

## Research Article

### How Business Cycle Volatility Affect Economic Growth in China? -An Empirical Study based on GARCH-M Model using the 1952-2012 Data

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**Abstract:** The considerable divergence in analyzing the relationship between business cycle volatility and economic growth calls for thorough empirical investigations, but according to the relationship between business cycle volatility and economic growth, foreign experience study did not get uniform results and the experience of the domestic research, less likely. This study attempts to make further test by constructing GARCH-M model with Chinese data from 1952 to 2012 and take the method of maximum likelihood to discuss the relationship between business cycle volatility and economic growth. The result, which is significant statistically, shows that business cycle volatility and economic growth in China is negatively correlated. Therefore, business cycle volatility will bring indirect welfare cost to the residents by decreasing economic growth rate. Stabilization policy will both suppress business cycle volatility and increase economic growth rate.

**Keywords:** Business cycle volatility, economic growth, GARCH-M model

## INTRODUCTION

The world financial crisis shows that under the condition of open economy and economic operation has significant uncertainty, risk transfer between national economy and the possibility of economic crisis continues to exist. The American economy emerged from recession after "911" terrorist attacks. It has negative economic growth characteristics of the typical economic cycle fluctuation appeared in the United States economy operation and a significant negative impact on world economic growth.

In the context of economic globalization, the national economic fluctuation and the national economic risk research again received wide attention. A lot of research started from the perspective of national measures of economic risks and analyze the relationship between the economic risk factors and effect and actively carry out the national economic risk early warning and risk management and the national economy, monitoring the country's economic risk and to prevent malignant uncertain, events has become the main target and contents of the national macroeconomic policy.

For a long time, economists tend to be independent to study the source of economic fluctuations and the determinants of economic growth; they usually think that the economic fluctuation and economic growth is a distinct phenomenon, so we need different analytical tools for research.

However, more and more theoretical and empirical literature began to challenge the mainstream view in recent years. They found that the isolated to research the

traditional dichotomy of economic fluctuation and economic growth is problematic between economic fluctuation and economic growth may not be a separate, but interrelated. Endogenous growth theory argues that the improvement of productivity depends on the number of resources configuration to it, as long as the temporary shocks can change the number of resources configuration for productivity improvement activities, which is likely to be any lasting impact on economic growth, both for the actual impact and nominal impact, therefore, the traditional dichotomy is starting to get more and more challenges.

Connection between economic fluctuation and economic growth depends on the driving mechanism of this relationship Driving mechanism is mainly divided into two categories: the first kind of situation is that the relationship between economic fluctuation and economic growth is determined by the third (group) the endogenous variables, namely the relationship between them depends on investment, technological innovation and human capital Economic fluctuations affect investment, technological innovation and human capital, thus indirectly affects economic growth; The second scenario is that the correlation between the economic fluctuation and economic growth is determined by the structure relationship between the endogenous-the asymmetric effects of the economic cycle fluctuations.

## LITERATURE REVIEW

Traditionally, business cycle and economic growth models are treated as different doctrines in the sense that short-run economic fluctuations and long-run economic

growth are determined independently in different time horizons. However, since the influential work of Ramey and Ramey (1995), finding that countries with higher volatility of growth have lower growth, considerable effort has been devoted to analyzing whether and how growth and volatility are linked.

The theoretical literature on the relationship between economic growth and growth volatility is far from being uncontroversial. The literature on irreversible investment and the option value of waiting predicts a negative relationship between growth uncertainty and average growth. An increase in uncertainty about future profits raises the value of waiting, thus delaying investment and lowering growth (Pindyck 1991; Ramey and Ramey, 1991). In contrast, there is an argument attributable to Black (1987) that imply a positive relationship. In such a world, countries with high average growth would also have high variance. Another argument for a positive link concerns precautionary savings. Still, proponents of endogenous growth theory assert that the relationship between growth and volatility depends on whether productivity-improving activity and production are substitutes or complements (Aghion and Saint-Paul 1998; Martin and Rogers 2000).

This conflict in theoretical predictions is reflected in the empirical literature. In cross-country investigations, Kormendi and Meguire (1985) and Grier and Tullock (1989) find that countries with a higher standard deviation of output growth also tend to experience higher mean growth rates. By contrast, Ramey and Ramey (1995), Martin and Rogers (2000), Fountas *et al.* (2002) and Rafferty (2005) find a negative relationship from different samples. Studies based on time series data mostly in an ARCH or GARCH framework also reach mixed conclusions. For example, using data on US, Grier and Perry (2000) and Grier *et al.* (2004) obtain evidence for positive effects of output volatility on growth, while Zarnowitz and Moore (1986) and Henry support the negative effect. Speight (1999) find no significant growth effect in the UK and Japan, respectively. Narayan *et al.* (2009) find that higher output volatility increases economic growth for China.

