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Relationship between Scale of Higher Education and Economic Growth in China

Feixue Huang
Department of Economics, Dalian University of Technology
Dalian 116024, China
E-mail: software666@163.com

Ling Jin
Department of Economics, Dalian University of Technology
Dalian 116024, China

Xiaoli Sun
School of Electronic and Information Engineering, Dalian University of Technology
Dalian 116600, China

Abstract

In order to study the problems of long-term and short-term interactional mechanism between scale evolution of higher education and economic growth in China, authors in this article are going to put forward the method of cointegration. Through selection of enrollment and actual GDP data per capita in China from 1972 to 2007, it is discovered from the empirical result that: (1) the log sequences of enrollment of higher education and actual GDP per capita in China are first-order integration; (2) long-term cointegration relationship exists between enrollment of higher education and actual GDP per capita in China, and the long-term influence between them is positive; (3) through VECM analysis, when fluctuation of enrollment in higher education deviates from the long-run equilibrium, the system will pull the state of nonequilibrium back to the state of equilibrium with an adjustment rate of 7%; (4) based on impulse response function and variance decomposition, it is proved that one unit positive impact of higher education scale can lead to its further expansion; one unit positive impact of actual GDP per capita can also play a driving role to scale of higher education within a short period of time, but may restrain it in the long run. Conclusions and suggestions: (1) expansion of scale of higher education in China should correspond with economic growth; (2) to improve the utilization ratio of resources in higher education should not only expand in size, but should also adjust structure of higher education.

Keywords: Scale of higher education, Economic growth, Cointegration, Vector Error Correction Model (VECM)

1. Introduction

Just as the American scholar Brubacher, J·S said, higher education belongs to the high level education in social culture and is the highest level of learning. As for study on scale of higher education, this article mainly discusses the following three aspects: development of higher education scale, relationship between higher education scale and economic growth and forecasting of higher education scale.

1.1 Development of the scale of higher education

When oversea scholars study constrainting factors on development of higher education, they tend to give similar consideration to factors of demographic, politics, economy and culture, and study influence of demographic factor upon development of higher education at a macro-scale level. Different countries have different focus of studies. In 1997, after research on relationship between demographic structure and higher education opportunities in Kinshasa --- capital of Zaire, American scholars Shapiro and Tambashe discovered that, improvement of higher education opportunities for women was one of effective measures to reduce their fertility rate. In 2001, after statistical analysis of changes of

population at the age of 18 from 1992 to 2001, Doyon believed decline in active population in higher education would encourage Japan to conduct a series of reforms in higher education. Furthermore, by means of quantitative analysis, oversea scholars have discussed in detail the dynamic relations between microstructures in demographic structure and development of higher education, such as gender structure, ethnic structure and immigration structure, etc, and also have probed into influences of higher education on birth rate and mortality rate, etc. Generally speaking, study on relation between demographic structure and higher education in foreign countries has been started earlier and there are sufficient materials. The focus of the study is the specific relationship between demographic structure factor and higher education.

1.2 Higher education scale and economic growth

There are several methods to study rate of contribution by education to economic growth, such as, Schurz Residual Method, Denison Coefficient Method and Method to Simplify Complex Labour, etc. Zhang Liqun made a discussion on development of higher education in central cities in coastal developed area with three aspects of higher education scale, level and countermeasure, and proposed countermeasures for development of higher education. Applying the theory of systematic science, Fan Hua and Tao Xueyu mentioned that the essence of systematic coordination of higher education and economic development was to fully utilize and promote the positive relations between them and also established a model of coordination degree. We conduct an empirical analysis in systematic coordination of higher education and economic development in Jiangsu Province from 1993 to 2003, and find out that expansion policy in higher education firstly implemented in Jiangsu has coincided with the development of regional economy. Degree of coordination in the compound system is being enhanced increasingly.

