

Empirical Analysis of the Relation to Output, Money Supply and Inflation

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Abstract: The central bank needs to predict the macroeconomic conditions in the future when it makes a new monetary policy. Namely, we make the optimal monetary policy with a comprehensive analysis on the domestic output, money supply and inflation rate. This article selects the datum of the National Bureau of Statistics of China, the People's Bank of China, and the Customs Statistics Information Network as the sample data for analysis and study. It is found that the estimation of the nominal output and the rate of inflation by FM model among the four kinds of variable structure model—Polynomial model, WG model, RS model and FM model is most consistent with the actual situation. At last, it is verified that a condition of opening Taylor rules doesn't accord with China's national conditions which is based on the Vensim.

Keywords: Inflation rate; Taylor rules; Money supply; Variable structure

1. INTRODUCTION

In the age of economic globalization, any economic system is not closed. It is not only limited by the own economic system, but also under the influence of the external economic activity. It is obvious that the formulation of China's monetary policy is relevant to the domestic macroeconomic and other relevant trading nation. Throughout China's economic policies, it is not difficult to find economic policy has distinct stages. And the economic laws are changing all the time. Therefore, it is the fact that variable structure in the monetary policy exists. Different periods of monetary has different expressional form and purpose for this variability, so we can't simply gather together for modeling and statistical analysis. We select the way of the staged variable structure in this paper. Engle (1982) [1] proposed Autoregressive conditional heteroscedasticity (ARCH) model to estimate the UK inflation mean and inflation variance. Wenbo Li and Xin Li (2010) use the historical analysis and the reaction method to conduct an empirical analysis of China's monetary policy in the framework of Taylor rule. The results showed the existence of our country's interest rate adjustment is tend to attempt to careful trial and error and smoothly operate, it makes the range of interest rates in general less than the Taylor rule value. Therefore, it is not enough to establish the stability of the macroeconomic. In fact, the central bank is often to adjust the amount of money, so it is not the large influence in the change of interest rates in China. However, the theoretical models often use the interest rate changes instead for the difficulty in obtaining the money supply data. This article makes the models which are not only considered the influence of interest rate, but also add the money supply as the influencing factors to them. Zhe Li, Ma Jun (2010) pointed out that many countries begin to put the Taylor rule as a guide for the establishment and implementation of monetary policy choice now. But as a result of the development of China's market economy status and particularity in the economic system, according to analysis

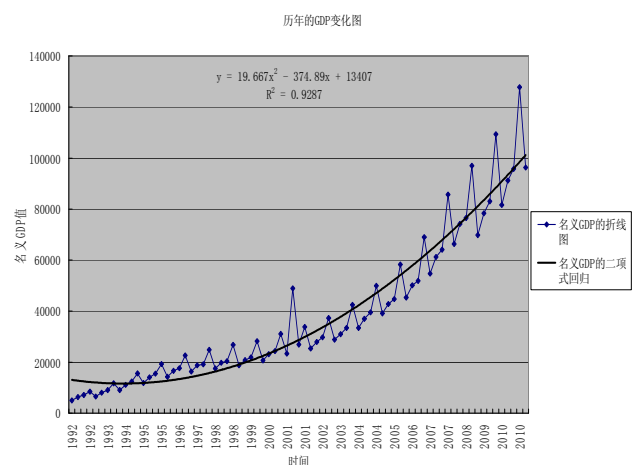
our country present specific situation is not suitable for the Taylor rule without the actual proof. Liu Bin (2004) is based on a hybrid model which takes the welfare as reference and uses stochastic simulation, gets the best prospective interval and forward-looking monetary policy rules, and analyzed prospectively the relationship between rules and economic forecasting. From the uncertainty of the model and decision makers take the uncertainty of attitude to it, Yangping Cai, Sheng Dai and Hongyun Jiang (2010) analyzes that the actual monetary policy is more conservative than specific economic model required optimal monetary policy, Under the condition of model uncertainty. They carry out empirical analysis to explain the phenomenon with Federal Reserve data. On the basis of some scholars' research results, we research the macroscopic policy of the change rules and analyze of Taylor rule does not accord with the national conditions of china.

2. MODEL HYPOTHESES

- 2.1** Assumptions on output, interest rates, and inflation expectations are stage expectations, that is, the prediction of the next period time is based on the first few periods.
- 2.2** Assumptions on the mutual influence coefficient among output, interest rates, and inflation changes by the stage. That is, the coefficient parameters in the model coefficient have only three years of stability.
- 2.3** Assuming that the sample period of the true rate of average value is the long-term equilibrium interest rate.

