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Research on the Coordinated Development of Higher Education and Regional Economy based on Co-integration Theory

-- A Case Study of Shanghai

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Abstract

The coordinated development of higher education and regional economy can be studied by establishing long-term stable relationship model, endogenous rectification mechanism and testing interaction. Based on the Co-integration theory, this paper selects data of the number of students in ordinary colleges and universities and the regional GDP in Shanghai from 1978 to 2015, creating Co-integration equations, establishing error correction models, and conducting Granger causality test. After conducting the empirical test, it is found that there is a clear coordination between higher education and regional economic growth. And for the short-term fluctuations, spontaneous correction control can be returned to the long-term equilibrium state, but the contribution rate of higher education to regional economic development still needs to be improved.

Keywords

Higher Education; Regional Economy; Co-integration Analysis; Error Correction Model; Granger Causality.

1. Introduction

As the focus of educational economics research, the relationship between economy and education has been favored by scholars. Generally speaking, the level of higher education will increase with the improvement of regional economic level. The more developed the region is, the higher the level of higher education will be. Since the enrollment expansion of colleges and universities in 1998, the scale of higher education in Shanghai has also been rapidly improved. The number of colleges and universities has been increasing, and higher education has entered the stage of mass development. At the same time, with the increasingly strong dependence of social economy on knowledge, the development cycle of high-tech has been shortened, and the society has gradually stepped into the era of knowledge economy. As one of the important driving forces to promote scientific and technological progress and economic development, higher education plays an indispensable key role. Based on this, this paper selects the number of students in Colleges and universities and GDP data in Shanghai from 1978 to 2015, and based on the Co-integration theory of dynamic econometrics, makes an empirical study on the interaction between higher education and regional economy, as well as the differences between their short-term and long-term relations, so as to provide certain reference for the development of higher education in Shanghai.

2. Review of Research Status

On the role of education in promoting economic growth, many scholars at home and abroad have done relevant research in this field, and achieved a lot of results. In the theory of human capital put forward by economists Schultz [1] and Becker [2], they select the dual perspectives

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of education and economic development, comprehensively and systematically investigate the interactive relationship between education development and economic growth, laying a foundation for the research on the relationship between education and economy. In addition, Schultz [3] and Danielson [4] also proposed Schultz's economic growth margin analysis method and Danielson economic growth factor analysis method to measure the contribution rate of education to economic growth.

In China, Lang Yongjie [5], Zhang genwen and Huang Zhibin [6] estimated the contribution rate of higher education to economic growth in Shanxi, Jiangsu and Anhui provinces by using Cobb Douglas production function model. The study found that although the overall development speed of higher education is relatively fast, its contribution rate to economic growth is relatively low. Yan Yuduo, Zhao Shukuan et al. [7] Based on the Denison factor analysis method, selected the data from 1991 to 2008, calculated and found that the contribution rate of China's higher education to economic growth showed an upward trend, with a faster growth rate, but there was a big gap compared with developed countries. Hu Yongmei and Xue Haiping [8] established the regression model of economic development level and higher education scale of countries with different income levels. Through analysis, it was concluded that under the current economic development level of China, the scale of higher education should not continue to expand.

On the whole, the research on the relationship between higher education and economic growth at home and abroad mainly focuses on the macro level of the country, while the research on the specific regional level is still relatively small, and mainly focuses on the research on the impact results, and the research on the impact mechanism also involves less, especially on the short-term and long-term elasticity of economic growth and higher education.

Based on this, taking the time series data of Shanghai from 1978 to 2015 as an example, this paper uses the Co-integration theory to construct the theoretical model of higher education scale and regional economic development level, avoiding the "pseudo regression" problem that may be caused by the least square method, and aiming at the long-term Co-integration, influence mechanism, causality and long-term elasticity of the number of students and GDP in Colleges and universities Based on the empirical analysis of the short-term elasticity, this paper puts forward some suggestions on the development of higher education in Shanghai.

