An Empirical Research on the Relations between Higher

Education Development and Economic Growth in China

Xiaohong Wang

Tianjin Polytechnic University, Tianjin 300160, China

Tel: 86-22-2452 8322 E-mail: zhhk@tjpu.edu.cn

Shufen Wang

Tianjin Foreign Studies University, Tianjin 300204, China

E-mail: wangsf@tjfsu.edu.cn

Abstract

With the development of science and technology, education is playing a more and more important role in economic growth. Therefore, the relations between higher education development and economic growth have been a hot issue for a long time. By employing the relevance analysis model in the empirical analysis on the role of higher education in economic growth, this article is expected to give some reference to the harmonious development of higher education and economic growth in China.

Keywords: Higher education development, Economic growth, Index system

As a quite significant part in education system, higher education is closely related to economy. Since reform and opening up, great progress has been made in China's higher education, and therefore, has promoted its economic growth. However, a series of problems have been caused accordingly. As a result, great importance has been attached to a subjective analysis on the relations between higher education development and economic growth due to its significance in laying down China's higher education strategies.

1. The Construction of Index Systems for the Relations between Higher Education Development and Economic Growth

1.1 The Construction Principles

Higher education development, as well as economic growth, is a process in which many factors interact with each other and is characterized by non-linear dynamics. Inspite of uncertainty, the relations between the two really exist. In the construction of the index systems in this article, the systematic, scientific, comparable, concise and operable principles have been followed. In addition, because the time sequence data employed in our analysis will help to reflect the development speed, speed indexs will not be taken into consideration in our quantitative analysis. Besides, those indexs causing difficulty in quantitative analysis have been excluded. Those indexes with less importance will not be emphasized in our analysis. Taking the above principles into our consideration, we have established the index systems for the relations between higher education development and economic growth.

1.2 The Construction of the Index System for Higher Education Development

This index system aims at measuring the level of higher education in China in an overall way, monitoring and evaluating higher education development as well as some influencing factors based on overall, exact and subjective knowledge about the operation and situation of China's higher education system. Starting with three aspects including scale, efficiency and financial support, we have established the index system for higher education development at three levels. It is shown in Table 1.

1.3 The Construction of the Index System for Economic Growth

This index system aims at learning about and evaluating the specific situation of China's economic development since reform and opening up as well as its development trends. Based on the scale, capacity, structure, quality of economic growth, together with income and expense, we have established the index system for economic growth at five levels, as shown in Table 2.

2. An Introduction to the Model for the Empirical Analysis on the Relations between Higher Education Development and Economic Growth

Higher education development and economic growth interact with each other in a united system, which is characteristic of

incomplete information, diversified principles and grey relations between information and result. Based on the specific nature of their relations, we have established the model as follows.

First, we establish the natural number sequences X(t) and Y(t):

$$X_i(t_k) = \{X_i(t_1), X_i(t_2), \ldots\ldots, X_i(t_n)\}$$
$$Y_j(t_k) = \{Y_j(t_1), Y_j(t_2), \ldots\ldots, y_j(t_n)\}$$
$$i, j, k = \{1, 2, \ldots\ldots, N\}$$

Then we can get the correlation coefficients of the two sequences at t_k:

$$R_{ij}(t_k) = \frac{1}{1 + \left| \dfrac{\Delta x(t)}{\sigma_{xi}} - \dfrac{\Delta y(t)}{\sigma_{yj}} \right|}, \quad t_k \in T \tag{1}$$

In it: $\quad \Delta x(t) = x(t+1) - x(t) \quad , \quad \Delta y(t) = y(t+1) - y(t)$

$$\sigma_{xi} = \sqrt{\frac{1}{N} \sum_{k=1}^{N} (x_{ik} - \bar{x}_i)^2} \quad , \sigma_{yj} = \sqrt{\frac{1}{N} \sum_{k=1}^{N} (y_{jk} - \bar{y}_j)^2}$$

Then we can figure out the average relevance degree of every X and Y index at t_k:

$$R_{ij} = \frac{1}{N-1} \sum_{k=1}^{N-1} R_{ij}(t_k) \tag{2}$$

When judging the relevance degree between Y_j and X_i, the following standard can be followed: if $0 < R_{ij} \leq 0.35$, it is a low relevance degree; if $0.35 < R_{ij} \leq 0.65$, it is a medium degree; if $0.65 < R_{ij} \leq 1$, it is a high degree.

