating the sample autocorrelation is not obvious; the sample path shows the sample data around the sample mean near stable fluctuations, shows no obvious trend of sample sample (sample distribution; see figure third for 1 of the posterior distribution density map) show convergence to the posterior distribution, the convergence in the empirical analysis of the sample obtained in the process of. In conclusion, the convergence of the sampling samples shows that the three graphical test results show that the sample of Bayesian based on MCMC is convergent through the default parameters, and the relevant valid samples are obtained.

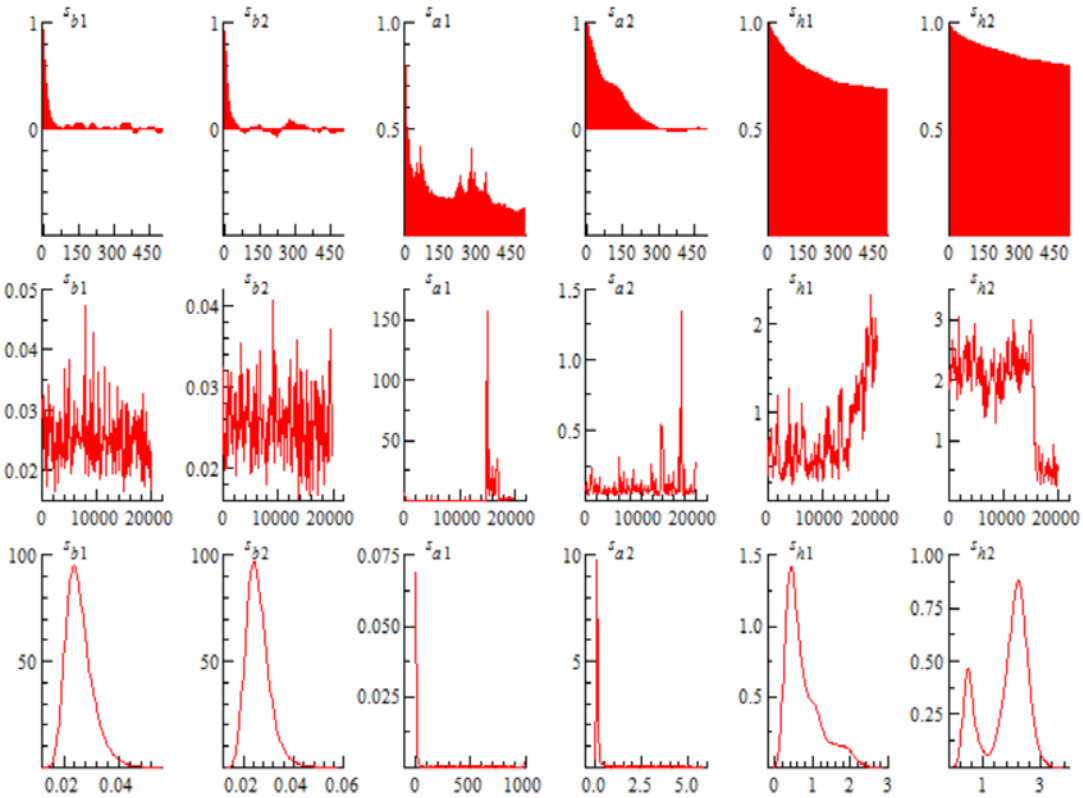

Figure 1 The first line is the autoregressive coefficient, the second line is the sample path, and the third line is the posterior distribution

The specific results of sampling stability test on the table 2, according to table 2, convergence diagnostic value (Geweke), namely CD statistic values did not exceed 5% of the critical value of 1.96, that converges to the posterior distribution of the null hypothesis cannot be rejected; invalid factor, IF statistic values were less than 334. The biggest one is 336.88, which shows that we can

get a sample of 20000/336.88 = 59 is not related to the most, that obtained by these 20000 samples for SV- TVP-VAR model for posterior inference is enough; therefore, the sampling stability diagnosis that estimation of SV -TVP-VAR model is effective and can be used to influence the dynamic variables. Further investigation and analysis.

Tabel 2 Parameter estimation results of SV-TVP-VAR model

parameter	Posterior mean	standard deviation	95%lower confidence intervals	95%upper confidence interval	CD statistic	IF statistic
$(\Sigma_\beta)_1$	0.0257	0.0048	0.0185	0.0371	0.001	33.67
$(\Sigma_\beta)_2$	0.0258	0.0046	0.0185	0.0365	0.973	25.92
$(\Sigma_a)_1$	1.3692	0.5910	0.0452	1.0064	0.008	93.80
$(\Sigma_a)_2$	0.1150	0.1933	0.0427	0.4330	0.360	157.52
$(\Sigma_h)_1$	0.7489	0.4668	0.2164	1.3584	0.000	309.20
$(\Sigma_h)_2$	1.8011	0.7547	0.3431	1.8177	0.000	336.88

(4) impulse response analysis

Based on the previous analysis of structural change point, the paper selects three points in February 2004, January 2009 and January 2012 respectively to represent China's economic boom period, the financial crisis period and the post economic crisis period.