As pointed out by Bound *et al.* (1995), weak instruments can lead to large inconsistency in parameter estimates. Note that in a time-series context, the simultaneity problem can also be tackled by employing an ARCH- or GARCH-in-mean modeling strategy where growth and volatility are jointly and endogenously determined (Grier *et al.*, 2004). However, as put forth by Lee (2010), such estimation is built on a country-by-country basis so that it is too country-specific to be generalized and ignores possible cross-country interdependence.

### VARIABLES AND EQUATIONS

This study uses the data of 1952-2010 of China's annual further to verify the economic fluctuations

Table 1: Result of ADF and KPSS test

Variable	ADF	I%	KPSS	I%
No Trend and intercept				
LNGDP	4.7975	-2.6069	0.7621	0.739
DLNGDP	3.3976	-2.6062	0.7360	0.739
Trend and intercept				
LNGDP	4.347	-4.1305	0.2297	0.216
DLNGDP	0.1605	-4.1273	0.2168	0.216

Table 2: Descriptive statistical analysis

Variable	Observations	S.D.	Maximum
	60	0.073013	0.192340
Variables	Mean	Median	Minimum
	0.078881	0.087814	-0.319126
Variables	Kurtosis	Skewness	Jarque-Bera
	16.1615	-2.902407	17.302500

impact on China's economic growth; It is more fully analyze the relationship between theory and reality significance based on the sampling data of 1952-2010 extension.

Engle put forward conditional heteroscedasticity model (ARCH) which is a very useful autoregressive mode for conditional variances of time series analysis in 1982 at the earliest, expanding into the generalized autoregressive conditional heteroscedasticity model (GARCH) model by Bollerslev (1986), which are widely used in various fields of economics research. The mean in conditional variance (or standard deviation) is as a variable in GARCH model equation, while variance equations remain unchanged. The Equation is in the form of:

$$Y_t = \alpha + \beta X_t + \gamma \sigma_t + \varepsilon_t \tag{1}$$

$$\begin{aligned} \varepsilon &\sim N(0, \sigma_t^2) \\ \sigma_t^2 &= a + b\varepsilon_{t-1}^2 + c\sigma_{t-1}^2 \end{aligned} \tag{2}$$

This is GARCH (1, 1)-M model. (1) is the mean equation and the difference of mean equation of the ARCH model and GARCH model in standard conditions is the variance as an explanatory variables to join the mean Eq. (2) is the Variance equation. Similarly, lagging behind the increase of the order number is a natural extension of higher-order GARCH -m model. In general, the quasi maximum likelihood method is adapted to GARCH -m estimate model. In the field of economics, economic fluctuations possible impact on economic growth also can use GARCH -m model for empirical analysis. This study uses the time series data of GDP index (1952 = 100). Among them, 1952-1978 data is from <China Compendium of Statistics: 1949-2004> 1979-2006 data from <China statistical yearbook2013 > (1978 = 100). Then they are converted into 1952 as the base of fixed base index of GDP. In this study adopts the variable LNGDP is the GDP index calculated the natural logarithm of GDP; DLNGDP means GDP index calculated LNGDP first order difference, said the actual growth rate. This study uses the ADF test and KPSS test to determine the relevant variables.

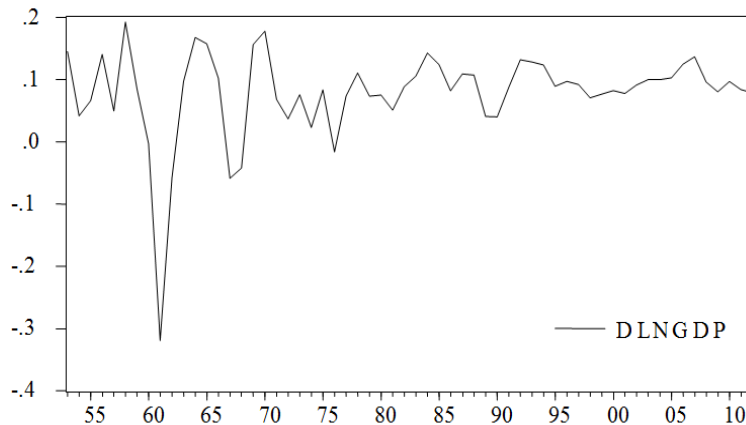


Fig. 1: Analysis of time series of China's economic growth rate

Two kinds of test results consistently show that LNGDP is a non-stationary variable at 1% significance level, while DLNGDP is a stable variable according to Table 1. Therefore, we use the economic growth rate time series (DLNGDP) for empirical analysis in order to avoid false regression problems.