3. THE RESEARCH ON MODEL UNCERTAINTY ON MONETARY POLICY

3.1 The variation of the nominal GDP (1)



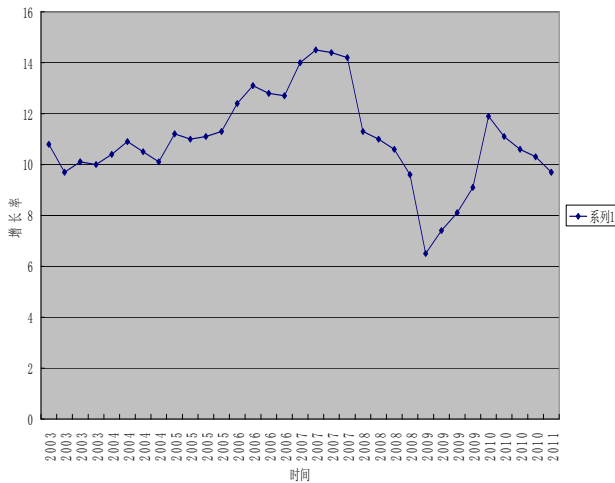
From the graph(1), we can see that the quarter of nominal GDP continues to increase from 1992 to 2010, and the quarter of nominal GDP is also increasing. In global terms, the actual quarter GDP is increasing by way of two polynomial. Therefore we get a forecasting equation on nominal GDP, as follows:

$$y = 19.667x^2 - 374.89x + 13407 \quad (1)$$

In other words, we put the GDP as endogenous variable only influenced by own structure.

3.2 Years of GDP compared to the same period last year the growth rate of change chart (2)

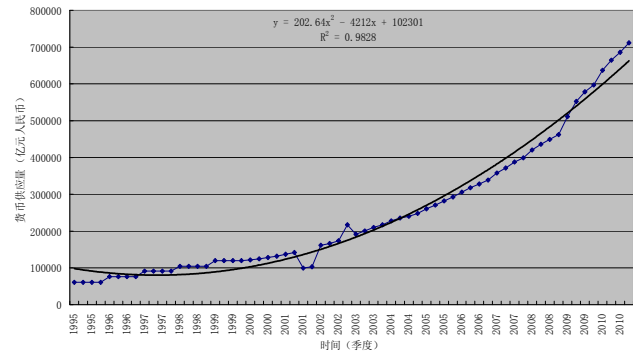
GDP比上年同期的增长率变化图



From the above graph (2), we find that China's GDP growth is smooth relatively from 2003 to 2005. It keeps between 10% and 12%. China's macroeconomic regulation and control is mainly the prudent fiscal policy and prudent monetary policy in this stage. Because attaching the importance to cooperate the financial policy with regional policy and using the land policy in macroeconomic regulation and control makes the economic development of our country stable and quickly this period. However, the same period of GDP growth rate is significantly faster from the beginning of the year 2006, and above 14% in 2007. It shows that our country due to overheating in investment cause economic overheating, so that the speed of the same period of GDP growth rate changes rapidly. In the summer of 2007, the United States the sub prime crisis occurred. Finally, GDP in the developed economies such as the USA, the Euro zone, British Japan is continuously negative growth, and economic recession in 2008. It also makes China's foreign trade so sharply shrinking that China's exports appear to reduce. Our country's GDP growth rate is declining which falls to 6.5% in 2009. Since then, the global economy began a slow recovery. China's macroeconomic regulation and control policy began to focus on expanding domestic demand and external demand, combine the steady growth with the structure, foster new industry, promote industrial upgrading and promote economic development fast and steady. GDP growth rate in 2010 reach a steady level.

3.3 Money supply of the variation of the M2 chart (2)

历年货币供应量变化图



Note: we couldn't find the quarterly data in 1995-1999 years, so we instead the quarterly data of the average annual data.

From the above graph (3), we can see that the money supply is basically increasing as the way of two polynomial. At this time we need correct model. For example, we may refit the curve after adding data point. We don't consider two abnormal points in 2001 and in 2002 for unimportance.

Money supply fitting of the equation as follows:

$$y = 202.64x^2 - 4212x + 102301 \quad (2)$$

Consider the above each factors their own development rules and characteristics, we refer to Yang-Ping Cai paper, we offer the following three correction model.

