

Macroeconomic econometric analysis of government policy

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Abstract. This paper first proposes three indicators, gross domestic product (GDP), consumer price index (CPI) and producer price index (PPI), to quantitatively describe the macroeconomic situation based on the theory of macroeconomic indicators. Next, in view of the fiscal and monetary policies promulgated by the Chinese government, two indicators, namely government budget expenditure, and new credit, are selected to quantitatively describe the government's economic policies. Then the Granger causality test and Johansen cointegration relationship analysis are conducted between these indicators. The study found that there is no significant causal relationship between China's government budget expenditure, new loans and GDP, but the long-term cointegration relationship is obvious, and this relationship is positive. And found that there is not only a significant bi-causal relationship between the price indexes (CPI, PPI), but also a long-term positive cointegration relationship. On this basis, a VEC model between government budget expenditure and GDP, CPI and PPI was established based on the integrity of the indicators, and a VAR model was established between the amount of credit and GDP, CPI and PPI.

Keywords: Granger causality; Johansen cointegration; VEC; VAR.

1. Introduction

At the beginning of the 20th century, there was little research and discussion in western economic circles on the impact of government policies on economic growth. It was not until 1936 that Keynes published "The General Theory of Employment, Interest and Money". He believed that capitalism could not automatically adjust through a free market economy and proposed the need to strengthen state intervention in the economy. Chugunov et al. (2021) aimed to enhance the theoretical and methodological basis of fiscal and monetary policy formation and determine the priority areas for improving their coordination to ensure sustainable economic development[1]. Ram (1986) used two periods of data from 1960 to 1969 and 1970 to 1979 to study the relationship between government consumption and economic growth in 115 countries, the research results showed that the coefficient of government consumption expenditure is positive, that is government expenditure has a positive effect on economic growth, and this positive effect is stronger in countries with lower incomes[2]. In the study of government expenditure classification, Gramlich et al. (1994) and Timilsina(2020) pointed out that there is a significant positive correlation between government expenditure on infrastructure construction and economic growth, and the promotion effect is obvious[3][4]. Kutasi et al. (2020) showed that under the impact of major events, it may have a significant impact on the global economy in the short term. Macroeconomic regulation can greatly avoid economic costs[5]. McKibbin et al. (2021) analysed the correlation between various types of public expenditures and GDP growth in different countries of the EU. The expenditures on social protection proved to have a negative, statistically significant and robust impact on GDP growth[6]. Arvin et al. (2021) had the analytical research on the issue of government expenditure over economic growth multiplier, which showed that the government fiscal expenditure multiplier of developing countries is usually larger than that of developed countries[7]. There are many papers analyzing the impact of macro government spending on the economy[8][9]. Peter et al. (2004) used meta-analysis analysis methods to analyze 123 scholars' articles on the impact of fiscal policy on economic development, and finally concluded that the role of fiscal policy in driving economic development is not significant, but they had an important impact on the government [10]. Through practical research on the relationship between money supply and real output in the United States,

Boschen and Mills (1995) believed that the growth of money supply had no impact on real output, which also supported the theory of monetary neutrality[11]. Gurdal (2021) found that the taxation policies to be implemented on the basis of the economic conjuncture of G7 countries are a powerful financial tool, with the potential to serve the economic objectives to be achieved[12]. Güler et al. (2021) credit supply contractions lead to adverse real outcomes, but economic magnitudes vary across samples and identification strategies[13].

This paper mainly analyzes the quantitative analysis of the impact of government policies on the macro economy. Section 2 will conduct a time series analysis of several major economic indicators (GDP, CPI and PPI) which lay the foundation for the research in Section 3; Section 3 uses the VEC and VAR models to conduct quantitative analysis on the impact of China's fiscal policy and monetary policy on macroeconomic indicators based on the analysis in Section 2; Finally, there is the summery part of this paper.

2. Quantitative Analysis of Macroeconomic Indicators

This section mainly uses time series analysis methods to conduct quantitative analysis and prediction of macroeconomic indicators GDP, CPI, and PPI. The original data used in this paper are all extracted from the website of the National Bureau of Statistics (www.stats.gov.cn). In this paper we select data from 1997 to 2010 for time series analysis, in which GDP is quarterly data and the rest is monthly data.