The time series trend of China's economic growth rate is shown in Fig. 1, the Descriptive statistical analysis is shown in Table 2.

The skewness is 0 and kurtosis is 3 for a standard normal distribution, Table 2 shows that, economic growth is the left from the perspective of skewness which means that the sequence distribution has long left tail; Economic growth is leptokurtic from the point of kurtosis. Bera-Jarque test showed that the growth of time series does not meet the normal distribution. In short, left, the peak of the distribution pattern in economic growth.

## RESULTS

**The ARCH effect test:** We determine the Autoregressive Moving Average (ARMA) model of the lag order number according to the AIC criterion and SC criteria for stationary variable DLNGDP in this study. ARMA (1, 1) model was finally chosen as follows:

$$DLNGDP = \alpha + \beta_0 AR(1) + \beta_1 MA(1) \quad (3)$$

OLS estimation results of the Equation is shown in Table 3.

The result of Eviews 5.0 is shown Appendix 1

F statistic associated probability is 0.005695, which is through F test according to the results of equation shows that the regression equation is highly significant at 1% significance level. And at the same time, MA (1) AR (1) estimation of the parameters of the t statistic associated probability is 0.077 and 0.0051, which is

through the test of significance at the 1% significance level.

The results of residual error of ARMA (1, 1) equation of DLNGDP OLS estimation is shown in Fig. 2.

We can preliminary judge that there is no first-order serial correlation through the DW = 1.854028. Breush-Godfrey LM test can be applied to test the regression equation of residual error sequence if there is a high order serial correlation with DW statistics only if there is a first-order serial correlation test the disturbance. Therefore, this study requires Breush-Godfrey LM test. The test of the null hypothesis is: there is no P order serial correlation, the alternative hypothesis is: P order serial correlation, Breush-Godfrey LM test results are shown in Table 4.

LM statistics shows that we can reject the null hypothesis under 10% significance level. There is no serial correlation of regression equation of the residual sequence. It suggests that the ARMA (1, 1) equation DLNGDP there exists no problem of serial correlation.

We can use ARCH-LM test to determine DLNGDP whether there is the ARCH effect through the DLNGDP residual sequence of ARMA (1, 2) equation. The test results are shown in Table 5.

The result of Eviews 5.0 is shown Appendix 1

According to Table 5, we can find that DLNGDP has significant ARCH effect and it is more important that, higher order ARCH-LM test get significant result of the fact that the variance equation with the objective of sustainability, therefore, we need to join the GARCH analysis. Therefore, we need to join the GARCH analysis.

**The Result of GARCH-M Model:** We use the GARCH (1, 1) model to estimate (3) in order to correct DLNGDP conditional heteroscedasticity in the data. GARCH (1, 1) model is (4):