3.4 monetary policy decision makers face model choice

2008 -2010 GDP normal value, real interest rates, money supply, rate of inflation in China

Unit: 10¹² RMB

time	GDP normal value	real interest rates (%)	rate of inflation (%)	money supply
2008.1	6.6284	-4.55914	8.03	42.064618
2008.2	7.4194	-4.81625	7.77	43.622545
2008.3	7.6548	-1.93006	5.28	46.231486
2008.4	9.7019	1.030164	2.54	51.11567
2009.1	6.9755	3.091211	-0.59	55.255364
2009.2	7.8326	2.54542	-1.516	57.840238
2009.3	8.3058	2.295276	1.267	57.840238
2009.4	10.9367	0.901689	0.64	59.715751
2010.1	8.1622	-0.69108	2.2	63.720967
2010.2	9.1217	-1.26385	2.93	66.461144
2010.3	9.6619	-1.29468	3.47	68.600996
2010.4	12.7749	-1.814	4.7	71.198919

Note: the above data from the national bureau of statistics (NBS) of the People's Republic of China and the people's bank of China website.

In addition, we need to pay attention to it: CPI is not included investment and asset prices, so rate of inflation may not have a significant change when real estate prices rise. According to the above form to analysis, real interest rate in 2010 is higher than real interest rate in 2008, but people feel particularly evident to inflation in the 2010. In my opinion, one reason is that people begin to pay close attention to financial management, so take notice of the change of the CPI. Another reason is that real estate price is rising in recent years, so ordinary people cannot afford it. In addition, as the rural population flow into the city for work, there has been a great growth on cost of living.

3.5.1 WG model

WG model is a prospective model. We estimate the current output (inflation) value with the expectations of the output (the inflation rate)

IS equation:

$$y_t = E_t y_{t+1} - k(i_t - E_t \pi_{t+1} - \gamma^*) + \lambda M_t + v_t \tag{3}$$

Total supply equation:

$$\pi_t = \alpha y_t + \lambda E_t \pi_{t+1} + h M_t + u_t \tag{4}$$

Where y_t is the quarterly average nominal GDP in percent;

$E_t y_{t+1}$ is the target GDP of the private sector predicts ; i_t is the quarterly average central bank rate in percent; $E_t \pi_{t+1}$ is the prediction of the quarterly average inflation rate ; γ^* is the equilibrium real interest rate in percent; M_t is the quarterly average money supply in percent; π_t is the quarterly average inflation rate in percent; u_t is the supply shock and v_t is the demand shock; $k, \lambda, \alpha, \beta, h$ is respectively the estimation of coefficient on the above parameters.

3.5.2 RS model

RS model is a good experience model ,and it is also the central bank of the common model.

IS equation:

$$y_{t+1} = d_0 y_t + d_1 y_{t-1} - d_3 (\bar{i}_t - \bar{\pi}_t) + s M_t + e_{y,t+1} \tag{5}$$

Total supply equation:

$$\pi_{t+1} = c_0 \pi_t + c_1 \pi_{t-1} + c_2 y_t + l M_{t-1} + e_{\pi,t+1} \tag{6}$$

Where \bar{i}_t is the quarterly average central bank interest rate at an annual rate in percent; $\bar{\pi}_t$ is the four-quarter inflation rate in percent. The remaining is the same to the above model.

3.5.3 FM model

IS equation:

$$y_t = g_1 y_{t-1} + g_2 E_t y_{t+1} + p(i_{t-1} - \pi_{t-1}) + n M_t + u_t \tag{7}$$

Total supply equation:

$$\pi_t = q_1 \pi_{t-1} + q_2 E_t \pi_{t+1} + M_{t-1} + \eta_t \tag{8}$$

Where the parameters in this model are same to the above model.

According to the data from China's national bureau of statistics and the people's bank of China and utilization of the regression tools in EXCEL we obtain the following results:

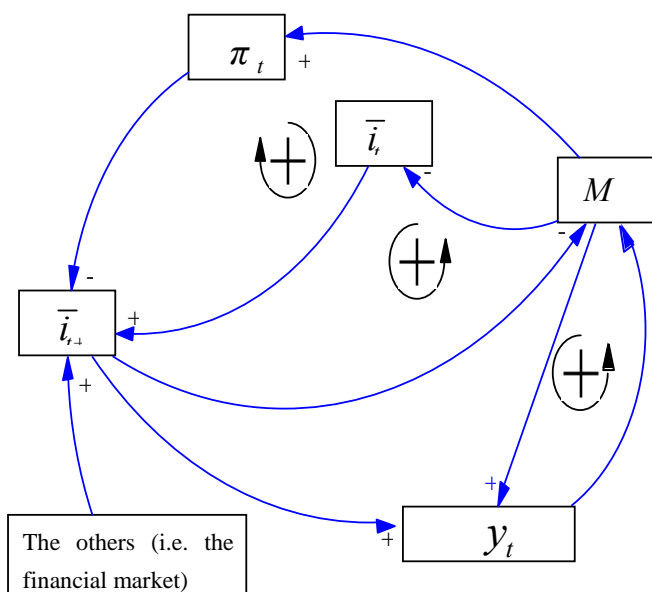
Prediction model	money supply (10 ¹² RMB)	GDP normal value (10 ¹² RMB)	rate of inflation (%)
Polynomial method	68.887468	9.2663.375	NONE
WG model	nothing	9.664073	1.829544
RS model	nothing	9.610937	2.072157
FM model	nothing	9.64952	3.220964
Real value	68.600996	9.6619	3.47