2.1 Quantitative analysis of GDP

GDP refers to the market value of all final products and services produced by a country (domestic) within a given period (a year or a quarter) using its own resources (regardless of who owns these resources) sum. Let's first observe the time series graph of GDP and the autocorrelation and partial correlation analysis graphs.

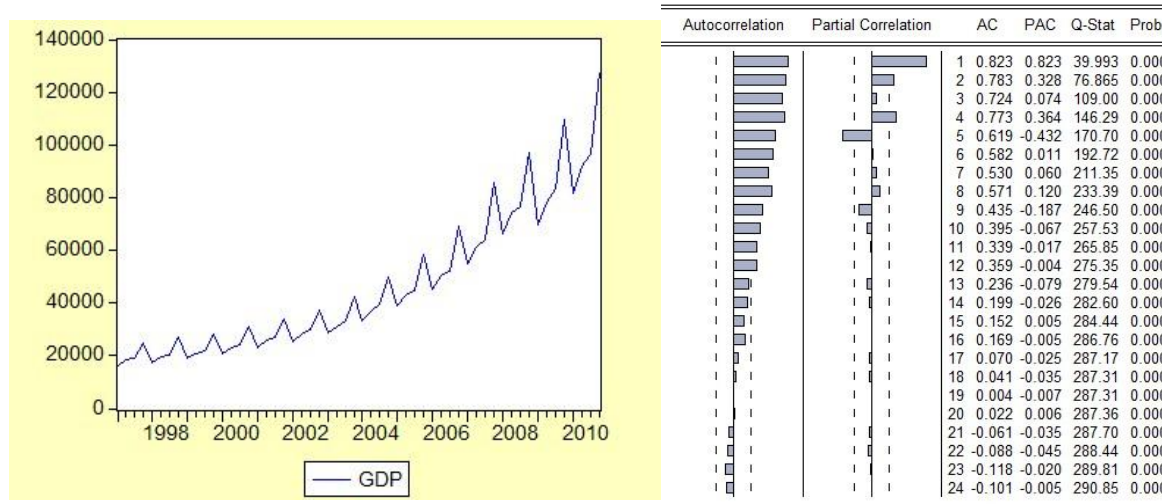


Fig. 1 GDP time series chart (left), GDP autocorrelation and partial correlation analysis

From Fig. 1, we know that the GDP time series has an obvious upward trend and seasonality. It is obvious that this is a non-stationary time series. The autocorrelation coefficient tends to 0 very slowly, and after 12 orders of lag, the autocorrelation coefficient falls within the range of 2 times the standard deviation. This is a typical form of an autocorrelation graph with a monotonic trend; and the autocorrelation coefficient in the lag period is a peak value appears when 4 is the period multiple, indicating that the series has typical seasonal changes. Therefore, we choose the multiplication method of X12 seasonal adjustment to obtain the seasonally adjusted series GDP_SA. First, we use the ADF test method to conduct a unit root test on the time series GDP_SA, and the GDP_SA series is a non-stationary time series on 5% confidence level. Therefore, the unit root test

is performed after the first-order difference of the time series GDP_SA. The processed data is recorded as D (GDP_SA), and find that time series D (GDP_SA) does not have a unit root on 5% confidence level. that is, the series is stationary. The results are shown in Table 1. Therefore, GDP_SA is the sequence I(1), and D(GDP_SA) is the sequence I(0).

Table 1 D(GDP_SA) unit root test result

Variables	t statistic	PValue	Results (5% critical value)
GDP_SA	0.881370	0.9998	Non-stationary
D(GDP_SA)	-3.681228	0.0323	Stationary

We tried to fit with commonly used models such as AR(1), MA(1), ARMA(1,1), ARMA(1,2) etc., and then by comparing the significance of the fitting, R-squared, AIC criterion and DW value and other parameters, the final fitting result was the rarefaction coefficient model ARMA(1,6), and the model form is

$$X_t = 0.962789X_{t-1} + \varepsilon_t + 0.450345\varepsilon_{t-6} \quad (1)$$

X_t represents D(GDP_SA), $\varepsilon_t \sim WN(0, \sigma^2)$.