3. Research Methods and Data Processing

3.1. Research Method

In the theory of dynamic econometrics, we can use Co-integration analysis, error correction model, Granger causality test and other methods to study the equilibrium relationship and related effects between non-stationary variables. Co-integration refers to two or more non-stationary time series formed by linear combination of stationary time series, which shows that there is a long-term equilibrium relationship between these economic variables, and any short-term deviation of variables will eventually return to the long-term equilibrium. Co-integration theory was first proposed by Engle and Granger in 1987. That is, if there is a Co-integration relationship between variables, the short-term disequilibrium relationship between them can always be expressed by an error correction model, as shown in formula (1).

$$\Delta Y_t = \text{lagged}(\Delta Y, \Delta X) - \lambda ecm_{t-1} + \mu_t \ (\lambda > 0) \quad (1)$$

The change of Y is affected by the change before X and Y and the degree of disequilibrium in the previous period. At t-1, when Y is greater than its long-term equilibrium solution, $-\lambda ecm_{t-1}$ is negative, which makes ΔY_t decrease; when Y is less than its long-term equilibrium solution, -

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λecm_{t-1} is positive, which makes ΔY_t increase. λecm_{t-1} reflects the control of long-term non-equilibrium error on short-term change.

Compared with other regression models, the use of difference item in error correction model eliminates the false regression problem and multi-collinearity problem caused by variable trend factors. The introduction of error correction item can also retain the influence of variable level information on dependent variables. The Co-integration analysis of higher education and regional economy, and the establishment of error correction model, can verify the long-term equilibrium relationship between them, and measure the adjustment range of short-term fluctuation approaching to long-term equilibrium.

3.2. Data Processing

In general, the measurement of the development level of higher education can be divided into two levels: scale and quality. However, the quality index is not objective enough and its comparability cannot be determined. Therefore, when studying the coordination between higher education and regional economic development, some scholars choose to use quantitative indicators such as the scale of higher education to measure the development level of higher education. This paper selects the data of the number of college students (ST) and gross domestic product (GDP) of Shanghai from 1978 to 2015 to empirically study the coordination relationship between higher education and regional economy. In order to reduce the volatility and heteroscedasticity of the data, this paper makes a logarithmic treatment of the data, which are respectively recorded as ln ST and ln GDP. The specific data are shown in Table 1.

Table 1: data of ST and GDP in Shanghai from 1978 to 2015

Year	ST (Ten thousand)	GDP(Billion)	Year	ST (Ten thousand)	GDP(Billion)	Year	ST (Ten thousand)	GDP(Billion)
1978	5.06	272.81	1991	11.69	893.77	2004	41.57	8165.38
1979	6.74	286.43	1992	11.95	1114.32	2005	44.26	9365.54
1980	7.67	311.89	1993	13.10	1519.23	2006	46.63	10718.04
1981	9.11	324.76	1994	14.04	1990.86	2007	48.49	12668.89
1982	8.39	337.07	1995	14.41	2518.08	2008	50.29	14276.79
1983	7.87	351.81	1996	14.79	2980.75	2009	51.28	15287.56
1984	8.99	390.85	1997	15.38	3465.28	2010	51.57	17436.85
1985	10.79	466.75	1998	16.51	3831.00	2011	51.13	19539.07
1986	11.77	490.83	1999	18.63	4222.30	2012	50.66	20558.98
1987	12.25	545.46	2000	22.68	4812.15	2013	50.48	22264.06
1988	12.82	648.30	2001	28.00	5257.66	2014	50.66	24068.20
1989	12.61	696.54	2002	33.16	5795.02	2015	51.16	25659.18
1990	12.13	272.81	2003	37.85	6762.38			

Source: Shanghai Statistical Yearbook, 1979-2016.

4. Econometric Analysis: Based on Shanghai Data from 1978 to 2015

4.1. Stationarity Test: Stability Test of Variable Series

The number of college students and GDP is an important part of macroeconomic data, which may be non-stationary, which leads to the instability of the residual sequenceμt produced by the model, which makes the correlation test invalid and leads to the pseudo regression problem. Therefore, the stability of time series data is tested before Co-integration analysis. Firstly, the linear trend of time series of each variable is obtained, as shown in Figure 1. As can be seen from Figure 1, the time series of ln GDP and ln ST have obvious increasing trend and there is multi-collinearity, so there may be strong correlation.

