

# Policy Simulation Experiments based on CUFEQ Model

Qianrong Zhang & Shengchu Pan

Recently, we constructed a quarterly macro-economic model of China, named as CUFEQ.

In order to study the effects of policy changes on China's economy after the financial crisis, we run several policy simulation experiments using CUFEQ model.

These simulation experiments can also help us to examine the nature of CUFEQ model.

# 1.. Overview of CUFEQ Model

CUFEQ is a demand-oriented quarterly macro-economic model. The objective of the model is to capture the trend of Chinese economy since 1992 and it is used for short-term economic forecasting and policy simulation analysis.

Quarterly data is available since 1992. Therefore, developing a quarterly macroeconomic model is feasible. We hope that the model can describe our economy more accurately. The model was built at the Central University of Finance and Economics, so it is named as CUFEQ.

CUFEQ follows Keynes' framework and is an aggregate model.

It contains 163 time series variables, of which 143 endogenous variables and 20 exogenous variables.

The sample period is from Q1, 1992 to Q4, 2008. The source of quarterly data is published statistical materials, such as "China's Monthly macroeconomic Indicators" and "China Statistical Year Book".

CUFEQ includes 143 equations, of which 90 behavioral equations and 53 identities.

It includes 9 modules. These are:  
GDP production,  
employment and income,  
consumption,  
investment,  
imports and exports,  
price,  
government finance,  
finance  
energy.

The structure of CUFEQ is as shown in figure 1.



# **GDP Production Module**

GDP is the sum of value-added of primary industry, secondary industry and tertiary industry.

The secondary industry is divided into industry and construction. The tertiary industry is divided into transport, storage and post, wholesale and retail trade, hotels and catering service, financial intermediation, real estate and other tertiary industry.

The module contains 11 behavioral equations and 14 identities.

# Employment and Income Module

Total number employed is the sum of number employed of primary industry, secondary industry and tertiary industry.

Incomes are divided into urban residents and rural residents incomes.

The module contains 13 behavioral equations and 8 identities.

# Consumption Module

Consumption is the sum of household consumption and government consumption.

Household consumption is divided into rural household and urban household consumption.

Total retail sales of consumer goods are the sum of rural and urban retail sales of consumer goods.

The module contains 4 behavioral equations and 9 identities.

# Investment Module

Investment is the sum of investment of primary industry, secondary industry and tertiary industry.

Investment of energy is divided into investment of coal, petroleum, natural gas and electricity.

The module contains 14 behavioral equations and 6 identities.

## **Imports and Exports Module**

Imports is the sum of ordinary, processing and other trade imports. Exports is the sum of ordinary, processing and other trade exports.

The module contains 5 behavioral equations and 6 identities.

## **Price Module**

Price is the transferring basis of macroeconomic variables between constant price and current price.

There are 19 price index behavioral equations in this module.

# Government Finance Module

The main equations in this module are tax equations. Tax includes domestic value-added tax, business tax, consumption tax, tariffs, personal income tax and corporate income tax.

In this module macro tax rate (TAXRA) is an important exogenous fiscal policy instrument, which is defined as the ratio of government tax income and GDP. Macro tax rate is used as the explanatory variable in various tax equations.

The module contains 8 behavioral equations and 4 identities.

# Finance Module

The module is divided into two parts: money demand and money supply.

Money supply includes deposits and foreign exchange reserves, etc.

Money demand contains short-term loans of industry, construction, commerce, agriculture and long-term loans.

The module contains 10 behavioral equations and 4 identities.

# Energy Module

Energy is divided into energy production and energy consumption.

Energy production is the sum of the production of coal, petroleum, natural gas and electricity.

Energy consumption is the sum of consumption of coal, petroleum, natural gas and electricity.

The module contains 6 behavioral equations and 2 identities.

## 2. Base Run

To run the simulation experiments, a base run is needed. Base run provides a comparing basis for each policy simulation experiment when the policy changes.

The simulation period is from Q1, 2009 to Q4, 2012, so the forecasts of exogenous variables are required.

# Forecasting Exogenous Variables

Exogenous variables include policy instruments and non-policy exogenous variables.