Sample (adjusted): 1997Q3 2010Q4
Included observations: 54 after adjustments
Convergence achieved after 6 iterations
Backcast: 1996Q1 1997Q2

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	0.962789	0.065585	14.68004	0.0000
MA(6)	0.450345	0.144458	3.117488	0.0030
R-squared	0.674593	Mean dependent var	1590.275	
Adjusted R-squared	0.668335	S.D. dependent var	1358.721	
S.E. of regression	782.4923	Akaike info criterion	16.19918	
Sum squared resid	31839301	Schwarz criterion	16.27285	
Log likelihood	-435.3778	Durbin-Watson stat	1.811393	
Inverted AR Roots	.96			
Inverted MA Roots	.76+.44i -.76+.44i	.76-.44i -.76-.44i	.00-.88i -.00+.88i	

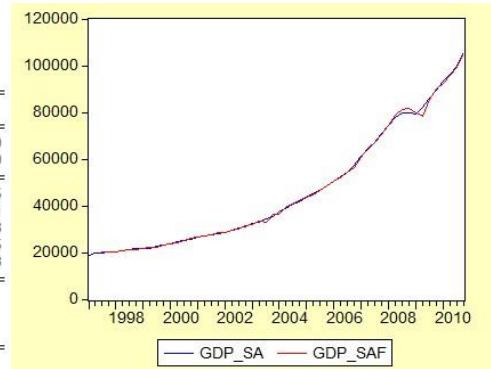


Fig. 2 D(GDP_SA) equation regression results (left), GDP_SA and forecast sequence comparison (right)

The estimation results of this model are shown in Fig. 2 (left), which shows that the fitting effect is well. In addition, we also conducted a residual test on D(GDP_SA), which will not be described in detail due to space issues. Through this model, the static forecast method is applied (the so-called static forecast refers to using the actual values of the original series to predict.) to predict the time series GDP_SA, and the prediction effect is good, see Fig. 2 (right).

2.2 Quantitative analysis of price index

Consumer Price Index (CPI) and Industrial Producer Price Index (PPI) are the two most important indicators in China's price indicator system. Similar to the time series analysis of GDP, since both CPI and PPI time series have a strong upward trend, and the autocorrelation coefficients of CPI and PPI are tailing. And because CPI / PPI are seasonal, after seasonal adjustment, we will perform time series analysis on the obtained seasonal adjustment series CPI_SA/PPI_SA. Therefore, we perform first-order difference on the two series to eliminate their trend, and perform first-order difference series on a stability test. The series after seasonal adjustment and first difference is recorded as D(CPI_SA)/D(PPI_SA), and perform the unit root test again on the differentiated series which shown in Table 2.

Table 2 D(CPI_SA) and D(PPI_SA) unit root test results

Variable	tStatistics	Pvalue	Results (5% critical value)
D(CPI_SA)	-12.45230	0.0000	Stationary
D(PPI_SA)	-4.693166	0.0000	Stationary

From Table 2 that the time series D(CPI_SA)/D(PPI_SA) are both stationary time series. This shows that the time series CPI_SA/PPI_SA is a I(1) sequence, and D(CPI_SA)/D(PPI_SA) is a

I(0) sequence. Therefore, we can fit the model to two stationary series of ARMA(p,q). Finally, by comparing the significance of the fitting, R2, AIC criterion and DW value and other parameters, we determined that the fitting result is a rare coefficient ARIMA(2,1,2)/ ARIMA(4,1,4) model, and the expressions of the model are

$$X_t = 0.205725 + 0.742331X_{t-1} - 0.695682X_{t-2} + \varepsilon_t - 1.010460\varepsilon_{t-1} + 0.974615\varepsilon_{t-2} \quad (2)$$

X_t is D(CPI_SA), $\varepsilon_t \sim WN(0, \sigma^2)$.

$$Y_t = 0.272114 + 0.339563Y_{t-1} - 0.503406Y_{t-2} + 0.339112Y_{t-3} - 0.567479Y_{t-4} + \varepsilon_t - 0.201734\varepsilon_{t-1} + 0.765144\varepsilon_{t-2} - 0.260810\varepsilon_{t-3} + 0.929158\varepsilon_{t-4} \quad (3)$$

Y_t is D(PPI_SA), $\varepsilon_t \sim WN(0, \sigma^2)$.

Denote the prediction sequence generated by CPI_SA/PPI_SA as CPI_SAF/PPI_SAF. From Fig. 3, we know that the fitting effect of the model is good. Model result analysis diagrams and residual tests were also made for CPI_SA and PPI_SA, which will not be described again due to space issues.

