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Dynamic Effects of the Chinese GDP and Number of Higher Education Based on Cointegrating[1]

L'ÉTUDE DES EFFETS DYNAMIQUES DU PIB CHINOIS SUR L'ÉDUCATION SUPÉRIEURE BASÉE SUR LA COINTÉGRATION

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Abstract: This study's objective was to the issue for the impact between regular higher education scale and GDP in China. We integrate Unit Root Test, Cointegration Test, Vector Error Correction Model (VECM), Variance Decomposition, etc. The sample is to use the annual data of GDP and number of Students Enrollment of Regular Institutions from 1952 to2004. Empirical results show that there is co-integration relation between GDP and number of Students Enrollment of Regular Institutions and economic growth can affect higher education scale and the contribution of education to economic growth is increasing gradually. To achieve good interaction between higher education and economic growth, the advice is that make scientific policy of regular higher education scale's expansion.
Key Word: Gross Domestic Product (GDP); Granger causality test; Vector Error Correction Model; Cointegration Test; number of Students Enrollment of Regular Institutions

Résumé: L'objectif de cette étude était d'examiner l'impact entre l'échelle de l'éducation supérieure et le PIB en Chine en utilisant test de racine unitaire, test de cointégration, modèle vectoriel de correction d'erreurs (MVCE),décomposition des écarts, etc. L'échantillon utilisé sont les données annuelles du PIB et le nombre des étudiants inscrits dans les institutions universitaires de 1952 à 2004. Les résultats empiriques montrent qu'il y a une relation de co-intégration entre le PIB et le nombre des étudiants inscrits dans les institutions universitaires, que la croissance économique peut affecter l'échelle de l'éducation supérieure et que la contribution de l'éducation à la croissance économique est en en train d'augementer progressivement. Pour obtenir une bonne

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interaction entre l'éducation supérieure et la croissance économique, les auteurs conseillent d'établir une politique scientifique de l'expansion régulière de l'échelle de l'éducation supérieure.

Mots-clés: Produit intérieur brut (PIB); test de causalité de Granger; Modèle vectoriel à correction d'erreur; test de cointégration; le nombre des étudiantes inscrits dans les institutions

1. INTRODUCTION

Foreign scholar Schultz expounded the concept, investment and formation ways of human capital, and the key role of human capital in economic growth systematically in 1990, and pointed out that education was the main way in forming human capital (Theodore, 1990). Yan Wang (2003) and so on measured human capital stock in China from 1978 to 1999, and then applied the Douglas function to test the data during this time. The results showed that the rapid accumulation of human capital had significant contribution to the economic growth and welfare improvement and total factor growth in gross domestic product still played an important role (WANG & YAO, 2003). Paul Glewwe and Hanan G. (2004) taking Vietnam for an example studied the extent of restrictions of household wealth in developing countries to investment in education, used the function of economic growth to study the relationship between wealth in the Vietnamese family and education needs and found that between wealth and educational needs there was a strong positive correlation (Paul & Hanan, 2004).

Chinese scholar Cai Zeng-zheng (1999) used the data of the world's 194 countries and regions to study the contribution of education in 1965-1990 to economic growth. First, he modeled all the functions and spillover effects of education and then estimated their contributions to economic growth. The main findings showed that the contribution of education to economic growth was tremendous and substantive, not only the spillover effect was positive but also quite substantial; The education sector comparing with the rest of the economy had low productivity; The role of Education to economic growth in the process of economic development displayed weak at first, then strong and a little of abating at last (CAI, 1999). Ye Mao-lin, Zheng Xiao-qi, Wang bin (2003) argued that education played an important role in economic growth, which was an important factor in promoting economic growth; Economic growth, in turn, could support the education and contribute to its development. "Both show dialectical correlation and form a virtuous circle." They in the point of the contribution of education to economic growth analyzed and recognized this dialectical relationship (YE et al., 2003). Wang Yan-chao (2007) used 1978-2004 years data to analyze the relation between China education and the economy growth. The results showed that government education expenditure which characterized total level of the national education played a significant positive role in China's economic growth, the function of the primary education to our economy was not remarkable, the function of the secondary education and the higher education was extremely remarkable. Among them, the function of secondary education was remarkably for positive, but the function of higher education was negative (WANG, 2007). Guo Lin, Che Shi Yi (2009) used total factor productivity method to analyze the impact of higher education in Beijing. They argued that the higher education and fixed assets investment were significantly promoting economic growth of Beijing so they should continue to play the advantage of higher education in Beijing, promote the change from outside to inside, take moderate-scale fees and promote charge diversity (GUO &CHE, 2009).