Non-parametric autoregressive method is used to forecast non-policy domestic exogenous variables. To forecast foreign exogenous variables we use the information from international organizations such as IMF and World Bank.

Forecasting government policy instruments is more difficult. To get the accurate forecasts of their values, we referred to the government work report this year and the research results of many economists.

During the period of financial crisis, China implemented a positive fiscal policy and loosening monetary policy, but in the post-crisis period, the intensity of the various stimulation policies should be decreased. So, we should have lower increasing rate of fiscal expenditure, money supply and higher interest rate in forecasting period.

Forecasting results of exogenous variables from Q1 2010 to Q4 2012 is shown in Table 1, where 10.1 on the first line means the first quarter of 2010, and so on. See appendix for description of these exogenous variables.

**Table 1 Forecasting Results of Main Exogenous Variables**

	10.1	10.2	10.3	10.4	11.1	11.2	11.3	11.4	12.1	12.2	12.3	12.4
WGDP (%)	3.0	3.0	3.0	3.0	3.3	3.3	3.3	3.3	3.5	3.5	3.5	3.5
WTRA (%)	6.8	6.8	6.8	6.8	7.5	7.5	7.5	7.5	8.1	8.1	8.1	8.1
LDERA (%)	2.25	2.25	2.52	2.52	2.79	2.79	3.06	3.06	3.06	3.06	3.06	3.06
LLORA (%)	5.40	5.40	5.67	5.67	5.94	5.94	6.21	6.21	6.21	6.21	6.21	6.21
SDERA (%)	2.25	2.25	2.52	2.52	2.79	2.79	3.06	3.06	3.06	3.06	3.06	3.06
SLORA (%)	4.86	4.86	5.13	5.13	5.40	5.40	5.67	5.67	5.67	5.67	5.67	5.67
EXRA	6.768	6.764	6.658	6.656	6.632	6.626	6.594	6.583	6.572	6.566	6.546	6.532
GOEXP (%)	7	8	10	11	19	19	19	19	18	18	18	18
TAXRA	0.224	0.232	0.170	0.127	0.219	0.227	0.167	0.123	0.214	0.222	0.164	0.121

## Base-run Results

Using forecasting values of exogenous variables above, we run CUFEQ and the forecasting values of main macroeconomic variables (base-run results) are shown in Table 2, in which the first line of each variable corresponds to actual value and the second line is growth rate.

## Table 2 Forecasting Values of Main Macroeconomic Variables

	10. 1	10. 2	10. 3	10. 4	11. 1	11. 2	11. 3	11. 4	12. 1	12. 4
GDP	41520 11. 5	41534 10. 2	42389 9. 6	43165 9. 3	45963 10. 7	46187 11. 2	46709 9. 9	47408 9. 8	50743 10. 4	52257 10. 2
EMP	74729 0. 73	75695 0. 95	77040 0. 86	785125 0. 76	75363 0. 85	76360 0. 88	77739 0. 91	79165 0. 83	75755 0. 52	79668 0. 64
UINC	36549 10. 07	38059 10. 4	39792 11. 1	40047 13. 97	40588 11. 05	42406 11. 4	44599 12. 08	46042. 1 14. 9	46705 15. 07	53855 16. 9
RINC	14731 12. 07	14969 11. 3	15403 10. 3	15880 10. 1	16847 14. 37	16867 12. 6	16984 10. 2	17391 9. 5	19210 14. 1	19665 13. 1
CCON	30813 13. 3	31831542 14. 59	32618 12. 5	33667 12. 8	34718 15. 1	36217 16. 1	36779 14. 8	37852 14. 3	39687 16. 52	43413 16. 4
GCON	12824 17. 2	13439 18. 10	13388 16. 3	13446 12. 1	14392 14. 63	15077 14. 7	15277 16. 2	15460 16. 9	16252 15. 1	17751 16. 5
TCON	43638 14. 42	45335 15. 61	46007 13. 6	47114 12. 7	49110 14. 95	51294 15. 6	52057 15. 2	53313 15. 1	55940 16. 1	61165 16. 5
CPI	121. 9 2. 7	122. 1 2. 5	123. 1 3. 1	124. 8 2. 8	124. 9 2. 4	125. 2 2. 5	125. 6 2. 1	127. 3 1. 9	127. 6 2. 2	129. 4 1. 7
INV	51375 24. 7	54617 26. 3	57661 25. 6	58437 26. 7	60946 22. 8	66224 24. 83	69971 25. 1	71153 26. 1	74415 25. 9	86251 26. 4
EXP	19554 16. 2	19885 14. 8	20801 13. 4	21836 15. 10	21830 15. 1	22138 13. 8	23016 14. 7	24393 15. 9	24704 16. 4	27873 17. 2
IMP	12804 32. 1	13291 30. 7	14266 27. 2	14810 22. 7	14950 19. 7	15188 16. 2	16019 15. 8	16324 13. 9	16986 16. 41	18754 17. 4
PPI	124. 6 5. 3	126. 9 5. 1	127. 6 5. 3	129. 8 5. 6	131. 1 5. 13	132. 2 4. 17	134. 8 5. 7	137. 4 5. 8	137. 7 5. 1	144. 1 4. 8