The above model has following features: (1) compared with other relevance analysis between functions and regression analysis, this model employs less data and provides high resolution, hence avoiding different indexes' orders of magnitude and dimensions and having favorable expansibility; (2) it is convenient to process the data on the computer because this model doesn't require standardization and reference point of the original data; (3) the evaluation result will not be influenced by zero and negative values in the original sequences; (4) both sequences have effect when we process and figure out relevance values with filtration. (Julong Deng, 1993)

3. The Calculation of the Model for the Relations between Higher Education Development and Economic Growth in China

The samples adopted in this research are the time sequence data on China's regular higher education level from 1998 to 2005, which come from the National Statistics Announcement for the Execution of Education Funds and China's Statistics Annual in 2006 on China Education News Net (http://www.jvb.com.cn/jyz/jytj/).

Based on the established analysis model and the index systems for higher education development and economic growth, we can deal with the following calculation course: First, put the data obtained from Table 1 and 2 into Formula (1) and figure out $R_{ij}(t)$ of Y(t) and X(t) at t moment with SPSS14.0, that is to say, altogether 780 ($10 \times 13 \times (7-1)$) values for $R_{ij}(t)$ can be got with 10 indexes of X(t) and 13 indexes of Y(t). Then, with Formula (2), we can get the average relevance degree of X and Y indexes from 1998 to 2005, with altogether 130 values (Shufen Wang, 2007). Last, according to the judgment standards for relevance degree, the relevance degree between higher education development and economic growth is shown in Table 3.

It is shown in Table 3 that in all the indexes, strong, medium and weak relevance degrees take respectively 42.3%, 57.7% and 0 in the whole. In the higher education development indexes with strong relevance, X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10} appear respectively 10, 10, 10, 10, 0, 10, 3, 0, 1, 1 time(s), taking 18.18%, 18.18%, 18.18%, 18.18%, 0, 18.18%, 5.45%, 0, 1.82%, 1.82% in all the 55 indexes with strong relevance. Among the indexes with medium relevance, X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10} appear respectively 3, 3, 3, 3, 13, 3, 10, 13, 12, 12 times, taking 4%, 4%, 4%, 4%, 17.3%, 4%, 13.3%, 17.3%, 16%, 16% in all the 75 indexes with medium relevance. However, there is no index with weak relevance.

Finally, we can get the average relevance coefficient $\bar{R} = 0.6890$ by dividing the total relevance values of Y(t) and X(t) at all the moments by the total number. The relevance degree between higher education development and economic growth in China can be shown generally.

4. Analysis and Evaluation of the Relations between Higher Education Development and Economic Growth in China

The following conclusions can be reached with the above empirical research:

(1) Generally speaking, the relations between China's higher education development and its economic growth are strong in-

phase and positive ones. Among all the 130 relevance values between 10 indexes of higher education development and 13 ones of economic growth, there are 55 values with strong relevance and 75 with medium one.

(2) The higher education development indexes with strong relevance have the greatest influence on economic growth. Among them, X_1, X_2, X_3, X_4 and X_6 play particularly important roles in the influences on economic growth.

(3) Government's financial support should be put more importance to due to its wide influences on economic growth indexes. In all the higher education development indexes with medium relevance, X_8, X_9 and X_{10} appear most frequently, taking 17.3%, 16%, 16% in the total with medium relevance. Therefore, its significant role in economic growth can not be neglected.

(4) In scale, efficiency and financial support of higher education, the first has the greatest influence on economic growth while the last has the least. In terms of the average influences economic growth has on higher education development, the average relevance degrees the 13 economic growth indexes have with X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10} are respectively 0.8271, 0.8273, 0.8226, 0.8091, 0.5675, 0.7901, 0.6056, 0.5165, 0.5848, 0.6010. To be more specific, in the three aspects of higher education including scale (X_1, X_2, X_3), efficient (X_4, X_5, X_6, X_7) and financial support (X_8, X_9, X_{10}), the average relevance degrees are respectively 0.8257, 0.6931, 0.5674. Thus, the constant expansion of higher education scale has obvious influences on economic growth.

(5) Higher education development has particularly important influences on social productivity, hence calling for great attention. In terms of the average influence degree all the higher education development indexes have on economic growth, the average relevance degrees between 10 higher education development indexes and Y_1, Y_2, Y_3, Y_4, Y_5, Y_6, Y_7, Y_8, Y_9, Y_{10}, Y_{11}, Y_{12}, Y_{13} are respectively 0.7068, 0.7170, 0.7347, 0.7437, 0.7395, 0.5376, 0.5796, 0.7523, 0.5422, 0.7302, 0.7522, 0.7179, 0.7329, among which Y_8 gets the greatest influence.