1.Analysis of time varying results of impulsive response in different hysteretic phases

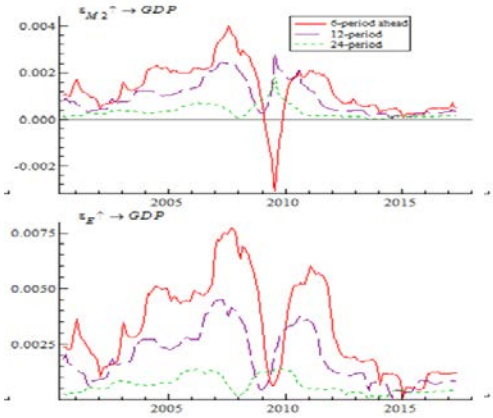

Figure 3 Pulse response at different lag stages

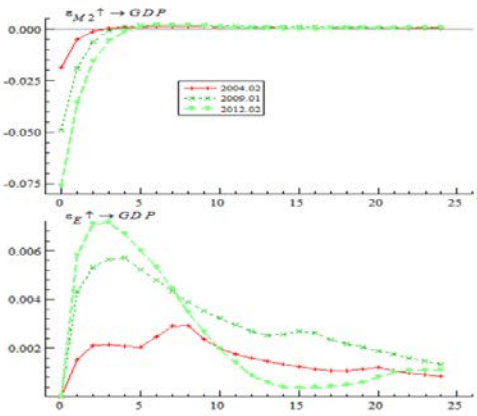

Figure 4 Results of impulse response at different time points

The time interval is set to the 6, 12 and 24 phases, and the long dynamic solid, short solid line and long dotted line are used to describe the dynamic adjustment path of the variable in six months, one year and two years. From the point of view of shocks, resulting in a unit shock in the exchange rate fluctuations, inflation has a positive response about 0.024 units in the 2 period, and in the sample period, the short-term response trend of greater volatility, and showed cyclical fluctuations trend. Then, the initial response value of the response curve represented by the short solid line is in 0.018 units, the maximum response value is in 0.0395 units, and finally tends to be

stable. The response value of the long dashed line tends to be near 0, which is relatively smooth. This shows in Figure 3 that the longer the lag order, the smaller the impact on the total output. This is because the impact of exchange rate fluctuations on the aggregate output is indirect, so the longer the lag period, the weaker the impact of exchange rate volatility on the total output. There is a unit shock to the money supply, with a 0.012 shock both in the short and medium term, and in 2009 the short-term shocks reached a minimum of -0.0027.

The impulse response results above comprehensive observation in different time, we can draw the following conclusions: firstly, considering the time delay of the impulse response results of the impulse response intensity output with prolonged lag period decreases, the money supply and the exchange rate volatility is sensitive to cyclical fluctuations trend.

2.Analysis of pulse response at different time points

Figure 4 shows the fluctuation of RMB exchange rate, monetary supply in different periods of the dynamic output impulse response results, although the results can not reflect the impulse response results, but can be easily seen in the effect of exchange rate fluctuations, the impact of money supply on output in different periods. According to the above structure change point detection, February 2004, January 2009 and February 2012 was selected as the reference point, respectively Chinese in three period before the financial crisis, economic status, in order to study based on the fluctuation of exchange rate, money supply impact at the point of the total output of the transmission mechanism and validity.

Based on the above observation at the point of impulse response results, we can find that overall impulse response time and intensity of February 2006 minimum attenuation most slowly on February 2012 and based on the impulse response and the maximum intensity decay most rapidly. The reason is that the development of China's financial market is rapid and mature, and the monetary policy transmission mechanism based on interest rate channel is becoming more flexible and more efficient.

4.Conclusion

In order to reflect the fluctuation of exchange rate and money supply to the total output of the time-varying and nonlinear characteristics, based on the analysis of exchange rate fluctuations, the money supply of the total output of the mechanism and path, the vector variable parameters based on Stochastic Volatility Model and autoregressive model. The empirical study shows that the traditional model of constant parameters and the conclusions obtained are significantly underestimated the impact of exchange rate fluctuations, the money supply to the total output of the obvious time-varying characteristics, the impact size has obvious difference in different lag, and the lag period is longer, with less impact of exchange rate fluctuations and transmission mechanism; and the money supply to the total output of more flexible and more efficient.

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