1.3 Forecasting of higher education scale

Wasik classified models of forecasting on enrollment in higher education into three categories: 1) extrapolation model, which uses historical data for linear extrapolation or uses equation of linear regression to forecast enrollment; 2) model of student flow, which uses different equations to evaluate flow of individuals in an educational system; 3) Markov chain model, which uses transfer matrix to forecast flow of students among different universities and colleges. In his doctoral dissertation <<Computer Models for Enrollment Forecasting: A Management Science Approach>>, Mohamed respectively applied the method of student flow (input-output and Markov chain model), regression analysis and moving average method to establish corresponding forecasting model of enrollment, and compared accuracy of these three mathematical methods in forecasting.

In conclusion, due to lack of application of modern cointegration to study interaction between evolvement of higher education scale and economic growth in China, and as a result of nonstationarity of data, traditional methods may generate a conclusion in which two unrelatable variables have significant correlation, which, by no means, has no meaning. This article proposes comprehensive application of some methods, such as unit root test, cointegration test, VECM, generalized impulse response and variance decomposition, etc. The authors choose *ZS* as enrollment in higher education in China from 1972 to 2007 and annual data *PGDP* as GDP per capita of economic growth. Through application of unit root and cointegration test, they get the long-term cointegration relation between demographic variable and economic variable. However, according to conclusions by Granger, a necessary connection exists between cointegration concept and error correction model, and error correction model can help get short-term influential mechanism. By means of generalized impulse response model and variance decomposition, the article further discusses dynamic equilibrium relationship and shock effect.

2. Methodology and process

2.1 Data source, pretreatment and variable declaration

For discussion of interaction between dynamic changes of higher education scale and economic growth in China, two variables are selected: *ZS* which stands for enrollment of higher education and *PGDP* which stands for GDP per capita of economic growth. Annual data in China from 1972 to 2007 are collected (data sources include all issues of <<Chinese Statistical Yearbook>> and <<Chinese Educational Yearbook>> which are formally issued by State Statistics Bureau, and also include various relevant official website). In order to reduce influences of heteroskedasticity, we take the logarithm of all data, and respectively record them as *LNZS* and *LNPGDP.*

2.2 Correlativity of variables of higher education scale and economy

In order to get a quantitative correlativity between variables of higher education and economy in China, in Table 1, we list out correlation matrix of the logarithm sequence *LNZS* of enrollment variable of higher education and the logarithm sequence *LNPGDP* of GDP per capita of economic variable in annual data from 1972 to 2007 in China.

Insert Table 1 Here

From analysis in Table 1, it is indicated that, a high positive correlativity exists between changes of scale of higher education and economic growth in China, and correlation coefficient reaches 0.956.

2.3 Cointegration analysis of variables of scale of higher education and economy in China

Since the sequences of the selected variables may be nonstationary, traditional econometrics theory usually cannot generate an objective and accurate result. Therefore, first of all, this part is going to test stationarity of variables of higher education scale and economy and then, after confirming the same cointegration orders of variables, is going to conduct Johansen cointegration for a long-term cointegration relation between variables. Eviews5.0 is selected as Quantitative analysis software.

2.3.1 Unit root test of stationarity of variables of higher education scale and economy in China

First of all, we test stationarity of data and the standard method to check stationarity of sequences is unit root test. Usually adopted methods are DF (Dickey-Fuller) Test, ADF (Augmented Dickey-Fuller) Test and PP (Phillips-Perron) Test. In this article, we are going to use ADF Test to test stationarity of sequences, as is shown in Table 2.

Insert Table 2 Here

Note: critical values in the table all represent MacKinnon critical value of rejection unit root hypothesis. $\triangle$ stands for lagging first order difference. 5% critical value stands for 5% level of significance. The minimum value of AIC and SC is the norm of lagging order. DW stands for DW test value of self relevance sequence.