### 3. Policy Simulation Experiments

The policy simulation period is from Q1, 2009 to Q4, 2012.

The simulation analyses of fiscal, monetary and exchange rate policy are based on comparing results of simulation and base-run.

We now report the results of three policy simulations.

# Fiscal Policy Experiment

It is realized that the strength of policies of stimulating economy should be reduced after the financial crisis. The objective of this experiment is to examine the impacts of withdrawing from positive fiscal policy gradually. The experiment is designed as follows.

**The experiment:** On the basis of base-run level, fiscal expenditure (GOEXP) decreases 3% from Q1 to Q4, 2010, 2% from Q1 to Q4, 2011 and 1% from Q1 to Q4, 2012. Macro tax rate (TAXRA) increases 1% in the first quarter and second quarter from 2010 to 2012 and 0.5% in the third and fourth quarter from 2010 to 2012.

All of the other exogenous variables and policy instruments remain the same as in the base run.

The results of fiscal simulation experiment are shown in table 3. The figures in the table body are percent changes from the values in the base run.

### Table 3 Results of Fiscal Policy Experiment

	10.1	10.2	10.3	10.4	11.1	11.2	11.3	11.4	12.1	12.4
GDP	-1.20	-1.53	-1.64	-1.67	-1.42	-1.33	-1.21	-1.06	-0.88	-0.67
EMP	-0.21	-0.27	-0.33	-0.42	-0.49	-0.44	-0.41	-0.37	-0.26	-0.23
UINC	-1.29	-1.68	-2.04	-2.31	-2.47	-2.34	-2.29	-1.83	-1.47	-1.24
RINC	-0.71	-0.85	-0.89	-0.91	-1.08	-0.96	-0.88	-0.76	-0.73	-0.65
CCON	-0.49	-0.61	-0.63	-0.71	-0.55	-0.56	-0.58	-0.51	-0.51	-0.36
GCON	-5.12	-5.35	-6.13	-5.74	-4.92	-4.73	-4.41	-4.18	-3.93	-3.38
TCON	-1.53	-1.96	-2.18	-1.99	-1.86	-1.73	-1.57	-1.49	-1.36	-1.08
CPI	-0.45	-0.51	-0.56	-0.61	-0.67	-0.64	-0.62	-0.54	-0.47	-0.36
INV	-3.28	-3.53	-3.82	-3.21	-2.83	-2.59	-2.41	-2.22	-1.86	-1.62
EXP	-0.13	-0.19	-0.27	-0.36	-0.43	-0.46	-0.49	-0.42	-0.35	-0.19
IMP	-0.17	-0.22	-0.35	-0.47	-0.69	-0.61	-0.58	-0.41	-0.37	-0.26
PPI	-1.06	-1.09	-1.14	-1.39	-1.31	-1.29	-1.28	-1.19	-1.12	-1.07

It presents typical results of a tighter fiscal policy.