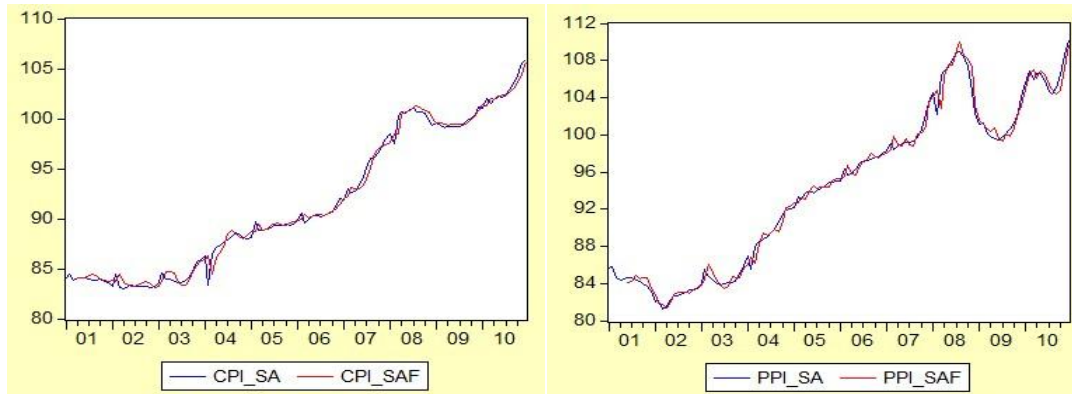


Fig. 3 Comparison of sequence CPI_SAF and predicted sequence (left) and comparison of sequence CPI_SAF and predicted sequence (right)

3. Quantitative analysis of government economic policies on macroeconomic indicators

The macroeconomic control policies are mainly divided into two aspects: government fiscal policy and government monetary policy. Fiscal policy refers to the fiscal working principles formulated by a country based on the economic, political and social development of a certain period, and is generally regulated through government fiscal expenditure and taxation policies. In this section, we select three variables: government's fiscal budget expenditure (CFS), and new credit (ICR) to quantitatively describe some macroeconomic indicators.

3.1 The impact of government spending on macroeconomic indicators

Since the GDP data used in this article are all seasonally adjusted data (i.e. GDP_SA). In order to unify each data to the same order of magnitude, we logarithmically process the government's fiscal budget expenditure (CFS); and logarithmically processing the data can effectively eliminate the heteroskedasticity of the data and preserve the nature of the data.

We first explain the stationarity of each data. Here we still use the ADF unit root test method to conduct unit root tests on LNGDP_SA, LNCPI, LNPPI and LNCFS, and the test results are summarized as follows.

Table 3 ADF unit root test results

Variables	ADF value	Pvalue	Results (5% critical value)
LNGDP_SA	2.803261	0.2050	Non-stationary
D(LNGDP_SA)	3.995285	0.0037	Stationary
LNCPI	3.121574	0.1062	Non-stationary

D(LNCPI)	8.122902	0.0000	Stationary
LNPPPI	3.264381	0.0774	Non-stationary
D(LNPPPI)	5.070239	0.0000	Stationary
LNCFS(month)	0.874810	0.9543	Non-stationary
D(LNCFS)(month)	30.28383	0.0001	Stationary
LNCFS(quarter)	1.165236	0.9027	Non-stationary
D(LNCFS)(quarter)	66.42159	0.0000	Stationary

As can be seen from Table 3, D(LNGDP_SA), D(LNCPI), D(LN PPI) and D(LNCFS) are all stationary. Therefore, we can perform Granger causality test on the stationary series D(LNGDP_SA), D(LNCPI), D(LNPPPI) and D(LNCFS), and the results are shown in Table 4.

