

Co-integration Analysis of the Relationship Between Industrial Structure Change and Economic Growth in Hubei Province of China*

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Abstract: Based on the time-series data from 1990 to 2006 in Hubei province of China, this paper analyzes the relationship between industrial structure changes and economic growth through the analysis on the co-integration and granger causation test model. The outcome research indicates: (1) There is long-term stable relation between the fluctuation of industrial structure and the practical economic growth. The industrial policy of adjusting and optimizing industrial structure so as to promote economic growth is active and efficient in Hubei province. (2) The value of tertiary industry and economic growth develop with the same fluctuation, and the influence is huge, which shows the marginal productivity of tertiary industry goes beyond any other marginal productivity, tertiary occupation is processed of developmental potential. (3) Between individual *GDP* and the increase of the proportion of tertiary industry exists no obvious mutual causation relation. (4) The increase of the proportion of tertiary industry is the cause of the increase of tertiary industry production rather than the way around.

Keywords: Industrial structure; Economic growth; Co-integration analysis; Granger causation test; Hubei province

1 Introduction

The researches of the relationship between regional economic growth and industrial structure attract many scholars' attention both at home and abroad at all times. Many researches indicate that there is a mutual promotion and restraint relation existing between the industrial structure changes and economic growth. Under a certain condition, industrial structure is the base of economic growth. In the long run, industrial structure will still be one of the main reasons that condition economic growth at stated periods from now on. At present, global economic produces some new characteristics, such as intra-industry taking place of the division of labor among products to become a new international form for division of labor, the reinforcement on the integration of trade and investment etc. At the same time, China's economic and social development have jumped into a new stage with the promotion of the reform and open policy and the macroeconomic control of the government. However, the issues between economic growth and industrial structure will continue to be the focus of governments of all levels and in the academic circles.

'Hubei Statistical Yearbook' in the relevant year is used in this essay as the basic data resource, and this essay has the period (1978-2008) researched, for this period is the important time for economic growth to step into the speedy development from the previous steady development in Hubei province. It analyzes the co-integration relation between industrial structure and economic growth in this period, and it refers to the mutual relevant mechanisms and rules between them so as to provide the practical plans for upgrading the industrial structure and promote economic growth better. It has great significance.

2 Index for Selection

This essay reflects the growth of economy through the individual *GDP*(*Y*) index of macroeconomics, and it also reflects the conditions of the industrial structure in the national economy by two indexes, one is the upgrading rate of industrial structure(X_1)—The proportion of *GDP* that tertiary industry makes up, the other one is the upgrading rate of employment structure(X_2)—The proportion of employment weighs in the total employment. Because of the natural logarithms of data doesn't change the co-integration relation in the primal variable, also makes the trend linearization, and determinates the heteroscedastic phenomenon which existing in the time series, so, transform the natural logarithm of individual *GDP*(*Y*), the proportion of *GDP* that tertiary industry makes up(X_1) as well as the proportion of employment weighs in the total employment(X_2) and use *LY*, *LX*₁, *LX*₂ respectively to show the individual *GDP*, the upgrading rate of industrial structure and the upgrading rate of employment

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3 Time-series Stability Test

In order to avoid the fake regression and increase the precision of analysis, the stability should be tested before testing the co-integration among all kinds of variables. Common method—*ADF*(Augmented Dickey-Full)in the unit root test can be used to test. Use Adjusted *R*-squared rule, AIC rule, SC rule etc. to attempt over and over, select the optional lag order in the model, finally get the result of the unit root test (in table 1). The result in Table1 indicates that time series *LY*, *LX₁* are first order integration sequence after tested and time series *LY*, *LX₂* are second order integration sequence.