GDP decreases 0.67% to 1.67% over 12 quarters from Q1, 2010 to Q4, 2012. The largest decrease occurs in the fourth quarter of 2010, and the extent of decrease then becomes lesser and lesser.

Employment (EMP) decreases 0.21% to 0.49%.

The biggest decrease of income of urban household (UINC) and rural household (RINC) are 2.47% and 1.08% respectively in the first quarter of 2011.

Government consumption (GCON) decreases 3.38% to 6.13%, household consumption (CCON) decreases 0.36% to 0.71%, and the total consumption (TCON) decreases 1.08% to 2.18%, indicating that the decrease of total consumption mainly caused by the big decrease of government consumption.

Investment (INV) decreases 1.62% to 3.82%.

Exports (EXP) and imports (IMP) decreases slightly. The biggest decrease of EXP and IMP is 0.49% and 0.69% respectively.

Big decrease in government consumption (GCON) and investment (INV) is caused by decrease of government fiscal expenditure (GOEXP).

Consumer price index (CPI) and producer price index for manufactured goods (PPI) go down. CPI decreases 0.36% to 0.67%, PPI decreases 1.06% to 1.39%.

# Monetary Policy Experiment

**The experiment:** Comparing to base-run, short-term and long-term loan interest rates increase 0.27 percent point at the beginning of each year from 2010 to 2012, and holds the rate in the whole year. All of the other exogenous variables and policy instruments remain the same as in the base run.

The results of monetary simulation experiment are shown in table 4. The figures in the table body are percent changes from the values in the base run.

**Table 4 Results of Monetary Policy Experiment**

	10.1	10.2	10.3	10.4	11.1	11.2	11.3	11.4	12.1	12.4
GDP	-0.28	-0.37	-0.46	-0.55	-0.47	-0.43	-0.42	-0.38	-0.31	-0.24
EMP	-0.07	-0.11	-0.12	-0.14	-0.18	-0.14	-0.13	-0.10	-0.08	-0.06
UINC	-0.19	-0.27	-0.31	-0.43	-0.37	-0.35	-0.35	-0.26	-0.21	-0.15
RINC	-0.12	-0.16	-0.22	-0.31	-0.24	-0.19	-0.16	-0.07	-0.06	-0.06
CCON	-0.08	-0.12	-0.15	-0.22	-0.17	-0.15	-0.15	-0.13	-0.09	-0.07
GCON	-1.25	-1.36	-1.37	-1.15	-1.03	-0.99	-0.94	-0.87	-0.73	-0.54
TCON	-0.36	-0.43	-0.42	-0.35	-0.29	-0.27	-0.24	-0.22	-0.19	-0.13
CPI	-1.51	-1.63	-1.81	-2.04	-1.93	-1.81	-1.76	-1.65	-1.58	-1.01
INV	-1.82	-1.97	-2.01	-2.12	-1.93	-2.59	-1.71	-1.62	-1.55	-1.19
EXP	-0.37	-0.46	-0.79	-0.84	-0.96	-0.96	-1.03	-0.85	-0.77	-0.52
IMP	-0.21	-0.28	-0.35	-0.41	-0.46	-0.51	-0.57	-0.51	-0.42	-0.28
PPI	-1.69	-1.74	-1.83	-1.86	-1.97	-1.77	-1.66	-1.41	-1.32	-1.01

The overall effect is a slight 'deflation'.

GDP decreases 0.24% to 0.55%.

Employment decreases 0.06% to 0.18%.

The biggest decrease of income of urban household and rural household is 0.43% and 0.31% respectively.

Government consumption decreases 0.54% to 1.37%, household consumption decreases 0.07% to 0.22%, and the total consumption decreases 0.13% to 0.42%.

Investment decreases 1.19% to 2.59%.  
Increasing interest rate has obvious influence on investment.

Exports decreases 0.37% to 1.03% and imports decreases slightly.

The biggest down of CPI and PPI is 2.04% and 1.97% respectively. Inflation goes down obviously in all the 12 quarters.