When the significance is 5%, original ADF value is above critical value, which indicates that a sequence is nonstationary. After the first order difference, ADF value of the log sequence *LNZS* of enrollment in higher education is below the 5% critical value, which indicates the sequence is stationary. Actual GDP-*LNPGDP* per capita is nonstationary, so Holt-Winters multiplication model in the exponential smoothing method is used to smooth it, and *LNPGDPM* sequence is generated, which, after test of its first order difference, is stationary. The results indicate that, the log sequence *LNZS* of enrollment in higher education and log sequence of actual GDP per capital after adjustment are both first order cointegration sequences, recorded as I(1) sequence. Although *LNZS* and *LNPGDPM* are not stationary sequences, and we cannot use traditional econometrics for analysis, their cointegration orders are similar. Thus, modern cointegration analysis can be used to establish VECM.

2.3.2 Cointegration test

Cointegration test is mainly used to analyze whether a long-term equilibrium relationship exists between variables. In 1987, conintegration theory and method by Engle and Granger offers an approach to modeling of nonstationary sequence. According to cointegration theory, if cointegration relation exists between two sequences with same cointegration orders, then a long-term stationary relation exists between these two variables, which can further effectively avoid the issue of spurious regression. Cointegration test is mainly used to analyze whether a long-term equilibrium relationship exists between variables. In order to study the long-term equilibrium relation between the two variables of enrollment in higher education and actual GDP per capita, we adopt the internationally recognized maximum likelihood method with multivariate model (Johansen, 1988, Johansen and Juselius, 1990, 1992). The test results are shown as in Table 3.

Insert Table 3 Here

Note: the significance level is 5%, those equations present the sequences with no definite trend, and the equations have an intercept.

When the significance level is 5%, the trace tests and the max-eigenvalue test both prove that there is only one cointegration equation. Just for analysis, here we choose a cointegration equation as follows:

$$LNZS = 1.087185\,LNPGDPM - 0.763931 \quad (1)$$

Cointegration test results indicate that, changes of higher education scale and economic growth present a highly positive relation. That is, whenever actual GDP per capita increases one percentage point, enrollment of higher education also increases one percentage point correspondingly.

2.4 Vector Error Correction Model

According to Granger theorem, for a group of variables with cointegration relation, there necessarily exist a expressing form of an error correction model. As has been mentioned above, cointegration relation exists among all variables, on the basis of which VECM is established to observe long-term and short-term relationship among all variables. Equation 1 has already given the long-term equilibrium relation between the log sequences of the two variables of enrollment in higher education and GDP per capita, whereas VECM can give the correction term that reflects influences of deviation of relation between variables from long-term equilibrium upon short-term changes. Equation (2) and (3) respectively give VECM of the two variables of higher education scale and economy.

$$\begin{aligned} D(LNZS) = &- 0.06991996284(\, LNZS(-1) - 1.087184932\,LNGDPSM(-1) + 0.7639306025\,) - \\ &0.03253230055\,D(LNZS(-1)) - 0.8754251516\,D(LNGDPSM(-1)) \end{aligned} \quad (2)$$

$$D(LNGDPSM)=-0.01083898386*(LNZS(-1)-1.087184932LNGDPSM(-1)+ 0.7639306025) + 0.2562374663D(LNZS(-1)) + 0.4651152253D(LNGDPSM(-1)) \quad (3)$$

Statistic test result of the model is shown in Table 4.

Insert Table 4 Here

Granger Causality Test of VECM is shown as in Table 5:

Insert Table 5 Here

Results of Granger Causality Test indicate that, VECM of enrollment in higher education and that of actual GDP per capita both have passed Granger Causality Test, which indicates that the fitting effects are both perfect.