Table 1 The Result of *ADF* Test for *LY*, *LX₁*, *LX₂*

Variable	<i>ADF</i> test	Critical value			<i>D.W</i>	Probability	Conclusion
		1%	5%	10%			
<i>LY</i>	0.656381	-3.92035	-3.065585	-2.673459	1.776119	0.9866	unstable
<i>LX₁</i>	-3.064785	-3.92035	-3.065585	-2.673459	1.86133	0.0501	unstable
<i>LX₂</i>	-2.432597	-3.92035	-3.065585	-2.673459	1.081678	0.149	unstable
Δ <i>LY</i>	-4.996342	-3.959148	-3.081002	-2.68133	1.601915	0.0015	stable
Δ <i>LX₁</i>	-3.823536	-3.959148	-3.081002	-2.68133	2.223781	0.0129	stable
Δ <i>LX₂</i>	-1.881934	-3.959148	-3.081002	-2.68133	1.864846	0.3308	unstable
Δ^2 <i>LX₂</i>	-3.712917	-4.05791	-3.11991	-2.701103	2.184791	0.0181	stable

4 Co-integration Model and Test

Times series *LY*, *LX₁* are first order integration sequence after tested while *LY*, *LX₁* are second order integration sequence. Though they them themselves are not stable, but some linear combination is stable. This linear combination reflects the long-term stable proportion among variables, which is called co-integration. In order to analyze the equilibrium relation among variables effectively, its does the OLS regression estimates of *LY* and *LX₁*, *LX₂*, plus *LY* and *LX₁*, *LX₂*, in addition, it also does the *ADF* test to each residual series in the regression model so as to ascertain the stable equilibrium relation among variables. Eviews’ OLS regression estimate leads to the estimate model and find out the residual test.

(1)The computation formula of the residual *e* between *LY* and *LX₁*:

$$e_t = LY_t - 1.998096LX_{1t} - 0.017856$$

$$(R^2 = 0.716576, DW = 0.146425)$$

We can see the absolute value of *ADF* is 4.217636, threshold absolute value is 3.959148 (level of significance is 1%), and the residual series *e* is a stable series. That is to say there exists a stable linear combination between *LY* and *LX₁*. In other words, there is a long-term equilibrium relation between the percent of tertiary industry and national *GDP*.

(2)The computation formula of the residual *e* between *LY* and *LX₁*:

$$e_t = LY_t - 2.187509LX_{2t} - 0.013453$$

$$(R^2 = 0.865689, DW = 0.216827)$$

We can see the absolute value of *ADF* is 4.186159, and threshold absolute value is 3.959148 (level of significance is 1%), so we can say the residual series *e* is a stable series. That is to say there exists a stable linear combination between *LY* and *LX₂*. In other words, there is a long-term equilibrium relation between the percent of tertiary industry and national *GDP*.

(3)The computation formula of the residual *vecm* between *LY* and *LX₁*, *LX₂*.

$$vecm_t = LY_t - 10.23554LX_{1t} + 4.148741LX_{2t}$$

In the above formula, *t* stands for time, and *vecm* stands for balanced error. Tested by error correction model *vecm*, Co-integration exists between *LY* and *LX₁*, also *LY* and *LX₂*, though *R²* after having been tested is rather high, the regression coefficient is outstanding, *DW* is obviously low, Which testifies there exists auto-correlation among the residual series. The *ADF* test to *vecm* in the co-integration formula shows balanced error series is stable, from here, we can get the conclusion that the co-integration relation in the formula showing is outstanding, that is to say, there exists long-term equilibrium relationship between *LY* and *LX₁*, *LX₂*. The proportion of tertiary industry changes 1% will cause individual *GDP* to change 10.23554% in the same direction. The proportion of the labor in tertiary industry changes 1% will cause individual *GDP* to change 4.148741% in the opposite way, and as for economic growth, the positive influence of tertiary industry is obviously more enormous than the negative influence of the proportion of labor.

5 Granger Causation Test

Co-integration formula only shows the equilibrium relation of three time series vectors, so it

doesn't take each vector under the short-term and not balanced condition into consideration. Furthermore, in the real course of economy, such situation is normal. Research the relation between the long-term equilibrium and the short-term adjustment among the time series vectors and build up error correction model. The result of co-integration test testifies there is long-term equilibrium relation among the proportion of individual *GDP* and tertiary industry as well as the population working in tertiary industry in Hubei province, however, it still cannot show there is regression relation among them, and whether this equilibrium relation can form causation relation or not need further demonstration.