# Exchange rate Simulation Experiment

Accompanying development of China's economic reform and opening, the trade surplus and FDI grows rapidly. Our foreign exchange reserves ranks first in the world now. Under the circumstances, RMB continues appreciating, and the pressure is expected to increase. We run the following simulation to study the effects of further appreciation of RMB on China's economy.

**The experiment:** Comparing to base-run, exchange rate appreciates 1.5% from Q1 to Q4, 2010, 2% from Q1 to Q4, 2011 and 1% from Q1 to Q4, 2012. All of the other exogenous variables and policy instruments remain the same as in the base run.

The result of exchange rate simulation experiment is shown in table 5. The figures in the table body are percent changes from the values in the base run.

**Table 5 Result of Exchange Rate Experiment**

	10.1	10.2	10.3	10.4	11.1	11.2	11.3	11.4	12.1	12.4
GDP	-0.12	-0.23	-0.36	-0.45	-0.52	-0.58	-0.61	-0.55	-0.47	-0.29
EMP	-0.34	-0.48	-0.57	-0.69	-0.67	-0.59	-0.54	-0.43	-0.39	-0.37
UINC	-0.32	-0.41	-0.54	-0.56	-0.47	-0.43	-0.43	-0.41	-0.37	-0.29
RINC	-0.49	-0.72	-0.95	-1.24	-1.56	-1.35	-1.27	-1.09	-0.94	-0.62
CCON	-0.21	-0.29	-0.33	-0.42	-0.56	-0.48	-0.43	-0.39	-0.34	-0.21
GCON	-0.03	-0.04	-0.05	-0.06	-0.05	-0.05	-0.04	-0.03	-0.03	-0.01
TCON	-0.17	-0.23	-0.27	-0.34	-0.37	-0.35	-0.34	-0.31	-0.27	-0.17
CPI	-0.46	-0.59	-0.73	-0.86	-0.78	-0.69	-0.65	-0.53	-0.41	-0.35
INV	0.46	0.62	0.87	1.05	1.24	1.19	1.17	0.96	0.87	0.73
EXP	-1.22	-1.39	-1.61	-1.82	-2.16	-2.03	-1.77	-1.64	-1.47	-1.43
IMP	0.54	0.61	0.87	1.02	1.34	1.62	1.23	1.09	0.96	0.72
PPI	-0.39	-0.45	-0.58	-0.71	-0.83	-0.80	-0.80	-0.74	-0.65	-0.49

GDP decreases 0.12 to 0.61%.

Employment decreases 0.34 to 0.69%.

The biggest decrease of income of urban household and rural household is 0.56% in Q4 2010 and 1.56% in Q1 2011 respectively.

Household consumption and government consumption decreases slightly, the total consumption decreases 0.17% to 0.37%.

The impact on exports and imports is obvious. Exports decreases 1.22% to 2.16% and imports increases 0.54% to 1.34%.

Investment increases 0.46% to 1.24%.

The biggest decrease of CPI and PPI is 0.86% in Q4, 2010 and 0.83% in Q1, 2011.

## 4. Conclusions

(1) The result of fiscal policy experiment shows that fiscal expenditure is a strong policy instrument. It has a strong impact on investment and government consumption.

(2) The effect of decreasing fiscal expenditure on government consumption is much bigger than on household consumption and reduction of total consumption is mainly caused by reduction of government consumption. It indicates that the growing strength of household consumption in China is insufficient and economic growth is lack of endogenous power.

(3) According to the result of monetary policy experiment, the relatively tight monetary policy has a slight negative effect on the economy.

On the other hand, increase of interest rate results in obvious down in CPI and PPI, shows that it can help to control inflation. Therefore, monetary policy is a better option when we want withdrawing from the policies of stimulating economy.

Being faced with increasing pressure of inflation, proper increase of the interest rate is a reasonable choice in the near future.

(4) The result of exchange rate simulation experiment shows that proper appreciation of RMB has slight influence on our economy although it results in a relatively big decrease of exports.

Another obvious negative impact is the decrease of income of rural residents. It reflects the fact that employee in China's export enterprises are mostly from countryside. When exports decreases, some workers will lose their jobs, the wages level of the remaining workers may go down.

Thank you for your attention!