Analysis of Equation (2) can tell us that, short-term fluctuation of the log sequence *LNZS* of enrollment in higher education is caused by two parts, one being direct influence of all difference items of *LNZS* and *LNPGDP* on short-term fluctuation of *LNZS*, and the other being adjustment of long-term equilibrium relation. In Equation (2) error correction coefficient is -0.06991996284, with a negative direction, indicating that when deviating from long-term equilibrium, error correction item has an opposite adjustment effect and the deviation degree is reduced. Thus, the change goes towards stationarity. However, since the value is small and convergence mechanism of deviating from long-term equilibrium plays a rather limited role. When fluctuation of enrollment deviates from long-term equilibrium, its own system can pull the nonequilibrium state back to equilibrium state only with an adjustive force of 0.09.

2.5 Impulse response

The fundamental idea of impulse response function is to analyze impact of unit standard deviation in a random disturbance term upon the current value and future value of various endogenous variables. Here we apply the method of generalized impulse response, and attribute respectively the two variables a positive impact with a unit size. Then, we get the generalized impulse response function between enrollment in higher education and GDP per capita under the model of VECM, as is shown in Figure 1:

Insert Figure 1 Here

In figure 1, abscissa axis stands for lagging period of time (Unit: Year) of the impact effect, and ordinate axis stands for response to the impact.

(1) As for unit positive impact of enrollment in higher education, the sequence LNZS is positively affected in the short time, but the influence will go down gradually, whereas actual GDP per capital is negatively affected in the short term, but the influence will also fall off and exhibits a positive trend in middle and later periods (13 years later). Afterwards, the influence on economy will be enlarged gradually, which proves that education has a serious lagging effect on economy;

(2) As for unit positive impact of actual GDP per capita, the sequence *LNZS* is positively affected in the short term, but the influence will gradually diminish, and will turn into negative influence after 15 years, whereas actual GDP per capita is positively affected by itself constantly.

3. Conclusion

This article applies some methods to analyze the mechanism of dynamic interaction between the enrollment in higher education and actual GDP per capita, the methods include cointegration test, VECM, Granger causality test, impulse response analysis and variance decomposition, with the following major discoveries:

(1) A long-term cointegration relation is found between variables of enrollment in higher education and actual GDP per capita of economic, which indicates that a long-term steady relationship exists between these two variables. With growth of the economy, scale of higher education exhibits an ascending trend;

(2) The model of VECM indicates that self-adjustment ability of the system is rather weak;

(3) The impulse response function proves that education has serious lagging effect on economy.

Growth of economy will necessarily call for more knowledge-based professionals, which will promote the development of higher education scale. However, in the long run, continual expansion of higher education scale will inevitably lead to the decreacing of the efficiency of resource investment, diminishing marginal utility and even lead to negative value, so expansion of higher education should not be practiced blindly.

References

Brubacher, J·S. (1991). Translated by Wu, Yuanxun, etc. *A History of the Problems of Education*. Hefei: Anhui Educational Publishing House, 429.

D, Shapiro & B O Tambashe. (1997). Education, Employment and Fertility in Kinshasa and Prospects for Changes in Reproductive Behavior. *Population Research and Policy Review,* 16(3):259—287.

Fan, Hua & Tao, Xueyu. (2005). Study on Coordination of Higher Education-Economic Development Composite System. *Science & Technology Review*, 23(9):53-55.

MD, Orwig, PK Jones & OT Lenning. (1972). Enrollment projection models for institutional planning. *Higher Education*, 1(4):435-448.

Mohamed Youssef Hassan. (1979). *Computer Models for Enrollment Forecasting: A Management Science Approach*. University of Pittsburgh.

P, Doyon. (2001). A Review of Higher Education in Modern Japan. *Higher Education*, 41(4):443—470.

Shi, Lu & Xu, Guangjian. (2004). Contribution and Application of Cointegration and Autoregressional Conditional Heteroscedasticity. *Macroeconomics*, (10):46-50.

Zhang, Liqun. (2002). Study on Higher Education in Central Cities in Coastal Developed Area. *Journal of Ningbo University,* 24(1):19-21.

