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## The simulation and the prediction of the inflation rate in China

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### ABSTRACT

As inflation rate is one of important macroeconomic variables, it's one of our government's responsibilities to manage the inflation. This essay, based on the AS-AD Model, uses linear and non-linear model to simulate the inflation behaviors from the first quarter of 1992 to the second quarter of 2010 in China. The results of the study indicate that the main factors which influence the inflation rate are the money supply and the residents' inflation expectations. For this reason, taking packages of disinflationary policies, such as controlling money supply, to curb the inflation effectively becomes necessary.

### KEYWORDS

Inflation rate, AS-AD model, Neural network model.



## INTRODUCTION

As China's Consumer Price Index has been rising all the way since 2010, the Central Bank is under great pressure of serious inflation. In order to control the inflation specifically and effectively, we have to get enough understanding about the inflation behaviors and its major causes. Those people in both theory and practice have devoted themselves a lot to the simulation and the prediction of the inflation. This essay is based on the linear and non-linear model and simulates the inflation behaviors after reviewing the previous researches, expecting to help people get further understanding about the inflation behaviors and the major causes in our country. Through this way, we try to better understand our country's economic operation as well as provide disinflationary policies with certain effective reference.

### THE ANALYSIS OF THE TREND OF CURRENT OVERALL PRICE LEVEL IN CHINA

It was a good phenomenon to see our country's overall price level keeping descending from April, 2008 to July, 2009. However, after that, our country witnesses a continuous climbing of overall price level, which caused both Consumer Price Index (CPI) and Producer Price Index (PPI) rose up at the same time (see Figure 1). Our country's CPI has been rising all the way since 2010. By December, 2010, the CPI and the PPI increased 4.6% and 5.9% year on year while the full-year CPI goes up 3.3%. As stepped into 2011, influenced by the inflation inertia and carryover effect, the Central Bank is faced with a great inflation pressure. On February 9<sup>th</sup>, 2011, China's National Bureau of Statistics announced the average price changes of major food among 50 cities nationwide in late January, which indicated that the prices of 29 kinds of food, except several ones going down slightly, would rise up continuously, with the vegetables posting their biggest gain.

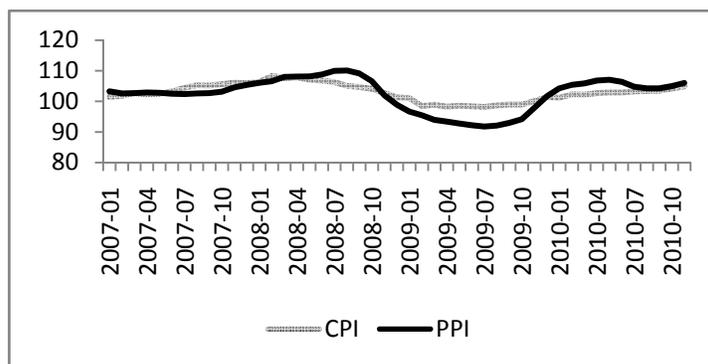


Figure 1 : Chart of CPI and PPI

In view of the rising overall price level, our government has been aware of the seriousness of the problem, and reacted to taking the stabilization of the overall price level to a new height. In November, 2010, the State Council promulgated Notice on Stabilizing Consumer Prices and Securing the Public Essential Living, aiming to control the overall price level effectively and to guide residents to form rational inflation expectations.<sup>[1]</sup> The People's Bank of China announced that it would raise financial institutions' one-year deposit and loan benchmark interest rates by 0.25 percentage points effective from Feb.9,2011 and would adjust other deposit and loan benchmark interest rates accordingly. After the adjustment, one-year deposit interest rate reached at 3% while one-year loan interest rate hit 6.06%. It's the first time in this year and the third time since 2010 for the Central Bank to push up rates. This action reflects the Central Bank's flexibility and perspectiveness towards the inflation pressure.

