CHAPTER 5 EMPIRICAL RESULTS

The steps to be taken to conduct the Granger-causality test are as follows. Prior to testing for causality between economic growth and income inequality, it is necessary to test for the order of integration of each variable. After the maximal order of integration is determined, the VAR system built into a SUR form as shown in equation (4.11) should be estimated. Finally, the chi-square statistic needs to be calculated to test the Granger no-causality relationship between economic growth and income inequality in the post-reform China.

5.1 Unit Root Test

As mentioned before, this study adopts an ADF test based on equation (4.9) and (4.10) to conduct a unit root test on all time-series variables. This study tests equation (4.9) first and then tests equation (4.10) if the linear trend is not significant and unit root exists in equation (4.9). If the null hypothesis of non-stationary cannot be rejected after conducting an ADF test with equation (4.9) and (4.10), the time series is transformed into a first differenced form and the same testing procedure is re-applied. The ADF statistics for each variable and for the first difference are shown in Table 5.1. According to the ADF statistics, the null hypothesis of a unit root cannot be rejected for most series in log form, but it can be rejected for all series in the log difference around a non-zero mean and a non-zero mean with a linear trend except for Max/Min (MM). Therefore, we can conclude that all series, except for MM, are stationary after the first difference (that is, they are integrated of order 1, $I(1)$. MM is integrated of order 2, $I(2)$.

Table 5.1 Unit Root Test

Variables	ADF test			
	Level		First Difference	
	Trend and Intercept	Intercept	Trend and Intercept	Intercept
Real Growth (Official Data)	-3.57 (1)*	-3.65 (1)*	-4.05 (3)**	-4.15 (1)**
Real Growth (Adjusted Data)	-4.24 (4)*	-4.36 (4)**	-4.29 (4)**	-4.50 (4)**
GINI	-2.63 (1)	-0.44 (1)	-3.10 (2)*	-2.85 (1)*
GE	-2.01 (1)	-0.82 (1)	-2.99 (1)	-2.44 (1)
CV	-1.72 (1)	-2.85 (1)*	-2.78 (1)	-1.78 (1)
MM	-1.76 (1)*	-1.63 (1)	-2.62 (2)*	-2.24 (1)*
Labor	-0.78 (1)	-1.76 (1)	-3.42 (1)*	-2.92 (1)*
Import	-2.62 (1)	-1.01 (2)	-3.32 (1)*	-3.34 (1)**
Export	-2.04 (1)	-1.32 (1)	-5.10 (1)**	-4.72 (1)**
Energy	-3.15 (1)	-0.67 (2)	-2.11 (1)	-2.27 (1)

Notes: 1. Numbers in parentheses for ADF tests represent the number of lags included in the regression to ensure white noise.

2. Symbols ** and * denote the null hypothesis of unit root is rejected at 5％and 10％ significant level, respectively.

5.2 Granger-Causality Test

According to unit root test of all time-series variables, the d_{max} of the VAR system equals 1 as level of income inequality is represented by GINI, GE and CV, but equals 2 as represented by MM. Because China's economic growth statistics suffer many flaws, this study uses a method proposed by Keidel (2001) to adjust growth rate and reapplies the empirical model. After carrying out the ADF test, the Granger no-causality test is applied. The Granger no-causality test results are derived from the Toda and Yamamoto procedure are shown in Table 5.2 (complete empirical results are presented in the Appendix).

Table 5.2 Granger-Causality between Per Capita GDP Growth Rate and Income Inequality Level (Adjusted Data)

Inequality indicators	GINI		GE		C V		MM	
H_0	*INEQ* does not cause *GROWTH*	*GROWTH* does not cause *INEQ*	*INEQ* does not cause *Growth*	*GROWTH* does not cause *INEQ*	*INEQ* does not cause *Growth*	*GROWTH* does not cause *INEQ*	*INEQ* does not cause *Growth*	*GROWTH* does not cause *INEQ*
$VAR(k+d_{max})$	2(1)	2(1)	2(1)	2(1)	2(1)	2(1)	3(2)	3(2)
p-values	0.8508	0.0058***	0.7754	0.0059***	0.3216	0.0087***	0.3193	1×10^{-7}***
Sum of lagged coefficient	-15.9276	0.0014	-31.0908	0.0011	-32.2886	0.0030	-1.0236	0.5562
Adj. R^2	0.7023	0.9122	0.7034	0.8893	0.7098	0.9556	0.8179	0.9628
				p-value				
$VAR(k+d_{max}+1)$	0.9556	0.0793*	0.9281	0.0586*	0.5687	0.0095***	0.6307	1×10^{-7}***
$VAR(k+d_{max}+2)$	0.8551	0.0161**	0.9046	0.0115**	0.7265	0.0004***	---	---

Notes: 1. Symbols***, **and * denote that statistics located in the rejection area at 1%, 5％and 10％significant level.