Considering empirical analysis methods, Wang Yu, Jiao Jian-ling (2005) investigated the relationship between human capital and economic growth of China based on the co-integration analysis and causality method. The results showed that there were long-term co-integrations between the variables. At the same time, the popularity of the compulsory education and growth of the rate of labor force with higher education had significantly promoted economic growth. The economic growth, in turn, drove the progress of middle and higher education enterprise to a great extent. But, there were still many problems that should be disposed of, such as insufficient investment in education by our government and imbalanced allocation of investment in the education levels and geographical regions. All these could cause low utility of education investment (SONG, 2003). Shi Ping (2007) analyzed higher education and economic growth based on the fifty-three years data (1952-2004). The conclusion was: there was no cointegration relation between these

two factors, which means there was no long term equilibrium relation. After liberation, the development of higher education of Shaanxi was mainly promoted by human factors, not by self-development. The scale of Shaanxi higher education development had unnoticeable effect on the stock of human resources and economic development. Granger cause and effect test showed that the economic growth of Shaanxi province and higher education, especially regular higher education, gradually had resumed their inherent relations in the course of marketization since China's reform and opening policy, but still had not formed a virtuously interactive relation yet (WANG & JIAO, 2007). Sun Jing-shui, Xu Li-li (2008) used cointegration test and other econometric analysis, built ECM and got the results that Human Capital had strong effect on Economic Growth, and its output elasticity larger than the physical capital's. On the other hand, the number of labor had been saturation, so it was essential in improving the health of the people (SUN & XU, 2008).

In sum, there is a lack of the study of the correlation between GDP and higher education since the founding of the People's Republic. This paper integrates ADF Test, Johansen Cointegration Test, Granger Causality Test, Vector Error Correction Model (VECM) and Variance Decomposition to reflect the relationship between Higher Education scale and economic growth. We choose number of Student Enrollment of Regular Institutes as the index of Higher Education scale, and choose GDP to measure the country's economic condition for it not only can reflect economic indication of a country but also can reflect a nation's power and wealth.

2. EMPIRICAL PROCESS AND RESULTS

2.1 Variable descriptions and data resources

In empirical process the paper uses: (1) Real GDP (symbolized with Y), calculated by nominal GDP and GDP index (the base year is 1952) and the data are obtained from "New China's Fifty-five Years Statistical Materials Compilation"; (2) Number of Students Enrollment of Regular Institutions (symbolized with X) , also get the data from "New China's Fifty-five Years Statistical Materials Compilation". The data of both are annual data from 1952 to 2004.

To ease the data volatility, eliminate heteroscedastic phenomenon in time series and do not change the cointegration relationship, Granger causality and other existing relations between the two variables, we get the nature logs of the two variables symbolized as: LY, LX. In the study we mainly use software Eviews5.0. GDP involved in the paper refers to real GDP and Regular Institutes of Higher Education is abbreviated to Regular IHEs.

2.2 ADF test

To ensure that the stationary of time series and avoid spurious regression, we first conduct unit root tests. ADF test is used to judge whether the two series are stationary.

From Table 1 we can get LY and LX are both nonstationary time series, but first difference of them are stationary, so LY and LX are integrated of order one or marked as LY～I（1）, LX～I（1）.

Table 1: Results of ADF Test

Variable	Type (C,T,N)	ADF statistic	Critical Value			Conclusion
			1%	5%	10%	
LY_t	（C,T,2）	-1.688323	-4.152511	-3.502373	-3.180699	Nonstationary
D（LY_t）	（C,T,1）	-5.618975	-4.152511	-3.502373	-3.180699	Stationary
LX_t	（C,T,2）	-1.886573	-4.152511	-3.502373	-3.180699	Nonstationary
D（YY_t）	（C,T,1）	-4.449619	-4.152511	-3.502373	--3.180699	Stationary

(C: intercept term； T: trend term； N: lag order; The test is based on SIC criterion）

3. GRANGER CAUSALITY TEST

In order to reveal the causal relationship between number of Student Enrollment of Regular IHEs and GDP in China, Granger Causality test is employed first. For the time series {Xt} and {Yt} according to Granger's definition, if the past value of Xt comparing with the past value of Yt can better improve the prediction of Yt , then it is called that Xt Granger cause Yt.

$$Y_t = \sum \alpha Y_{t-1} + \sum \beta_j X_{t-j} + \varepsilon_t \left(1 \le i \le p, 1 \le j \le q\right) \quad (1)$$

If and only if $\beta_j = 0$, X does not Granger cause Y.