Table 4 Granger causality test results

Null hypothesis	Order of lag	Fvalue	Pvalue
D(LN CFS) does not Granger Cause D(LNCPI)	2	19.9075	4.0E-08
D(LNCPI) does not Granger Cause D(LNCFS)	2	10.0785	9.4E-05
D(LNCFS) does not Granger Cause D(LNPPPI)	3	4.45553	0.00542
D(LNPPPI) does not Granger Cause D(LNCFS)	3	10.4556	4.2E-06
D(LNCFS) does not Granger Cause D(LNGDP_SA)	3	0.19349	0.89997
D(LNGDP_SA) does not Granger Cause D(LNCFS)	3	0.94597	0.43127

From Table 4, at the 5% critical value level, D(LNCFS), D(LNCPI) and D(LNPPPI) are mutually causal (the 2nd order and the 3rd order are the minimum bi-causal relationships). But they have no causal relationship with D(LNGDP_SA) (Note: For the causal relationship between D(LNCFS) and D(LNGDP_SA), we tested the lag order 1-8, and also accepted the null hypothesis, there is no causal relationship). This shows that there is no obvious short-term interaction between China's fiscal budget expenditure and China's GDP; while the short-term causal relationship between fiscal budget expenditure and the two price indicators is very significant.

From Table 4, at 5% confidence level, LNGDP_SA, LNCPI, LNPPPI and LNCFS are all I(1) sequences that meet the Johansen cointegration test conditions, so we can further analyze the long-term cointegration relationship between them. Inspection, the results are shown in Table 5.

Table 5 Johansen cointegration test of LNGDP_SA and LNCFS

Null hypothesis	Eigenvalues	Statistical trace	Pvalue	Maximum statistic	Pvalue
None *	0.510176	26.30747	0.0008	25.69355	0.0005
At most 1	0.016909	0.613919	0.4333	0.613919	0.4333

Note: The Johansen cointegration test assumes that the sequence has a definite linear trend, the cointegration equation only has an intercept term, and the lag order is 1-3.

From the test results in Table 5, at the critical level of 5%, the null hypothesis of 0 cointegrating vectors is rejected, and the null hypothesis of at least 1 cointegrating vector is accepted. This shows that there is a long-term equilibrium relationship between seasonally adjusted GDP and China's fiscal budget expenditure, and its cointegration vector is (1.000000, -1.260404). Finally, we can get the cointegration equation as

$$\text{EMC(LNCFS)} = \text{LNCFS} - 1.260404\text{LNGDP_SA} \quad (4)$$

From the above cointegration equation that there is a positive correlation between the two.

The results of further testing of LNCPI and LNCFS and LNPPPI and LNCFS are shown in Table 6 and Table 7.

Table 6 Johansen cointegration test of LNCPI and LNCFS

Null hypothesis	Eigenvalues	Statistical trace	Pvalue	Maximum statistic	Pvalue
None *	0.311819	44.59512	0.000 0	43.72326	0.000 0
At most 1	0.007424	0.871857	0.3504	0.871857	0.3504

Note: The Johansen cointegration test assumes that the sequence has a definite linear trend, the cointegration equation only has an intercept term, and the lag order is 1-2.

Table 7 Johansen cointegration test between LNPPI and LNCFS

Null hypothesis	Eigenvalues	Statistical trace	Pvalue	Maximum statistic	Pvalue
None *	0.182648	23.40618	0.0026	23.39551	0.00 14
At most 1	9.20E-05	0.010669	0.9174	0.010669	0.9174

Note: The Johansen cointegration test assumes that the sequence has a definite linear trend, the cointegration equation only has an intercept term, and the lag order is 1-3.

From Table 6-7, we know that both Johansen cointegration tests reject the null hypothesis of 0 cointegration vectors and accept the null hypothesis of at least 1 cointegration vector. This shows that there is also a long-term equilibrium relationship between China's two price indexes, namely CPI and PPI, and government budget expenditures. After the above-mentioned Granger causality test and Johansen cointegration test, we know that there is not only a significant causal relationship between LNCFS and LNCPI and LNPPI, but also a long-term equilibrium relationship, so we can conduct a vector error correction model (VEC model) on them.

Through the above cointegration test, there is a cointegration relationship between LNCFS and LNCPI according to the AIC criterion, we determined that the lag order is 2nd order, and passed the AR root test and lag order exclusion test in the VEC view. After several comparisons, we finally selected a VEC model that does not contain constant or linear trend terms, has a lag order of 1-2, and has a cointegration relationship to fit LNCPI and LNCFS. We obtained the fitting equation set as follows.