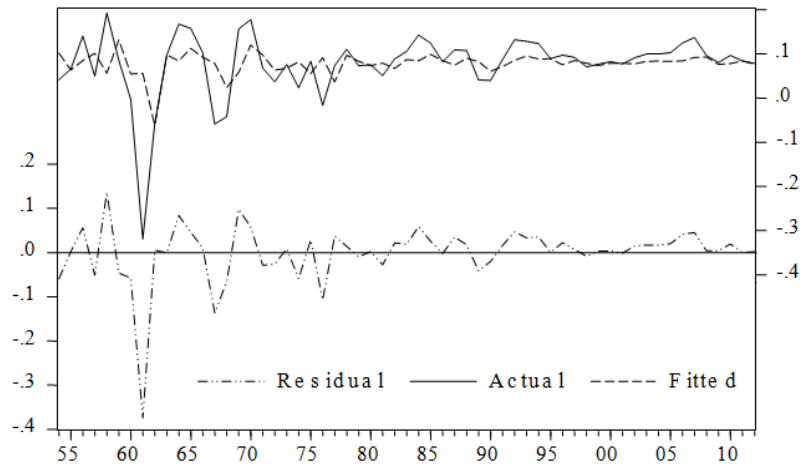


Fig. 2: Residual error of ARMA (1, 1) equations

Table 3: OLS estimation results of the equation

Variable	Coefficient	S.D.	t-statistic	Prob (F-statistic)
C	0.077395	0.011654	6.640982	0.0000
AR (1)	0.381370	0.130744	2.916928	0.0051
MA (1)	-0.191130	0.139789	-1.367274	0.0770
R-squared	0.268547	Mean dependent var		0.077761
Adjusted R-squared	0.338852	S.D. dependent var		0.073118
S.E. of regression	0.067852	Akaike info criterion		-2.493463
Sum squared resid	0.257819	Schwarz criterion		-2.387825
Log likelihood	76.55716	F-statistic		5.675979
Durbin-Watson stat	1.854028	Prob (F-statistic)		0.005695

Table 4: Result of Breush-Godfrey LM test

F-statistic	1.47483	Probability	0.132079
Obs*R-squared	2.84208	Probability	0.270018

Table 5: Result of ARCH LM test

F-statistic	15.26480	Probability	0.000000
Obs*R-squared	37.94845	Probability	0.000008

$$DLNGDP = \alpha + \beta_0 AR(1) + \beta_1 MA(1) + \beta_2 MA(2) \quad (4)$$

$$\sigma^2 = a + b\epsilon_{t-1}^2 + c\sigma_{t-1}^2$$

We can see that GARCH and ARCH are statistically significant through the Table 6 in particular. GARCH is significant at level of 1% and ARCH is significant at 10% level. Residual error diagnosis (Table 7) can be found that two equations no longer exist the ARCH effect by means of GARCH (1, 1) model.

The volatility of China's economic growth is bigger in the 70s and 1960s and it is significantly reduced since the reform and opening up. We can see the trend from Fig. 3.

Based on the above understanding, we need to estimate the following GARCH (1, 1)-M model in order to quantitative analysis of economic fluctuations (standard deviation) of economic growth (growth) of quantitative effect on economic growth:

$$DLNGDP = \alpha + \beta_0 AR(1) + \beta_1 MA(1) + \beta_2 MA(2) + \gamma\sigma_t$$

$$\sigma^2 = a + b\epsilon_{t-1}^2 + c\sigma_{t-1}^2 \quad (5)$$

Using E views 5.0, we can get the result as Table 8:

GARCH (1, 1)-M model estimation results show that China's economic fluctuation on economic growth is very significant (at 1% significance level) and the negative impact that cannot allow to ignore. China's economic fluctuation exist significant negative effect on economic growth, namely the greater the economic fluctuate, the lower the economic grow; When economic fluctuation is smaller, the rate of economic growth is higher. In recent years, academia began to question the study of isolated economic fluctuation and economic growth both theoretical research and empirical research.

## FURTHER DISCUSSION

The results of this study show that, economic fluctuation exist significant negative on economic growth based on the experience of the Chinese data research results which consistent with at home and abroad the same kind of research. The universal experience results for some real economic problem have the important enlightenment.

First of all, Economic fluctuation is not conducive to economic growth which helps think deeply about the planned economy to market economy transition before the failure of the former Soviet Union and eastern European socialist countries and the success of China or for the failure of the "radical reform" and "gradual reform". Its success provides another perspective may explain. The economics has formed the "Washington

Table 6: The estimation results of the GARCH (1, 1)

Mean equation				
Variable	Coefficient	S.D.	t-statistic	Prob (F-statistic)
C	0.040371	0.022790	1.771473	0.0765
AR (1)	0.542980	0.228281	2.378555	0.0174
MA (1)	1.032094	0.218329	4.300210	0.0023
MA (2)	0.591208	0.176291	3.002190	0.1092
Variance equation				
C	2.99E-05	3.21E-05	0.932714	0.3510
RESID (-1)^2	0.458720	0.243360	1.884943	0.059400
GARCH (-1)	0.610767	0.137514	4.441494	0.000000
R-squared	0.101367	Mean dependent var		0.077761
Adjusted R-squared	0.034802	S.D. dependent var		0.073118
S.E. of regression	0.071834	Akaike info criterion		-3.214782
Sum squared resid	0.278650	Schwarz criterion		-3.038720
Log likelihood	99.83608	F-statistic		1.522826
Durbin-watson stat	1.916978	Prob (F-statistic)		0.208560

Table 7: The estimation results of the GARCH (1, 1)

Variable	Mean	S.D.	Q(4)
Residual	-0.137721	1.213192	3.7389 (0.047)
Variable			
	Q <sub>2</sub> (4)	Q(12)	Q <sub>2</sub> (12)
Residual	1.1983 (0.258)	6.6739 (0.572)	4.0198 (0.899)