Inflation rate is one of the most important macroeconomic variables. By definition, inflation indicates the general rising of the general price level, while inflation rate refers to the pace of the general price level increases. In general, there are two following basic reasons that attract people's great concerns over the inflation. Firstly, inflation will cause the changes of the income distribution. In addition, inflation will result in the price distortion as well as the increasing of the uncertainty. A stable price level means that the product and service price aren't distorted by inflation, which will strengthen the role of price in promoting effective allocation of resources.<sup>[2]</sup> This essay selects CPI to measure the general price level, and takes the growth rate of CPI as inflation rate.

### EMPIRICAL ANALYSIS ON THE SIMULATION AND THE PREDICTION OF CHINA INFLATION RATE

#### Theory model

This essay takes the closed economy model into consideration, which consists of three modules: the Aggregate-supply (AS) curve, the Aggregate-demand (AD) curve and the inflation expectation formation mechanism. The AS curve goes the following form:  $y_t = \alpha y_{t-1} + \beta(\pi_t - \pi_t^*) + \varepsilon_t$ , where  $y_t$  means the part of output that deviates from its long-term trend which can also be called as output gap,  $\pi_t$  represents the actual inflation rate,  $\pi_t^*$  refers to the anticipated inflation rate,

and  $\varepsilon_t$  means the supply shock. And the formula of the AD curve is  $y_t = \delta m_t + \gamma \pi_t^* + \xi_t$ . In this formula,  $m_t$  means the deviation value of the real money supply that deviates from its long-term trend, while  $\xi_t$  refers to the demand shock. The inflation expectation  $\pi_t^*$  affects the aggregate demand through the way of influencing the real interest rate which will then put impact on the investment.

Based on the theoretical model, the formula of the inflation goes the following form:

$$\pi_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 m_t + \sum_{i=1}^{\infty} \rho_i \pi_{t-i-1} + \eta_t \quad (1)$$

The formula (1) indicates that the current inflation rate is mainly affected by the following factors: the former status of the output gap (which corresponds to the lag effect), the current real money balances gap and the former status of the inflation rate. And  $\eta_t$  means a group of combinations of supply and demand shock.

### The results of linear model estimation

In order to enlarge the sample size, this essay collects the data quarterly from the first quarter in 1992(1992Q1) to the first quarter in 2010(2010Q1) which released by CEINET database.<sup>[3]</sup> All of the data have been modified by X12 with seasonal adjustments. Meanwhile, the calculation of the output gap and the real money balances gap is based on HP filtering method. To better estimate the results of these two modeling approaches, the essay divides the samples into two parts, the data samples of 1992Q1-2008Q4 are used to estimate the parameters while those of 2009Q1-2010Q1 are used for the ex post prediction.

To avoid spurious regression problem, the essay took the unit root test and ADF test on all variables. The result comes out that all the variables are in stationary sequence which can conduct direct regression. Taking the economic and statistical significance into consideration, we conclude the optimal estimation about the linear model in following form:

$$\pi_t = 0.31 + 0.28y_{t-1} + 0.09m_t + 1.26\pi_{t-1} - 0.33\pi_{t-3} \quad (2)$$

$$t = (2.47) (2.61) (2.45) (20.91) (-5.34)$$

Among the Figures,  $R^2=0.97$ , the numbers in the parentheses are the statistics of the estimated parameters  $t$  and all the coefficients passed the test under 5% significance level. Lagrangian multiplier and Breusch-Pagan-Godfrey tests indicate that there is no problem of serial correlation and heteroscedasticity in the model. To make better comparison with neural network model, the mean square error (MSE) of the linear model calculation is:  $MSE=1.5964$ .

The result of (2) formula indicates that the previous output gap, current real money balances gap and the previous numerical value of inflation rate have a positive impact on current inflation rate. Every 1% increase of previous output gap, current real money balances gap and previous inflation rate will respectively raise the current inflation rate by an average of 0.28%, 0.09%, and 1.26%. It can be seen that the inflation is of large inertia.

