Study on Relation between Adjustments of Hierarchy of Higher Education and Economic Growth of China since the Reform and Opening-up

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Abstract. Hierarchy of higher education of China has been accommodated again and again to meet needs of economic growth of the country. As higher education was provided to more and more people, whether such adjustments adapted to needs of economic growth became a hot topic in recent years. This dissertation, based on previous studies, gives a historical presentation of the relation between adjustments of hierarchy of higher education and economic growth of China since the Reform and Opening-up, and proposes relevant theoretical hypotheses, with principal component analysis and regression analysis of the relation. It is concluded that, since the Reform and Opening-up, there has been a significant nonlinear correlation between adjustments of hierarchy of higher education and economic growth of China, and the adjustments have gone through a process of gradual modulation from poor adaption to good adaption as to structure, scale and proportion.

Keywords: Higher Education, Hierarchy, Economic Growth

1. Introduction

Higher education industry of China has soared since the reform and opening-up, with a swift leap from the phase of elite education to that of mass education. Both scale of each level and total scale of higher education of China top the world. The hierarchy of China’s higher education has been accommodated again and again to meet needs of economic growth, as China's economic growth pattern changes. Unfortunately, a structural imbalance between poor employment of graduates and difficult recruitment by enterprises kept growing in recent years. Many scholars, as well as the rest of Chinese society, think that enforcement of structural reform of China’s higher education for the leap from elite education to mass education is not satisfactory, the current hierarchy of China’s higher education fails to match the soaring scale of higher education, and what’s more, education development and economy development fail out of balance (Zong et al., 2011). In previous studies, Chinese and foreign scholars mostly concentrated on contributions of higher education and each level thereof to economic growth, in addition to qualitative researches on the hierarchy of higher education and economic growth. Empirical studies on the relation between adjustments of hierarchy of higher education and economic growth were very few, and were limited to the period of time since enrollment expansion in 1999. Therefore, this study is aimed at the relation between adjustments of hierarchy of higher education and economic growth of China since the start of the reform and opening-up, and reaches a conclusion of some reference significance for adjustments of the same hierarchy.
2. Literature Review and Hypotheses

2.1 Hierarchy of Higher Education

Hierarchy of higher education is composed of different levels with different requirements, showing how these levels are related to and combined with each other (Pan, 1996). As the reform and opening-up goes further and as required by economic development, the demand for skilled talents has grown gradually and higher vocational education has developed swiftly. Higher vocational education and junior college education together are called higher technical and vocational education in China, which is currently at the level of junior college. In this dissertation, the hierarchy of higher education is composed of three levels, namely, the higher technical and vocational education (hereinafter referred to as junior college education), undergraduate education and postgraduate education, in reference to the education indicator system of UNSECO (ISCED-2011), which is now the most authoritative and widely-accepted one in the world.

All the countries in the world are similar in orientation of and training objectives for talents at different levels of higher education: the level of junior college education is for students to learn in-depth knowledge of specialties and develop necessary professional abilities, emphasizing skills and application; the level of undergraduate education is for students to learn in-depth knowledge of and research specialties and to develop wisdom, moral values and application ability in addition to learning of common knowledge, emphasizing both knowledge and application; the level of postgraduate education is for students to learn and research academic theories and application thereof, to explore their profound meanings and to promote cultural development, emphasizing training of talents oriented for academic research and sophisticated technology research (Ji, 2005).