$$\begin{aligned} D(LNCPI) = & -0.002956(LNCPI(-1) - 0.622528LNCFS(-1)) \\ & + 0.291905D(LNCPI(-1)) + 0.116755D(LNCPI(-2)) \\ & + 0.001600D(LNCFS(-1)) + 0.005942D(LNCFS(-2)) \end{aligned} \quad (5)$$

$$\begin{aligned} D(LNCFS) = & -0.149445(LNCPI(-1) - 0.622528LNCFS(-1)) \\ & - 25.924306D(LNCPI(-1)) - 5.809793D(LNCPI(-2)) \\ & - 0.781002D(LNCFS(-1)) - 0.637442D(LNCFS(-2)) \end{aligned} \quad (6)$$

Through the VEC model equation, the cointegration equation between LNCPI and LNCFS is

$$EMC(LNCPI) = LNCPI - 0.622528LNCFS \quad (7)$$

And we can see from the cointegration equation that there is a positive correlation between LNCPI and LNCFS.

Next, we illustrate the fitting effect of the equation through the VEC view of the model. First, let's observe the AR root table

Table 8 AR root test table

AR root	1.0000	0.99246	-0.268983 - 0.634209i	-0.268983 + 0.634209i	0.373389	-0.226904
Mold	1.0000	0.99246	0.688892	0.688892	0.373389	0.226904

From Table 8, for this second-order VEC model with a cointegration relationship, except for one root with a value of 1.000000, the rest of the roots are less than, that is within the unit circle, so the model is stable. Conducting the lag exclusion test again, we found that under the null hypothesis: under the assumption that the lag term is excluded, and the null hypothesis is rejected for all items, that is, there is no lag term that needs to be eliminated. See Table 9 for specific inspection results.

Table 9 Lagged exclusion test

Lag orders	D(LNCPI)	D(LNCFS)	Joint
1	11.37481[0.003388]	65.64993[5.55e-15]	77.90316[4.44e-16]
2	26.96948[1.39e-06]	54.28826[1.63e-12]	83.75918[0.000000]

We can fit LNPPI and LNCFS with a VEC model with no constant or linear trend terms, a lag order of 1-3, and a cointegration relationship, and then perform AR root tests and lag exclusion tests on the fitted equations. The obtained fitting equation set and test results are as follows.

$$\begin{aligned} D(LNPPI) = D(LNPPI) = & -0.000142(LNCFS(-1) - 3.372220LNPPI(-1)) \\ & -0.001827D(LNCFS(-1)) - 0.0011560D(LNCFS(-2)) - 0.004336D(LNCFS(-3)) \\ & +0.790445D(LNPPI(-1)) - 0.366688D(LNPPI(-2)) + 0.1791698D(LNPPI(-3)) \end{aligned} \quad (8)$$

$$\begin{aligned} D(LNCFS) = & -0.004367(LNCFS(-1) - 3.372220LNPPI(-1)) \\ & -0.667726D(LNCFS(-1)) - 0.455450D(LNCFS(-2)) \\ & -0.048491D(LNCFS(-3)) - 7.164509D(LNPPI(-1)) \\ & +39.642715D(LNPPI(-2)) - 24.509736D(LNPPI(-3)) \end{aligned} \quad (9)$$

Through the VEC model equation, we know that the cointegration equation between LNCPI and LNCFS is:

$$EMC(LNCFS) = LNCFS - 3.372220LNPPI \quad (10)$$

From the cointegration equation, there is also a positive correlation between LNCFS and LNPPI.

Table 10 AR root test table

AR root	1.0000	0.9979	-0.2809 - 0.7615i	-0.2809 + 0.7615i	0.6633	0.3295 - 0.5508i	0.32954+ 0.5508i	-0.6398
Mold	1.0000	0.9979	0.8117	0.8117	0.6633	0.6419	0.64189	0.6398

From Table10 we know that the fitting equation is stationary; and from Table11, the equation has no lag order that needs to be excluded; therefore, the fitted equation is valid.