Before Granger causality test the time series must be stationary, so we did unit root test to each variable. The result is LX and LY are both integrated of order one, so we need first difference of two variables.

Table 2: Results of Granger causality test

		D(LX) and D(LY)							
Lag order		1	2	3	4	5	6	7	8
Null hypothesis	DLX does not Granger cause DLY	0.26317	0.81470	0.36712	0.34025	0.24536	0.03674	0.01283	0.02264
	DLY does not Granger cause DLX	0.04708	0.16522	0.18277	0.15989	0.03716	0.17427	0.03582	0.00562

In table 2, when lag order is 7 the value of P is less than 0.05, then null hypothesis is rejected, so DLX and DLY are the Granger cause with one another. We can declare that Student Enrollment of Regular IHEs and GDP in China have mutual influences with each other in the long term.

4. COINTEGRATION TEST

Since LY and LX are non-stationary time series, we can not use traditional econometric theory to build the model. To this end, the Cointegration theory and vector error correction model (abbr. VECM) of modern econometrics are used to study the long-term and short-term dynamic equilibrium between GDP and number of Student Enrollment of Regular IHEs.

Table 3: Results of Lag Length Criteria test

Lag Length	LogL	LR	FPE	AIC	SC	HQ
0	-118.4406	NA	0.576599	5.125133	5.203863	5.154760
1	49.32592	314.1161	0.000543	-1.843656	-1.607467	-1.754777
2	68.18946	33.71357	0.000289	-2.476147	-2.082499*	-2.328015
3	72.98808	8.167853	0.000280	-2.510131	-1.959023	-2.302745
4	81.26880	13.39011*	0.000234*	-2.692289*	-1.983722	-2.425651*
5	84.23729	4.547475	0.000247	-2.648395	-1.782369	-2.322504
6	88.21239	5.751203	0.000250	-2.647336	-1.623850	-2.262191

Johansen cointegration test of vector auto-regressive (abbr. VAR) model is set up to test the co-integration relationship between LY and LX. Before Johansen cointegration test we should determine the order of VAR model. Generally using the lag length criteria test to determine the lag orders (p) (as shown in Table 3). AIC and FPE in Order 4 are the smallest and SC in Order 2 is the smallest, but the

optimal lag order of VAR is 4 judging by LR. For the lag order of co-integration test is that of first difference of variables so it is equal to the optimal lag order of unconstrained VAR model minus one, then the lag order of co-integration test is 3.

In the condition that sequences have mean and cointegration equations have intercepts, from table 4 we know that for the null hypothesis that there is no cointegration relationship, the trace statistic (31.87108) and the maximum eigenvalue statistic (25.06787) are both greater than the critical value of 5% confidence level, so both reject the null hypothesis; For the null hypothesis that there is at most one cointegration relationship, the trace statistic (6.803210) and the maximum eigenvalue statistic (6.803210) are both less than the critical value of 5% confidence level, so both accept the null hypothesis. Therefore, in the 5% significance level, there is only one cointegration relationship between LY and LX, that is, in the study there is a long-term equilibrium relationship between two variables.

Table 4: Results of Johansen cointegration test

Variables group	eigenvalue	Trace statistic	5% critical value	Max-eigen statistic	5% critical value	No, of CEs
LY and LX	0.400458	31.87108	20.26184	25.06787	15.89210	None *
	0.129634	6.803210	9.164546	6.803210	9.164546	At most 1

According to the normalized cointegrating coefficients, cointegrating equation is as shown:

$$LY=0.372380LX+2.747849 \quad (2)$$

(0.37164) (1.72220)

Estimated standard deviations are in parentheses of the model. There is a long-term equilibrium relation between number of Student Enrollment of Regular IHEs and GDP. The coefficient of LX is positive so they have a positive correlation. Specifically, when number of Student Enrollment of Regular IHEs changes 1%, there is a positive change of 0.3724 in GDP.

5. VECTOR ERROR CORRECTION MODEL (VECM)

We need to test the stationary of the residual before building VECM. The results are shown in Table 5, the ADF value of residual Et is less than the critical value in 5% significance level, which indicates the residual Et is stationary, and therefore Et can be taken as the error correction term to create a vector error correction model (VECM).