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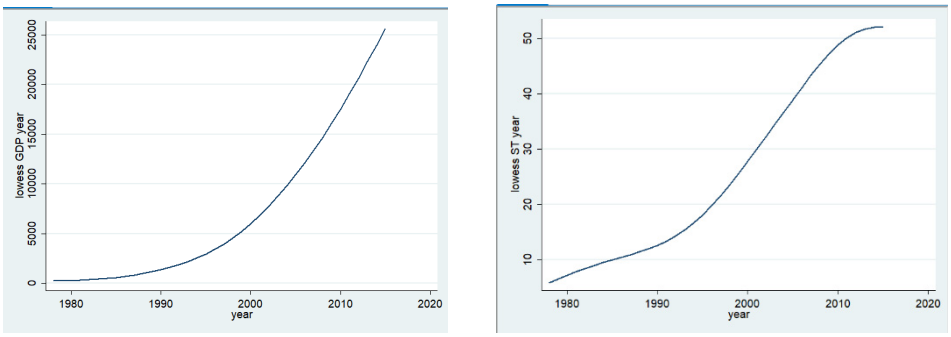

Figure 1: linear trend of ln GDP and ln ST series

In order to make the analysis results more reliable, the stationarity test is carried out on the series of college students and GDP. The unit root test method is used, and the ADF test method is specifically used. When the test results show that the sequence is stable, the conclusion that the sequence is stable can be made, otherwise it is not stable. The test results obtained by state 14.0 are shown in Table 2.

Table 2: ADF test results of sequences

Variable Sequence	Test Value (C, T, L)	Critical Value (P value)	Conclusion
ln GDP	-1.396(C, T, 1)	-3.211 (10%)	unstable
△ln GDP	-2.708(C,0,0)	-2.617 (10%)	stable
ln ST	-1.764(C, T, 3)	-3.218 (10%)	unstable
△ln ST	-3.769(C,0,1)	-3.675 (1%)	stable

Note: △ln GDP and △ln ST respectively represent the first-order difference of ln GDP and ln ST series; in (C, T, L), C is the unit root test including intercept, T is including time trend, L is the included lag order; C or T is 0, which does not include intercept or time trend; the lag order of ADF test method is judged according to AIC and SC information criterion.

It can be seen from Table 2 that the ADF test values of ln GDP and ln ST series are -1.396 and -1.764 respectively, which are both greater than the critical value of 10% significance. Therefore, the original series accepts the assumption of unit root. Since the series ln GDP and ln ST show a linear trend, a first-order difference is made on the two series, and then the difference series is tested by ADF. The test results show that the ADF test value of the first-order difference series of ln GDP is less than the critical value of 10% of significance; the ADF test value of the first-order difference series of ln ST is less than the critical value of 1% of significance, so the null hypothesis is rejected, namely accept the null hypothesis that there is no unit root, which means that the first difference sequence of ln GDP and ln ST is stationary.

4.2. Co-integration Test: Detection of Long-term Stable Relationship of Factors

Although the series of the number of students in ordinary colleges and universities and the series of regional GDP are non-stationary, they still have the possibility of Co-integration, that is, they may have a long-term stable relationship. From the results of the stationarity test, ln GDP and ln ST are both first-order single integrals, and Co-integration analysis can be done. Because it is a non-stationary variable with the same single integral order, the Engle-Granger two-step method is used to test the Co-integration relationship. First, use ordinary least squares regression (OLS) to regress the two variables to obtain the regression model; then, perform stationarity test on the residual of the regression equation. If the residuals of the regression equation are stable, these variables are said to be co-integrated. Using the software stata14.0, the Co-integration regression equation is estimated, as shown in formula (2):

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$$\ln GDP=1.780+2.037\ln ST \quad (2)$$
$$(0.282)\ (0.092)$$

Among them, R^2=0.932, F=493.23, DW=0.1864, and the t-test results are in parentheses. Use DW statistics to test the autocorrelation of the error term in (1). Given DW=0.1864 and α=0.05, there is only one explanatory variable in the regression formula, and the corresponding d_L=1.26, because DW=0.1864<1.26, according to the discriminant rule, the error term has serious autocorrelation.