2. Empirical results regarding other variables are available upon requests.

3. Symbol --- denotes that the VAR system does not have a higher order due to inefficient of observations.

The results in Table 5.2 suggest that the null hypothesis of "Granger no-causality from income inequality to economic growth (*INEQ* to *GROW*) can not be rejected at a 10% significant level no matter what index is used to represent income inequality. In other words, inequality cannot influence growth in China. This study suggests some probabilities to explain this disappointing result.

Firstly, the effects of income inequality on economic growth are still inconclusive because the results of previous empirical studies are ambiguous. Barro (1999) found that income inequality would negatively influence economic growth in poor countries but had a positive effect in rich countries. When the data of poor and rich countries were pooled, the effect disappeared. Accordingly, Barro (1999) considered that the equalization policy employed by governments in poor countries would promote economic growth. However, it is difficult to find that the China government attempted to execute an equalization policy in post reform China. Even Deng Xiaoping thought it was necessary to "let minor people became rich" to encourage people's effort to work. Barro's demonstration does not exist in post reform China and the positive effect of income inequality on economic growth would not occur.

Secondly, the political economy theory predicts income inequality will not affect economic growth. Persson and Tabellini (1994) had confirmed that in undemocratic countries there was no political channel for the poor putting pressure on governments and it led to the insignificant effect of income inequality. Although post reform China is a transitional economy, it is an undemocratic country in the political sense. The results of Clarke (1995) did not concur with that of Persson and Tabellini (1994), but their definitions and classifications of democracies and non- democracies were different. Compared with pure empirical study of Clarke (1995), Persson and

Tabellini (1994) provided more theoretical foundations to explain why income inequality did not influence growth. Therefore, this study adopts latter viewpoints to explain China's scenario.[38]

The results in Table 5.2 also suggest that the null hypothesis of "Granger no-causality from economic growth to provincial inequality (*GROW* to *INEQ*) can be rejected strongly at 1% significant level no matter what index is used to represent inequality. The positive sum of lagged coefficients implies that economic growth has a totally positive effect on income inequality. That is to say, a higher economic growth comes with a higher provincial inequality in the post-reform China.

This study infers that economic growth positively influences income inequality through the channel of foreign investment and technology. Speedy economic growth expands China's market size and development potential, which attracts more foreign investment and technology. Foreign capital and technology prefer flowing into coastal provinces rather than inland provinces because the former possess better economic circumstances (some are determined by natural conditions; some are determined by the policies authorized by central government described above) and provide more employment opportunities.[39] Therefore, these increase the output gap between coastal and inland provinces and lead to higher income inequality.

Part of this result can attributed to government policy. Krongkaew and Kakwani (2003) used a political economic theory to explain why growth led to inequality in Thailand.[40] They indicated:

[38] Clarke (1995) also recognized its result was fragile to different classifications and did hold for the shorter time.
[39] Broadman and Sun (1997) found large market size was an important determinant of China's foreign direct investment.
[40] Krongkaew and Kakwani (2003) also explained their finding by adopting imperfect competitive theory and institutional viewpoint.

"One straight answer why inequality increases as the country grows would be: because the policy makers would like to see it that way."

Krongkaew and Kakwani (2003) argued that a government could employ some policies to promote growth but these policies would be harmful for income distribution.

Krongkaew and Kakwani (2003)'s argument for the situation in Thailand can be applied to illustrate this study's empirical result because China's government pays more attention to the development of coastal or eastern provinces during the reform period. China's economic reform policies, such as rural reform and the township village enterprise policy, drove the rapid economic growth of over the whole country. However, some policies were only carried out in coastal or eastern provinces. Wang and Hu (1999) thought it was because central government expected to get greater economic efficiency and rapid growth that it put more resources in coastal provinces to develop and authorize local governments to employ preferred policies. These policies determine the destination of foreign capital and technology, which are appealing to China's growing market and development.

5.3 Test of Robustness

Granger-Causality is sensitive to the lag length. Pindyck and Rubinfeld (1991) indicated that "it is best to run the test for few different lag structures and make sure that the results are not sensitive to the choice of *k*." In order to ensure that the empirical results are not sensitive to the choice of lag length, the model has also been estimated using $k+1$ and $k+2$ lag structure. The estimated *p*-values for different lag structures are also presented in Table 5.2.

Table 5.2 shows that the empirical results do not change very much whether *k+1* or *k+2* is used. The income inequality still cannot affect growth, but its *p*-value decreases with increasing lagged length. Besides, the effect of growth on GE and GINI are now only significant at a 10% and a 5% significant level while *k+1* and *k+2* are used, respectively. The effect of growth on CV and MM are still very significant at a 1% significant level.

The results presented in Table 5.3 uses official economic growth data to estimate causal relationship. It seems that results in Table 5.2 and Table 5.3 are similar. Inequality does not influence growth, but growth promotes provincial inequality, except for CV. These results are also robust no matter if *k+1* or *k+2* is employed.

Finally, this study adds a trend term into the equation (4.11) and runs the VAR model again. This study sets the year 1978 as 1, 1979 as 2, ... and 2002 as 25. Table 5.4 and Table 5.5 present the empirical results. They show no difference between the results of model with trend and without trend. However, the positive effect of growth on inequality became more significant, especially when the orders of VAR are $k+d_{max}+2$ and $k+d_{max}+1$. The coefficients of growth are significant at 1% significant level.