Table 2 The Result of Granger Causation Test (the lag phase is 3)

Null Hypothesis	F-Statistic	Probability
LX_1 does not GrangerCause LY	0.4122	0.74954
LY does not GrangerCause LX_1	0.9431	0.46958
LX_2 does not GrangerCause LY	9.87471	0.00656
LY does not GrangerCause LX_2	0.2244	0.87654
LX_2 does not GrangerCause LX_1	5.23497	0.03301
LX_1 does not GrangerCause LX_2	0.33863	0.79838

As for the long-term equilibrium, is $GDP(Y)$ the cause of the changes of the proportion of tertiary industry(X_1) and the proportion of the labor in the whole employment in tertiary industry(X_2)? Or the two cause the change of $GDP(Y)$? In the fluctuation, what is the cause, what is the result, or the two be reciprocal causation? It needs the Granger causation test to X_1 , X_2 and GDP . Suppose the lag phase is 3, Granger causation test to X_1 , X_2 and GDP , result in Table 2.

The result in Table 2 shows that when the lag phase is 3, the calculus of probability that shows LX_1 is not the cause of LX_2 reaches 3.3% which tells us that the proportion of labor in the whole employment in tertiary industry(X_2) is the Granger cause of the proportion of tertiary industry; The calculus of probability that shows LX_2 is not the cause of LY reaches 0.65% which tell us the proportion of labor in the whole employment in tertiary industry(X_2) is the granger cause of individual GDP ; During the whole result of the test, the calculus of probability that shows LY is not the granger cause of LX_1 and LX_1 is not the granger cause of LY reach above 40%, which is to say the proportion of tertiary industry(X_1) and individual GDP are not the cause and result to each other. It also indicates in recent development of Hubei economy, the effect of the proportion of labor in the whole employment in tertiary industry to economic growth is obviously more enormous than the proportion of tertiary industry does. The main reason is that although tertiary industry in Hubei increases year after year, the Services producing industries develops not so fast, industrial structure in Hubei takes the development way of labor intensive, and the proportion of tertiary industry is not too high, so the influence to economic growth is not so obvious.

6 Conclusion and Discussion

6.1 Conclusion

Based on the time-series data from 1990 to 2006 in Hubei province, through the analysis on the co-integration and Granger causation test model, it discloses that there exists long-term equilibrium relation between tertiary industry and economic growth, and as for economic growth, the positive influence of tertiary industry is obviously more enormous than the negative influence of the proportion of labor, which indicates there is obvious co-integration between industrial structure and economic growth. The report concludes as follows

(1)There is long-term stable relation between the fluctuation of industrial structure and the practical economic growth. Industrial structure and economic growth both don't have stability, or the fluctuation can be huge, but in terms of long run, there is some economic mechanisms that can make them two have a common random fluctuation trend. The industrial policy of adjusting and optimizing industrial structure so as to promote economic growth is active and efficient in Hubei province.

(2)The value of tertiary industry and economic growth develop with the same fluctuation, and the influence is huge, which shows the marginal productivity of tertiary industry goes beyond any other marginal productivity, tertiary occupation is processed of developmental potential.

(3)Between individual GDP and the increase of the proportion of tertiary industry exists no obvious mutual causation relation. Individual GDP is not the cause of the increase of tertiary industry. That is to say, the upgrading course of industrial structure is not brought in by the rapid economic growth.

(4)The increase of the proportion of tertiary industry is the cause of the increase of tertiary industry production rather than the way around.

6.2 Discussion

(1)The conclusions above coincide with the actual situation, to be specifically, since 1990, primary industry has weaken its donation to economic growth gradually, while tertiary industry has strengthen, at the same time, secondary production has been the booster for economic growth of all time.

(2)Hubei province takes the development way of labor intensive, it need some exchange in the future, for that it should take some new ways, such as capital-intensive way, technology-intensive way, etc.

(3)Our government should put some emphasis on propelling industrial structure to upgrade and optimize, and turn the secondary production into intensive management from extensive management, in addition, guide rational development of tertiary industry.

(4)Between the adjustment of industrial structure and economic growth exists a one-way causation relation, namely, the adjustment of industrial structure booms the growth of economy rather than the growth of economy causes the adjustment of structure; Compared with the influence of primary industry and secondary production, tertiary industry has the greatest donation to the growth of economy and expands the value of tertiary industry so as to lead the economy in Hubei to grow positively.

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