In order to eliminate the autocorrelation problem of the error term, this paper adds an appropriate lag term. According to the LR statistics, AIC criterion and SC criterion selected by the optimal lag period of the VAR model, the optimal lag period is 3. The Co-integration test adds a vector Co-integration constraint to the unconstrained model, so the Co-integration test lag order is the optimal lag order of the unconstrained VAR model minus 1, that is, the Co-integration test lag order is 2, and ln ST and the distributed lag model of ln GDP is shown in formula (3):

$$\text{Ln GDP}=0.10+0.28\ln ST-0.49\ln ST_{t-1}+0.24\ln ST_{t-2}+1.66\ln GDP_{t-1}-0.69\ln GDP_{t-2} \quad (3)$$
$$(1.92^{*})\ (1.88^{*})\quad (-2.04^{**})\quad (1.87^{*})\quad (12.99^{***})\quad (-5.14^{***})$$

Note: ***, **, and * are significant at 1%, 5% and 10% respectively.

Among them, R^2=0.9991, DW=2.206, and the autocorrelation is eliminated. Through the stability test of the residual, the t value is -6.502, which is less than $ADF_{0.01}$=-3.682, that is, the residual sequence is a stationary sequence. Therefore, it is considered that ln GDP and ln ST are (1,1)-order cointegrated, and (3) is their long-term stable equilibrium relationship.

Long-term elasticity means that one variable changes in a certain proportion relative to another variable from a long-term perspective. It is calculated by $Ex,y=\Delta y/\Delta x \bullet x/y$. Therefore, from 1978 to 2015, the long-term elasticity of economic growth with respect to the number of students in colleges and universities is (0.28-0.49+0.24)/(1-1.66+0.69)=0.894 (calculated using a value accurate to four decimal places) , Which means that in the long run, for every 1% increase in the number of Shanghai higher education students, Shanghai's GDP will increase by 0.894% accordingly.

4.3. Error Correction Model: Endogenous Correction Mechanism Test

After verifying the Co-integration relationship between economic variables, it is obtained that there is a long-term static and stable relationship between economic variables, but this stable relationship may be out of balance in the short-term. At this time, an error correction model (ECM) is needed to connect the short-term behavior and long-term value, establish an error correction mechanism to correct the unbalanced part, as shown in formula (4):

$$\Delta\ln GDP=0.323\Delta\ln ST-0.306\Delta\ln ST_{t-1}+0.976\Delta\ln GDP_{t-1}-0.435ecm_{t-1} \quad (4)$$
$$(2.34^{**})\quad (-2.15^{**})\quad (12.26^{***})\quad (-2.18^{**})$$

Note: ***, **, * means significant at 1%, 5%, and 10% respectively.

Among them, R^2=0.8969, DW=1.7941, in the error correction model (4), the regression coefficients of each variable have passed the significance test, and the error correction term coefficient (-0.435) is negative, in line with the reverse correction mechanism. The fluctuation of GDP is affected by short-term fluctuations and unbalanced errors. The short-term fluctuations are reflected by the difference term of each variable, and the unbalanced errors are

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reflected by the Co-integration equation. Short-term fluctuations include three parts: Δln ST, Δln ST_{t-1}, and Δln GDP_{t-1}. For each change of one unit of the three, the current year's economic growth changes by 0.323, -0.306 and 0.976 units accordingly. The coefficient of unbalanced error is -0.435, which means that the unbalanced error of the previous year has made a reverse correction to the current year's Δln GDP at a rate of 43.5%. It also shows that Shanghai's GDP is affected by many factors. The balanced relationship between the number of students in education and GDP has a moderate self-correction ability for the current unbalanced error adjustment. When short-term fluctuations cause the long-term equilibrium relationship to deviate, the error correction mechanism can correct this deviation and return the relationship between the scale of Shanghai's higher education and the regional GDP to the long-term equilibrium relationship.