Table 1. Correlation matrix of the variables of higher education scale and economy

	LNZS	*LNPGDP*
LNZS	1.000000	0.9559258097
LNPGDP	0.9559258097	1.000000

Table 2. Unit root test result of time series of relevant variables after being taken the logarithm

Variables	ADF value	5% critical value	D-W	Stationary or not
LNZS	0.252500	-2.948404	0.9722	No
△LNZS	-5.076194	-2.951125	0.0002	Yes
LNPGDP	-0.013712	-2.960411	0.9502	No
△LNPGDP	-2.927301	-2.924021	0.0529	No
LNPGDPM	0.531642	-2.951125	0.9854	No
△LNPGDPM	-2.962517	-2.960411	0.0498	Yes

Table 3. Cointegration test result of variables of higher education scale and economy

LNZS	*LNPGDP*	*c*
1.000000	-1.087185	0.763931
standard deviation	0.22405	1.62758

Table 4. Statistic test result of the model

	D(LNZS)	*D(LNPGDPM)*
R^2	0.383018	0.204323
Correction R^2	0.343212	0.152989
Square Sum of Residuals	0.443705	0.280132
Standard error	0.119637	0.095061
F statistic	9.622271	3.980296
Log Likelihood	25.51834	33.33660
AIC	-1.324608	-1.784506
SC	-1.189929	-1.649827

Table 5. Granger causality test of VECM

dependent variable	independent variable	Chi-sq	df	Prob.
D(LNZS)	D(LNPGDPM)	16.90109	1	0.0000
D(LNPGDPM)	D(LNZS)	5.124243	1	0.0000

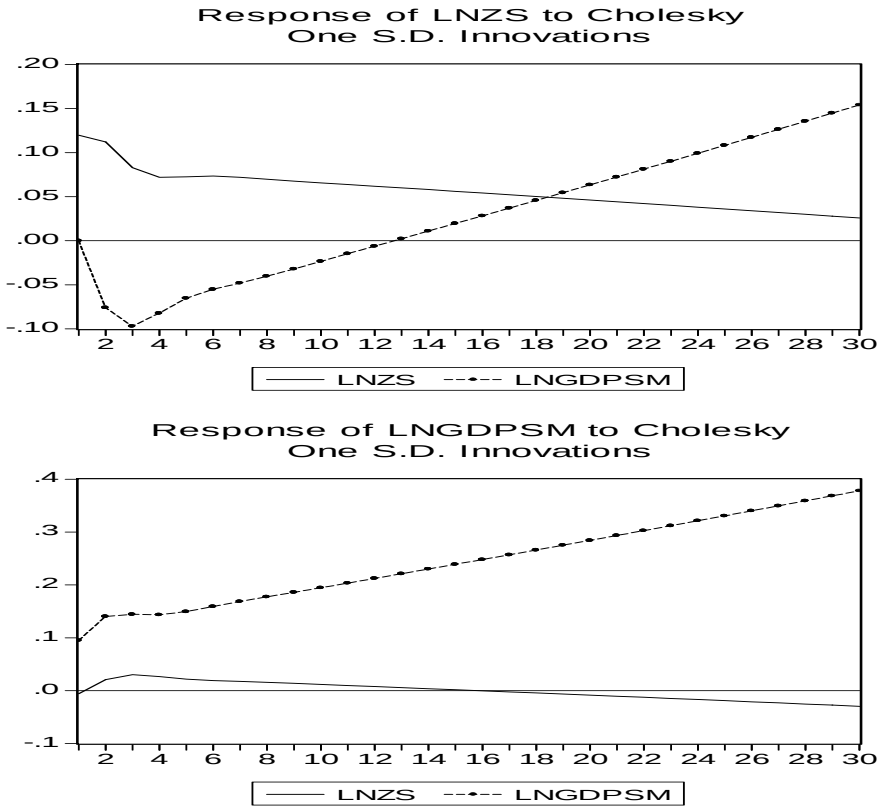

Figure 1. Generalized impulse response function of LNZS and LNPGDPM