### The use of ANN model in simulating inflation rate

The essay chooses the most common MLPNN model to predict the inflation rate. A typical MLPNN mainly includes three layers: input layer, hidden layer and output layer. All the layers connect with each other through certain weight. Keeping consistent with the linear model, the input layer receives four dimensional vectors which respectively represent four arguments in the linear model, while the hidden layer contains non-linear function which is used for non-linear mapping, and the output layer only includes a neuron which is so-called current inflation rate.<sup>[4]</sup> And the next step is picking up the number of neuron in the hidden layer.

The essay estimates the optimal structure by choosing various MLPNN. Firstly, select different number of neuron from the hidden layer, train them separately with LM algorithm and increase the number of neuron gradually until the impact of neuron number is small on the training result. Secondly, the number of chosen neuron should range from 4 to 20. Because the initial weight of MLPNN is randomly selected, we train each neural network for 10 times and calculate the average MSE.<sup>[5]</sup> The result reveals that it's optimal to select 11 neurons. From now on, the essay has built an optimal neural network model whose MSE equals to 0.8632, which is obviously smaller than the MSE of linear model. Therefore, it can be seen that according to the first part of the data, the non-linear neural network model is superior to the linear one.

### The ex post prediction and comparison

The essay uses the second part of data for the ex post prediction, and tries to compare the result of two models. From the chart 1, the result of the ex post prediction indicates that the non-linear neural network model is obviously superior to the linear one. Firstly, the ex post prediction of the former model doesn't come out with wrong symbol while the latter shows up opposite symbol in 2009Q1. Then, the MSE of the prediction in non-linear one is 0.1467, which is obviously smaller than

0.6953 of linear one. These outcomes all reveal that the non-linear neural network model is superior to the linear one in predicting inflation rate.

**TABLE 1 : The ex post prediction and comparison of the result of two models**

Time	Actual Value	Predicted Value of Linear Model	Predicted Value of Non-Linear Model
2009Q1	-0.0060	0.0034	-0.0129
2009Q2	-0.0153	-0.0234	-0.0126
2009Q3	-0.0127	-0.0217	-0.0116
2009Q4	0.0067	0.0023	0.0043
2010Q1	0.0220	0.0316	0.0251

### CONCLUSION AND INSPIRATION

This essay, based on the AS-AD Model, uses linear and non-linear model to simulate the inflation behaviors through the first quarter of 1992 to the second quarter of 2010 in China and comes to the following basic conclusions: Firstly, AS-AD model makes preferable match with China's actual data; Secondly, because of the complication of China's inflation action, viewed from the fitting degree and the accuracy of ex post prediction, the non-linear model can better simulate the action of inflation rate; Thirdly, no matter from the linear or the non-linear model, the main factors of inflation rate are the money supply and resident inflation expectations.

According to the conclusions above, we come out with the inspirations that the Central Bank should pay attention to the following points when it implements the anti-inflation policies: First of all, our government should take multiple measures such as using package plans to curb the inflation. Due to the great inflationary pressure our country's facing nowadays, the government can take the combination of pricing and quantitative monetary policy instruments into consideration, which means that the government should adjust the base rate and money supply if needed. Secondly, the government ought to make the stabilization of general price level as the priority of those monetary policies and guides residents' inflation expectations more rationally. And then, the government has to focus more on the factors of imported inflation and try to avoid it. Meanwhile, although it's not that easy to simulate and predict the macroeconomic variables because of the complication of China's economic operation, the essay, to some extent, provides more accurate references for the simulation and prediction. Of course, the essay only examines closed economy model. However, with the development of economic globalization, those foreign factors that affect domestic economy have counted as well. Therefore, to comprehensively analyze the factors which influence China's inflation under the condition of open economy has become the direction of our next research.

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