Table 8: The estimation results of the GARCH (1, 1)-M

Mean equation				
Variable	Coefficient	S.D.	t-statistic	Prob (F-statistic)
@SQRT (GARCH)	-0.320024	1.099396	-0.291091	0.7710
C	3.403760	0.130064	26.16988	0.0000
AR (1)	-24.53689	0.410246	-59.81023	0.0000
MA (1)	2.044081	0.117329	3.287339	0.1019
MA (2)	-1.4982212	0.276383	3.00219	0.0087
Variance equation				
C	-0.093960	8.32E-05	-1129.497	0.0000
RESID (-1)^2	-0.065162	0.000745	-87.48387	0.0000
GARCH (-1)	22.29983	0.016852	1323.286	0.0000
R-squared	-8.074	Mean dependent var		0.077761
Adjusted R-squared	-8.836	S.D. dependent var		0.073118
S.E. of regression	2.17E+34	Akaike info criterion		86.37403
Sum squared resid	2.50E+70	Schwarz criterion		86.58531
Log likelihood	-2542.034	F-statistic		0.621268
Durbin-watson stat	-2.185	Prob (F-statistic)		0.000000

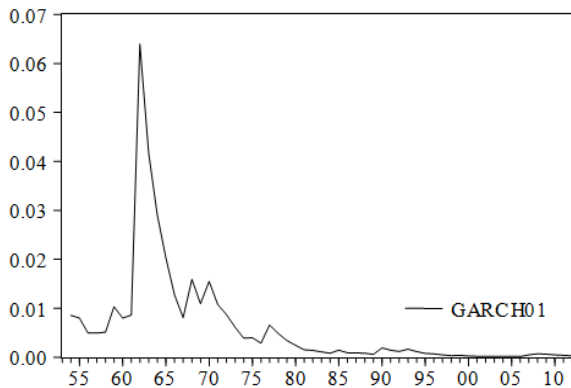


Fig. 3: Graph of The volatility of China's economic growth

Consensus" that transformation should one pace reaches the designated position. But the former Soviet Union and Eastern Europe and sustained a serious decline in output, unemployment and social unrest pursuing the

radical reform". China has realized the economic growth and social stability following the path of gradual reform which is different from the former Soviet Union and Eastern Europe. Chinese people and political leaders got the chance to choose reform concrete implementation steps to ensure that the entire reform process speed and stability of equilibrium because of China's gradualist reform path. Which is appropriate to reduce vibration and large friction; And the former Soviet union and eastern Europe choose the opposite way of reform, has a huge friction and social unrest, which brings many difficulties to the people and the society and disaster. Radical reform leads to greater economic fluctuation, the larger economic volatility leads to lower economic growth, eventually lead to reform a complete failure. The successful "gradual reform" may contain the same logic of opposite results: It should take the incremental reform in China in order to avoid economic reforms to bring huge economic fluctuations, the smaller the impact of reforms to the economy, the lower is economic

volatility fluctuate, leading to economic growth rate is relatively high. Chinese policymakers realize that radical reform may cause economic fluctuations, in turn, would result in grave damage to economic growth. It is first adopted the popularization of the "pilot" and then "gradual reform".

Second, it is theoretical significance for exploring the benefits of economic fluctuation problem that economic fluctuation is not conducive to economic growth. Macro economics should be established on the basis of reasonable microscopic, the behavior of the individual utility maximization and profit maximization ultimately determines the output of the macroeconomic trends, deviation of production trend can reduce the welfare of the community level and therefore, economic fluctuations are regarded as an unpopular. Lucas (1987) was the first to build the model and the quantitative research results show that the economic fluctuations of the welfare loss is very small and the economic growth rate in the welfare loss is very big. Therefore, successful long-term supply side policy can bring further optimize social welfare. It is much higher short-term demand management policies which can bring social benefits. It is negative to economic growth of China's economic fluctuations which means that it reduces economic growth. As a bridge, economic fluctuations will indirectly bring benefits to residents. Therefore, Estimating the welfare cost of economic fluctuations is undervalued ignoring the negative impact of economic fluctuation on economic growth. It is very important for the correct measure of the true costs of welfare economic fluctuation. Based on this, the field has a very meaningful research direction by building a reasonable considering the theoretical framework of economic fluctuation which slow down economic growth, we can explore the direct and indirect benefits loss of economic fluctuations.