5. Conclusion

To sum up, higher education development and economic growth interact with and influence each other. In order to ensure the harmonious and sustainable development of China's economy, the government is expected to make greater investment in higher education. In addition, a virtuous cycle in which one promotes the other's development should be formed by expanding the scale and improving the efficiency of higher education. In addition, I hope this article will provide some theoretical bases for the Chinese government's laying down policies in accordance with the harmonious development between higher education development and economic growth as well as offer support for China's great efforts to enhance the effect of the "relying on science and education to rejuvenate the nation" strategy.

Table 1. The index system for higher education development

Higher education development (X)	Scale	The number of colleges and universities X_1
		The number of students in colleges and universities (10 thousand) X_2
		The number of faculty members in colleges and universities X_3
	Efficiency	The percentage of professional teachers in the whole faculty in colleges and universities (%)X_4
		The percentage of teachers with an advanced title in professional teachers in colleges and universities (%)X_5
		The percentage of teachers with at least a master's degree in professional teachers in colleges and universities(%)X_6
		The ratio of students to teachers in colleges and universities(%)X_7
	Financial support	The percentage of budgetary education funds in financial expense (%)X_8
		The average budgetary education funds for college and university students (yuan) X_9
		The average budgetary public funds for college and university students (yuan) X_{10}

Table 2. The index system for economic growth

Economic growth (Y)	Scale	The total amount of GDP (billion yuan)Y_1
		The total investment in fixed assets (billion yuan) Y_2
	Capacity	Per capita GDP (yuan)Y_3
		Per capita financial income(yuan/person)Y_4
		Per capita financial expense(yuan/person)Y_5
	Structure	The contribution rate of secondary industry(%)Y_6
		The contribution rate of tertiary industry(%)Y_7
	Quality	All-personnel labor productivity (yuan/person)Y_8
		The percentage of the number of employees in secondary industry in the total of employees (%)Y_9
		The percentage of the number of employees in tertiary industry in the total of employees (%)Y_{10}
	Income and expense	Town dwellers' per capita dispensable income(yuan)Y_{11}
		Rural dwellers' per capita net income(yuan)Y_{12}
		The general level of consumption(yuan/year)Y_{13}

Table 3. The correspondence table for the relevance indexes between higher education development and economic growth

The correspondence table for strong relevance indexes	
Y_1	X_1, X_2, X_3, X_4, X_6
Y_2	X_1, X_2, X_3, X_4, X_6
Y_3	X_1, X_2, X_3, X_4, X_6
Y_4	$X_1, X_2, X_3, X_4, X_6, X_7$
Y_5	$X_1, X_2, X_3, X_4, X_6, X_7$
Y_6	
Y_7	X_9, X_{10}
Y_8	X_1, X_2, X_3, X_4, X_6
Y_9	
Y_{10}	X_1, X_2, X_3, X_4, X_6
Y_{11}	X_1, X_2, X_3, X_4, X_6
Y_{12}	X_1, X_2, X_3, X_4, X_6
Y_{13}	$X_1, X_2, X_3, X_4, X_6, X_7$
The correspondence table for medium relevance indexes	
Y_1	$X_5, X_7, X_8, X_9, X_{10}$
Y_2	$X_5, X_7, X_8, X_9, X_{10}$
Y_3	$X_5, X_7, X_8, X_9, X_{10}$
Y_4	X_5, X_8, X_9, X_{10}
Y_5	X_5, X_8, X_9, X_{10}
Y_6	$X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10}$
Y_7	$X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8$
Y_8	$X_5, X_7, X_8, X_9, X_{10}$
Y_9	$X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10}$
Y_{10}	$X_5, X_7, X_8, X_9, X_{10}$
Y_{11}	$X_5, X_7, X_8, X_9, X_{10}$
Y_{12}	$X_5, X_7, X_8, X_9, X_{10}$
Y_{13}	X_5, X_8, X_9, X_{10}

References

Deng, Julong. (1993). *Grey Control System*. Huazhong Technology University Press.

Lin, Yong. (2003). *An Empirical Research on the Harmonious Development of Education and Economy in China*. Exploring Education Development. 2003(6):13-16.

Zhan, Zhengmao. (2004). *Study on the Synthetic Appraising Index of Chinese Higher-Dducation Development Level*. Science of Science and Management of S.&.T. 2004(9):128-132.

Wang, Shufen. (2007). *Applied Statistics*. Beijing University Press & China Forestry Publishing House.