Table 11 Test of lagged exclusions

Lag orders	D(LNCFS)	D(LNPPI)	Joint
1	52.45638[4.07e-12]	82.12427[0.000000]	153.9765[0.000000]
2	56.00450[6.90e-13]	9.709480[0.007791]	62.35187[9.29e-13]
3	16.41017[0.000273]	11.19026[0.003716]	29.00134[7.81e-06]

3.2 The impact of new credit on macroeconomic indicators

New credit refers to the difference between the loan amount of the current period and the loan amount of the previous period in the use of credit funds. In China, loans are the most important financing tool. Although the proportion of loan financing in total social financing has been declining in recent years, as of the first quarter of 2011, China's loan financing still accounted for 10% of total social financing. 53.5%. Therefore, the important role of loans in China's social and economic development is self-evident. When analyzing the impact on GDP, since GDP only has quarterly data, we also convert monthly new credit into quarterly data. Here, in order to be consistent with the above, we also logarithmically process the credit increase data, and the processed data is recorded as LNICR. Through the ADF test, at the 5% confidence level, the LNICR series is a stationary time series. From the discussion in the previous section, LNGDP_SA, LNCPI and LNPPI are 1-order integral sequences, so the sequences D(LNGDP_SA), D(LNCPI) and D(LNPPI) are stationary sequences. Therefore, we can conduct Granger causality discussions between LNICR and D(LNGDP_SA), D(LNCPI) and D(LNPPI) respectively.

Table 12 Granger causality test results

Null hypothesis	Lag orders	Fvalue	Pvalue
LN ICR does not Granger Cause D(LNCPI)	5	7.16767	8.6E-06
D(LNCPI) does not Granger Cause LN ICR	5	2.31460	0.04895
LN ICR does not Granger Cause D(LNPPI)	3	6.40481	0.00049
D(LNPPI) does not Granger Cause LN ICR	3	2.95266	0.03583
LN ICR does not Granger Cause D(LNGDP_SA)	3	0.19280	0.90044
D(LNGDP_SA) does not Granger Cause LN ICR	3	1.38209	0.26796

It can be seen from Table 12, at 5% confidence level, the lag orders are 5th and 3rd respectively (5th and 3rd are the double There is bi-causality when the minimum lag order of causality); while there is no causality for the test between D(LNGDP_SA) and LN ICR (Note: For the Granger causality test between LN ICR and D(LNGDP_SA), in fact 1-8 order were tested, and the null hypothesis was accepted). This shows that there is no obvious causal relationship between China's new credit limit and China's GDP within an eight-order lag; while there is a significant causal relationship between new credit limit and the two price indicators. Therefore, we can establish a vector autoregressive model (VAR model) between the stationary series LN ICR and D(LNCPI) and D(LNPPI), Regression analysis is performed between the amount of new loans in China and the logarithmic growth rate of China's CPI and PPI.

Since the two time series variables have a bi-causal relationship when lagged by order 5, and combined with the various criteria in the lag length standard in the VAR model, the lag order of the model was finally selected to be order 5; then based on the test results of the lag exclusion items, the lag order was removed Insignificant order; the lag order of the model is finally determined to be 5-5, and the equation results can be obtained as follows

$$D(LNCPI) = -0.013020D(LNCPI(-5)) + 0.001697LN ICR(-5) - 0.010970 \quad (11)$$

$$LN ICR = 30.095200D(LNCPI(-5)) + 0.281975LN ICR(-5) + 5.559456 \quad (12)$$

The results of each test of the equation are described in the following tables.

Table 13 AR root test table

AR root	0.834	-0.675 - 0.490i	-0.675 + 0.490i	0.257 - 0.794i	0.258 + 0.794i	-0.207 - 0.638i	-0.207 + 0.638i	-0.670	0.542 - 0.394i	0.542 + 0.394i
Mold	0.834	0.834	0.834	0.834	0.834	0.670	0.670	0.670	0.670	0.670

Table 14 Based on VAR model dependent variable Granger causality test of LN ICR(left) and D(LNCPI)(right).

Excluded	Chi- sq	df	Prob.
LN ICR	8.233782	1	0.0041
All	8.233782	1	0.0041

Excluded	Chi- sq	df	Prob.
D(LNCPI)	5.063972	1	0.0244
All	5.063972	1	0.0244

It can be seen from Table 13 that the reciprocal of all root modes of this VAR model is less than 1, it is located within the unit circle, so the model is stable; Table 14 shows that under this model, there is still a relationship between D(LNCPI) and LN ICR Significant causal relationship; from the lag exclusion test in Table 15, we can see that all coefficients are significant and there are no lag terms that need to be excluded; therefore, the model equation we obtained between D(LNCPI) and LN ICR is Significantly effective.