4.4. Granger Causality Test: Factor Interaction Analysis

From the results of the Co-integration test, we can get that there is a Co-integration relationship between higher education and regional economic development. But to explore the specific role of higher education and economic development in this long-term equilibrium relationship, it is also necessary to conduct a Granger causality test on ln GDP and ln ST. The lag period is selected from 1 to 6, and Granger causality test is performed on ln GDP and ln ST. The results are shown in Table 3. It can be seen from Table 3 that when the lag period is 2 or 4, there is no causal relationship between ln GDP and ln ST. But starting from the fifth period, the p value is less than 5%, that is, at least at the 95% confidence level, it can be considered that ln ST is the Granger cause of ln GDP, but ln GDP is not the Granger cause of ln ST. Therefore, Granger causality shows that the number of students in colleges and universities ln ST is the Granger cause of economic development ln GDP, but the growth of GDP does not necessarily lead to the increase in the number of students in colleges and universities.

Table 3: Granger relationship test of ln GDP and ln ST

Lag period		1 year	2 year	3 year	4 year	5 year	6 year
ln ST is not a Granger reason for ln GDP	chi2 statistic	4.018	5.905	11.754	7.952	47.967	30.848
	Significance level	0.045	0.052	0.008	0.093	0.000	0.000
ln GDP is not a Granger reason for ln ST	chi2 statistic	0.590	0.823	3.863	2.659	7.165	9.818
	Significance level	0.442	0.663	0.277	0.616	0.209	0.133

5. Conclusion and Inspiration

In the study of the Co-integration relationship between Shanghai's GDP and the number of students in ordinary colleges and universities, it is found that there is a clear coordination relationship between regional economic growth and the scale of higher education. It can also be seen from the Granger causality test that the students The number is the Granger reason for regional economic development. From the analysis of the results of the error correction model, it can be seen that there is an error adjustment mechanism from short-term imbalance to long-term equilibrium adjustment between the number of students in ordinary colleges and universities in Shanghai and Shanghai's regional GDP. When the period deviates from the long-term equilibrium point, the error adjustment mechanism will be adjusted and corrected by 43.5% in the next period to make it return to the long-term equilibrium state.

It can also be found from the research that the long-term utility is more significant than the short-term utility in the promotion of the scale of Shanghai's higher education to regional economic growth. From the perspective of elasticity coefficient, the short-term elasticity of

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regional GDP to the number of students in colleges and universities is 0.323, while the long-term elasticity is 0.894, and the long-term elasticity is 0.571 higher than the short-term elasticity. It can also be seen from the Granger causality test that when the lag period is 5 to 6, the causality is very significant (P value is less than 0.05).

Generally speaking, the contribution of education development in different countries and regions to regional economic growth is not the same. For example, the contribution rate of education in developed countries such as the United Kingdom and the United States to economic growth is 2. The contribution rate of 0.894 to economic growth is still relatively low. This may be due to the fact that Shanghai's educational output is not flexible enough and the education time is not long enough. Therefore, while Shanghai pays attention to increasing the speed of economic development, it also needs to accelerate the pace of absorbing high-quality talents, promote the integration of production, education and research, and increase the contribution rate of higher education to economic growth.

At the same time, it can be seen from the research results that although the scale of higher education may not have a significant effect on economic growth in the short term, it is very obvious in the long run. Over the years, Shanghai's GDP has maintained a steady growth, but the demand for talents is also expanding, and high-quality talents under higher education will have a dynamic and long-term impact on regional economic growth. Therefore, It is particularly important to ensure the investment in higher education, set up a reasonable human resource strategy, and improve the employment system as soon as possible. Only by truly transforming education investment into human capital can we better serve economic construction and truly play the role of education in promoting economic growth.

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