### CONCLUSION

This study uses China's 1952-1952 time-series data, using the quasi maximum likelihood estimation system in order to investigate the influence of economic fluctuation on economic growth based on the GARCH - m model. The result shows that the economic fluctuations in China's economic growth are very significant and negative impact that allow not to ignore. The research results is consist with the existing research on economic fluctuation that it is bad for economic growth. This is both useful for theoretical research on the empirical evidence from China and help us to understand China's macroeconomic fluctuations in the economy of direction and extent of the impact of economic growth.

First, the conclusion that Economic fluctuation has a significant negative impact on China's economic growth provides a strong support for stabilizing the policy. The government reduces economic volatility through stabilization policy, which will produce indirectly promoting effect on economic growth. The

Appendix 1: The GDP index in 1952-2012

Year	Index	LNGDP	DLNGDP
1952	100.000	4.605170	
1953	115.600	4.750136	0.144966
1954	120.500	4.791650	0.041514
1955	128.700	4.857484	0.065834
1956	148.100	4.997888	0.140404
1957	155.600	5.047289	0.049401
1958	188.600	5.239628	0.19234
1959	205.300	5.324472	0.084844
1960	204.600	5.321057	-0.00342
1961	148.700	5.001931	-0.31913
1962	140.400	4.944495	-0.05744
1963	154.700	5.041488	0.096992
1964	182.900	5.208940	0.167452
1965	214.100	5.366443	0.157504
1966	237.100	5.468482	0.102039
1967	223.600	5.409859	-0.05862
1968	214.400	5.367843	-0.04202
1969	250.600	5.523858	0.156015
1970	299.300	5.701446	0.177588
1971	320.400	5.769570	0.068124
1972	332.400	5.806339	0.036769
1973	358.500	5.881929	0.075590
1974	366.800	5.904817	0.022888
1975	398.700	5.988209	0.083393
1976	392.200	5.971772	-0.01644
1977	422.100	6.045242	0.073470
1978	471.400	6.155707	0.110465
1979	507.230	6.228957	0.073250
1980	546.860	6.304197	0.075240
1981	575.290	6.354870	0.050673
1982	628.500	6.443332	0.088462
1983	698.450	6.548867	0.105535
1984	805.340	6.691266	0.142399
1985	911.780	6.815396	0.124130
1986	989.650	6.897349	0.081954
1987	1103.63	7.006364	0.109015
1988	1228.46	7.113514	0.107149
1989	1279.53	7.154247	0.040733
1990	1331.57	7.194114	0.039867
1991	1452.85	7.281281	0.087167
1992	1657.19	7.412880	0.131600
1993	1883.69	7.540990	0.128109
1994	2130.60	7.664158	0.123168
1995	2329.46	7.753394	0.089236
1996	2566.89	7.850451	0.097057
1997	2814.01	7.942367	0.091916
1998	3019.78	8.012941	0.070573
1999	3259.69	8.089389	0.076448
2000	3538.54	8.171471	0.082082
2001	3823.58	8.248943	0.077472
2002	4188.59	8.340118	0.091175
2003	4627.38	8.439746	0.099627
2004	5112.35	8.539415	0.099669
2005	5665.00	8.642061	0.102646
2006	6416.82	8.766678	0.124617
2007	7356.40	8.903326	0.136648
2008	8097.51	8.999311	0.095985
2009	8773.06	9.079440	0.080129
2010	9663.79	9.176141	0.096701
2011	10506.99	9.259796	0.083655
2012	11362.13	9.338041	0.078245

government traditionally used to slow down economic volatility into a long-term, stable policy neutral tool at this level.

Second, the research results that economic fluctuation is not conducive to economic growth shows that the government slows down the economic fluctuation which does not infect economic growth. The government reduces short-term economic fluctuation that is also the long-term commitment to the economic

growth. The two leads to Rome which is conducive to long-term economic growth.

The policy dedicated to promote economic growth policy in addition to the education fairness and improve the quality of education and incentives and subsidies for research slowing economic fluctuation is a vital aspect. Stability of neutral means the government pays close attention to the behavior of economic fluctuations which is actually in the emphasis on economic growth, ignoring the economic fluctuation departure attaches great importance to the economic growth in the first place. This from a new view for China's macroeconomic importance of short-term stability and long-term sustainable growth.

The shortcomings of this study is about mechanism of the economic cycle influence economic growth not to do further discussion. And the running mode of China's economy is not same before and after the reform and opening to the outside, we didn't discuss whether appropriate that it is weather appropriate in a unified framework of analysis.

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