Table 5.3. Granger-Causality between Per Capita GDP Growth Rate and Income Inequality Level (Official Data)

Inequality indicators	GINI		GE		CV		MM	
H_0	*INEQ* does not cause *GROWTH*	*GROWTH* does not cause *INEQ*	*INEQ* does not cause *Growth*	*GROWTH* does not cause *INEQ*	*INEQ* does not cause *Growth*	*GROWTH* does not cause *INEQ*	*INEQ* does not cause *Growth*	*GROWTH* does not cause *INEQ*
$VAR(k+d_{max})$	2(1)	2(1)	2(1)	2(1)	2(1)	2(1)	3(2)	3(2)
p-values	0.6641	0.0437**	0.7005	0.0458**	0.4277	0.2428	0.9939	0.0005***
Sum of lagged coefficient	-31.4468	0.0016	-36.9959	0.0012	-23.2447	0.0021	-0.0597	0.2534
Adj. R^2	0.6818	0.9101	0.6634	0.8857	0.6454	0.9502	0.7703	0.9446
				p-value				
$VAR(k+d_{max}+1)$	0.2859	0.0117**	0.6739	0.0083***	0.9032	0.0221**	0.4611	1×10^{-5}***
$VAR(k+d_{max}+2)$	0.2153	0.0192**	0.3740	0.0060***	0.3656	0.0001***	---	---

Notes: 1. Symbols***, **and * denote that statistics located in the rejection area at 1%, 5％and 10％significant level.

2. Empirical results regarding other variables are available upon requests.

3. Symbol --- denotes that the VAR system does not have a higher order due to inefficient of observations.

Table 5.4 Granger-Causality between Per Capita GDP Growth Rate and Income Inequality Level (Official Data with Trend)

Inequality indicators	GINI		GE		C V		MM	
H_0	*INEQ* does not cause *GROWTH*	*GROWTH* does not cause *INEQ*	*INEQ* does not cause *Growth*	*GROWTH* does not cause *INEQ*	*INEQ* does not cause *Growth*	*GROWTH* does not cause *INEQ*	*INEQ* does not cause *Growth*	*GROWTH* does not cause *INEQ*
$VAR(k+d_{max})$	2(1)	2(1)	2(1)	2(1)	2(1)	2(1)	3(2)	3(2)
p-values	0.8842	0.0327**	0.8426	0.0414**	0.2856	0.2930	0.4013	0.0303**
Sum of lagged coefficient	-10.1188	0.0017	-17.7645	0.0012	-28.5768	0.0019	-0.8511	0.2028
Adj. R^2	0.7253	0.9148	0.7208	0.8899	0.7452	0.9528	0.7452	0.9485
				p-value				
$VAR(k+d_{max}+1)$	0.5026	0.0057***	0.6265	0.0086***	0.1982	0.0422**	0.2633	0.0002***
$VAR(k+d_{max}+2)$	0.2758	0.0387**	0.4911	0.0096***	0.9324	0.0001***	---	---

Notes: 1. Symbols***, **and * denote that statistics located in the rejection area at 1%, 5％and 10％significant level.

2. Empirical results regarding other variables are available upon requests.

3. Symbol --- denotes that the VAR system does not have a higher order due to inefficient of observations.

Table 5.5 Granger-Causality between Per Capita GDP Growth Rate and Income Inequality Level (Adjusted Data with Trend)

Inequality indicators	GINI		GE		C V		MM	
H_0	*INEQ* does not cause *GROWTH*	*GROWTH* does not cause *INEQ*	*INEQ* does not cause *Growth*	*GROWTH* does not cause *INEQ*	*INEQ* does not cause *Growth*	*GROWTH* does not cause *INEQ*	*INEQ* does not cause *Growth*	*GROWTH* does not cause *INEQ*
$VAR(k+d_{max})$	2(1)	2(1)	2(1)	2(1)	2(1)	2(1)	3(2)	3(2)
p-values	0.9358	0.0002***	0.9798	0.0059***	0.3998	0.0030***	0.3193	2×10^{-5}***
Sum of lagged coefficient	6.6700	0.0017	-4.7014	0.0014	-26.3251	0.0038	-36.6626	0.0055
Adj. R^2	0.7339	0.9326	0.7340	0.9134	0.7448	0.9596	0.7897	0.9610
				p-value				
$VAR(k+d_{max}+1)$	0.8446	2×10^{-5}***	0.7444	2×10^{-5}***	0.1746	9×10^{-5}***	0.8100	1×10^{-8}***
$VAR(k+d_{max}+2)$	0.1308	4×10^{-5}***	0.1581	7×10^{-6}***	0.1462	1×10^{-8}***	---	---

Notes: 1. Symbols***, **and * denote that statistics located in the rejection area at 1%, 5％and 10％significant level.

2. Empirical results regarding other variables are available upon requests.

3. Symbol --- denotes that the VAR system does not have a higher order due to inefficient of observations.