Table 5: Results of ADF Test for Residual

Variable	Type	ADF statistic	Critical value			conclusion
	(C,T,N)		1%	5%	10%	
E_t	(0,0,3)	-2.324928	-2.613010	-1.947665	-1.612573	stationary

As we already verified there is a long-term equilibrium relationship between LY and LX and there is a cointegration equation, so a VECM will be established next. For the lag order of VECM is that of first difference of variables so it is equal to the optimal lag order of unconstrained VAR model minus one, then the lag order of VECM is 3. VECM chooses the form that sequences have mean and cointegration equations have intercepts. Estimated results are seen in Table 6.

CointEq1=CointEq2=LY(-1)-0.372308LX(-1)-2.747849 are error correction terms, which reflect the deviation extent of LX to LY from long-term equilibrium in the short term. Coefficients of CointEq1 and CointEq2 describe the direction and speed of LY and LX adjusting to the long-run equilibrium level when LX deviates from the long-term equilibrium for disturbance. As can be seen from Table 6, the error correction coefficient of LY and LX are positive, with positive adjustment function, indicating number of Student Enrollment of Regular IHEs and GDP have a rapid growth trend and the adjustment of GDP is greater. In addition, from the restrictive VECM we can see that the delayed impact is more significant in the rear terms and the coefficients are also larger.

Figure 1 shows the response process of LY for LX's impulse, which is the response process of GDP from number of Student Enrollment of Regular IHEs' impulse. The response is instability in previous years

and rises to 0.1% in the seventh year, which indicates the response of LY shocked by LX has an increasing trend.

Table 6: Estimated Results of VECM

Error Correction:	D(LY)	D(LX)
CointEq1	0.024912	0.007288
	[5.27114]	[0.49086]
D(LY(-1))	0.332042	0.169412
	[2.32211]	[0.37711]
D(LY(-2))	-0.258873	0.670355
	[-1.75227]	[1.44427]
D(LY(-3))	-0.330073	-0.620522
	[-2.28807]	[-1.36914]
D(LX(-1))	-0.030490	0.844739
	[-0.63269]	[5.57950]
D(LX(-2))	0.068142	-0.343909
	[1.15815]	[-1.86046]
D(LX(-3))	-0.087172	0.027926
	[-1.86961]	[0.19064]

(Statistics are within [ ])

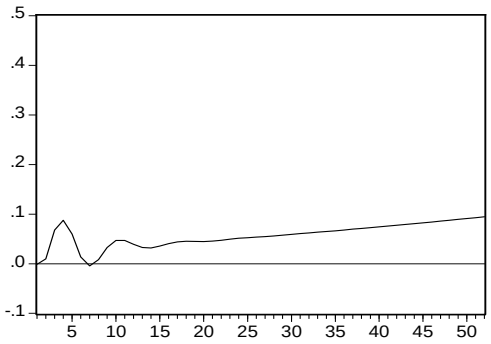

Figure 1: The Impulse Response of LY from LX

Applying variance decomposition method to decompose the variance of LY in different forecast periods, is to decompose the variances of GDP in 10-steps into the contribution rate of itself and LX. Results are shown in Table 7.

Table 7: Results of Variance Decomposition of LY

	S.E.	LX	LY
1	0.065962	0.002690	99.99731
2	0.111526	0.610192	99.38981
3	0.138582	0.605019	99.39498
4	0.148907	1.690296	98.30970
5	0.157262	5.669244	94.33076
6	0.169371	12.36958	87.63042
7	0.184932	17.45498	82.54502
8	0.201133	19.90567	80.09433
9	0.216264	21.13167	78.86833
10	0.230106	22.55757	77.44243

From the results of variance decomposition, the growth of LY can be explained by itself in the forecast periods from 100% felling to 77.44%, while LX can explain from 0% to 22.56%. As can be seen, number of Regular IHEs' contribution to economic growth has been steady improving.

CONCLUSIONS

Number of Student Enrollment of Regular IHEs (LX) and GDP (LY) are all nonstationary time series, but first difference of them are stationary and there is a long-term equilibrium relationship. Specifically, number of Student Enrollment of Regular IHEs (LX) has positive impact on GDP (LY).

In recent years GDP and number of Regular IHEs are both increasing rapidly, of which Regular IHEs scale has significant influence on GDP in the long term. In addition, number of Student Enrollment of Regular IHEs is also impacted by economic growth.

In view that the contribution of education to economic growth is gradually increasing, we should focus on the accumulation and transformation of human resources to human capital and then economic growth can be built on the basis of long-term stability. Ultimately the good interaction between higher education and economic growth will be realized.

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