Table 15 Lagging exclusion test

Lag orders	D(LNCPI)	LN ICR	Joint
5	8.250571[0.016159]	15.49743[0.000431]	25.29710[4.38e-05]

Next, we estimate the VAR model between LNICR and D(LNPPI). According to the above causality test, the two series have a bi-causal relationship when the lag is 3 orders. According to the AIC and SC criteria in the lag length standard test results in the model, the lag order of the model is finally selected to be 3th order; through the test of the lag term, it can be found that there is no lag term that needs to be removed; the lag order of the model is finally determined to be 1-3, and we get the following equation

$$\begin{aligned} \text{LNICR} = & 0.072553\text{LNICR}(-1) + 0.305109\text{LNICR}(-2) + 0.323196\text{LNICR}(-3) \\ & -36.382037\text{D}(\text{LNPPI}(-1)) + 33.216986\text{D}(\text{LNPPI}(-2)) \\ & -25.167107\text{D}(\text{LNPPI}(-3)) + 2.418661 \end{aligned} \quad (13)$$

$$\begin{aligned} \text{D}(\text{LNPPI}) = & 0.002845\text{LNICR}(-1) - 0.000181\text{LNICR}(-2) - 0.001109\text{LNICR}(-3) \\ & +0.896968\text{D}(\text{LNPPI}(-1)) - 0.332893\text{D}(\text{LNPPI}(-2)) + 0.105094\text{D}(\text{LNPPI}(-3)) - 0.011342 \end{aligned} \quad (14)$$

Table 16 AR root test table

AR root	0.784969	-0.305165 - 0.544304i	-0.305165 + 0.544304i	0.605704	0.094590 - 0.154008i
Mold	0.784969	0.624013	0.624013	0.605704	0.180737

Table 17 Based on VAR model dependent variable Granger causality test of LNICR(left) and D(LNPPI)(right)

Excluded	Chi-sq	df	Prob.	Excluded	Chi-sq	df	Prob.
LNICR	19.21443	3	0.0002	D(LNPPI)	8.857983	3	0.0312
All	19.21443	3	0.0002	All	8.857983	3	0.0312

From Table 16, we can see that the reciprocals of all root modes in the model fall within the unit circle, so the model is stable; from Table 17, we can see that under this VAR model, the relationship between D(LNCPI) and LNICR The causal relationship of Effective. Table 18 shows that all coefficients are significant at the critical value level of 5%, and there are no lagged items that need to be excluded; therefore, the fitted VAR model equations are remarkably effective.

Table 18 Lag exclusion test

Lags orders	LNICR	D(LNPPI)	Joint
1	10.42730[0.005442]	80.10524[0.000000]	85.84648[0.000000]
2	10.12226[0.006338]	8.514316[0.014162]	19.40619[0.000654]
3	22.66991[1.19e-05]	5.960648[0.049776]	23.41634[0.000105]

4. Summary

There is no significant causal relationship between government's fiscal budget expenditure and China's GDP, but there is a certain cointegration relationship; this shows that China's fiscal expenditure has no obvious effect on China's macroeconomic growth in the short term, but has a cointegration relationship in the long term. And there is not only a significant bi-causal relationship between government budget expenditures and China's price index, namely CPI and PPI, but also a long-term cointegration relationship; this shows that changes in government expenditures have an impact on the price market, whether it is producer prices or consumer prices, which has a significant impact in the short and long term; therefore, China's market price index can be macro-regulated to a certain extent through the control of the Chinese government's fiscal budget expenditures. We also fitted the VEC model between LNCPI and LNCFS and between LNPPI and LNCFS, through the

cointegration equation in the model, we found that there is a positive correlation between LNCPI and LNPPI and LNCFS.

There is also no significant causal relationship between the amount of new credit and changes in China's GDP indicators; however, there is a dual causal relationship between the amount of new credit and China's price indicators, namely CPI and PPI, with a lag of 5 orders and a lag of 3 orders respectively. we conducted a VAR model analysis on the relationship between new credit amount and consumer price index and industrial producer price index based on the Granger causality test. The VAR model with a lag order of 5 is established between the logarithmic amount of new credit and the logarithmic growth rate of the consumer price index, and the relationship between the logarithmic amount of new credit and the logarithmic growth rate of the producer price index is established. The model with a lag order of 1-3 indicates that PPI responds relatively quickly to new credit, generally within 1 to 3 months, while the CPI response to new credit is lagging, generally around 5 months.

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