Note: money supply、the actual GDP and estimated values are the data in the third quarter of 2010.

We obtain the different results in the different prediction method. But nominal GDP predictions are not significant difference. Obviously, predictions on output and inflation rate with FM model among the three kinds of prediction method is more close to the actual value, so we can think FM model is more close to the fact. We combine the current national policy: the central bank raised three times RMB financial institutions benchmark interest rates in 2010 and again improve financial institutions raised benchmark interest rates in 2011, participation actively in the open market operation measures. The purpose is to control the current high inflation level. Therefore, we can estimate nominal interest rates will not fall in the short time, but rate of inflation may fall slightly, and the actual interest rate is on

the rise at the same time. But nominal GDP in China continues to rise which is expected. The improvement of the international situation promote to exports in China after the economic crisis. Domestic rural population will work in city which will promote to the growth of domestic demand. Along with the increasing of China's foreign exchange reserves and nominal GDP, it follows the increasing of the money supply.

4. DIAGRAM OF THE GDP ABSOLUTE AMOUNT, THE REAL INTEREST RATE, MONEY SUPPLY, INFLATION RATE



Vensim software to draw notes: arrow pointing to the causal direction arrow said, the " + " and " - " denote the positive influence and negative influence. Arrow with the circle that influence each other to, inside the " + " indicates a positive causal effect cycle.

5. THE TAYLOR RULE OF EMPIRICAL ANALYSIS IN THE CONDITION OF OPENING

According to the hypothesis, the central bank makes the decisions according to the Taylor rule in the condition of opening:

$$\hat{i}_t = (i_{t-1} - \pi^*) + k\pi_t + h\Delta(y_t + y_t^f) \tag{9}$$

Generally, if the sample period is long enough ,we can use the average real interest rates as sample long-term equilibrium of the real interest rate with the approximate calculation to1994 -2010 real interest rates, it can be found

that the real interest rate in the sample period was an average of 0.16%, so given that the sample period long-term equilibrium real interest rates take 0.16% annual interest rate 0.64%, convert to 1994- 2010 inflation rate of 4.26% on average, with reference to the government recently reported the inflation goal, assuming that target inflation rate was 5% at the same time, it is assumed that the countries to the inflation rate and domestic supply gap is the same importance, namely $k = h = 1/2$

Therefore, equation (12) can be translated into this form:

$$\hat{i}_t = (i_{t-1} - 5\%) + \frac{1}{2}\pi_t + \frac{1}{2}\Delta(y_t + y_t^f) \tag{10}$$

Prediction results are as follows:

time	The Taylor rule interest rates (%)	The nominal rates (%)	real interest rates (%)
2008.1	-1.24725	3.470862	-4.55914
2008.2	2.04793	2.943761	-4.81625
2008.3	15.24002	3.339939	-1.93006
2008.4	17.62048	3.230164	1.030164
2009.1	-9.74614	2.491211	3.091211
2009.2	-8.75733	1.00542	2.54542
2009.3	-0.91225	1.025276	2.295276
2009.4	4.13881	1.571689	0.901689
2010.1	-6.86977	1.508918	-0.69108
2010.2	-0.30005	1.669483	-1.26385
2010.3	2.68752	2.175325	-1.29468

Note: the data in the third quarter of 2010 are the predicted value.

From the above form, we can see that the Taylor rule in China on the interest rate nominal interest rates and real interest rates are the difference, thus, we can infer that the Taylor rule of is not apply to the study of our country's current interest rates

6. CONCLUSION AND ENLIGHTENMENT

It is known that the monetary policy makers need to consider each aspect when they face the uncertainty of the model with the corresponding to make a few of methods of robustness measures . In this paper, we do not only considering the interest rate and inflation rate, nominal GDP influence on the basis of predecessors' paper, but also we consider the money supply as an influence factors .Therefore the predictions in FM model is more close to true values. And, we verify that the Taylor rule don't apply to our country. What we need to pay attention to is the change of the relationship between the various parameters. It needs to be studied further.

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