2.2 Hierarchy of Higher Education and Economic Growth

2.2.1. Impacts of Hierarchy of Higher Education on Economic Growth

Time and costs spent by different individuals on education vary among different levels of higher education. Such expenditures are a kind of investment which expects material and immaterial rewards in the future, known as human capital investment (Blaug, 1967). Orientation of and training objectives for talents vary remarkably from one level to another of higher education, which actually improves different systems of ability, knowledge and quality of human capital and meets diverse demands arising from economic growth for differently-targeted talents who engage themselves in social labor. Human capital coming from different levels of higher education is the key for scientific and technical progress. The level of postgraduate education directly boosts research and development of sophisticated technology; the level of undergraduate education promotes innovation and inheritance of knowledge and application of technology; and the level of junior college education helps application of technology to production. Hence, thanks to human capital from different levels of higher education, technical level and productivity are improved, relative costs of industries are decreased, and resources are redistributed in a more rational way. During the redistribution of resources, human capital transfers among industries by means of stock transfer and redistribution of resources, which promotes gradual upgrading of industrial structure, drives change of growth pattern and keeps improving and adjusting economic structure (Zheng, 2009).
2.2.2 Impacts of Economic Growth on Hierarchy of Higher Education

Impacts of economic growth on hierarchy of higher education are mainly of two kinds: (1) Direct impacts. When economy grows, the nation invests more in higher education, enhancing both scale and quality of each level of higher education. Besides, as economy keeps growing, per capita income, ability to pay and expenditures on human capital investment also increase accordingly, showing a greater demand for education and a greater scale of each level of higher education. What’s more, hierarchy of higher education develops upwards gradually, as required for employment competition. (2) Indirect impacts. In the process of economic growth, social reproduction requires different structures of labor force and different proportions of various kinds of labor force in different stages. Upgrading of industrial structure during economic growth requires higher and higher knowledge and technical levels in each industry, accompanied with a change from labor-intensive pattern to knowledge-intensive and skill-intensive patterns, which causes changes in structure of labor factors. Since education background, technical level and innovation ability of laborers will become the core of industrial structure, changes in both economic growth pattern and industrial structure require adjustments of the hierarchy of higher education. Ye (2004) conducted a contrastive analysis of GDP per capita, industrial structure and employment structure of countries like the U.S.A., Japan and Germany, based on S.S.Kuznets and Rostow’s theory of stages of economic growth. He has concluded that economic growth decides social demands for labor forces of different levels, and thus decides the hierarchy of higher education in the same period. Therefore, different levels of higher education can boost economic growth by enhancing human capital and driving technical progress, upgrading of industrial structure and changing of growth pattern. In turn, economic growth impacts and decides the hierarchy of higher education. Previous studies have shown that, economy is boosted only when education structure is rational and is hindered when the structure is underdeveloped or overdeveloped. Similarly, the hierarchy of higher education drives economy growth only when it adapts to the upgrading of industrial structure, scientific and technical progress and consumption structure, etc., or else resources will be wasted.

2.2.3 Adjustments of Hierarchy of Higher Education and Changes in Economic Growth of China since the Reform and Opening-up

The hierarchy of higher education of China has been adjusted again and again while higher education has developed swiftly in the country since the reform and opening-up. In 1978, total new enrollment of junior college and graduate students were 402,000, and new enrollment of postgraduate was 10,700 (NBSC, 2012), where ratio of new enrollments at junior college, graduate and postgraduate levels was 31: 66: 3. In 1979, new enrollment of undergraduates was enlarged but both new enrollment and proportion of junior college students were low, when the ratio of new enrollments at the three levels was 14: 83: 3. Since the length of undergraduate schooling exceeded that of junior college, great shortages of talents emerged in various kinds of trades while an urgent need for junior college students arose from economic development. The government published relevant policies to enlarge proportion of new enrollment at junior college level and kept exploring vocational education. After that, the proportion of undergraduate enrollment dropped gradually, that of junior college enrollment increased gradually and that of postgraduate enrollment rose slowly. From 1993 to 1999, the proportion of new enrollment at undergraduate level soared while that at junior college level declined gradually. In 1999, a policy of enrollment expansion was enforced for higher education, and the government invested more in building of higher technical and vocational education. The proportion of new enrollment at junior college level in total new enrollment went up year by year in the
following years, and even exceeded that at undergraduate level in a certain period of time. In 2006, the ratio of new enrollments at the three levels was 50:43.2: 6.8. As independent universities developed and postgraduate education improved, the ratio of the three levels of higher education changed again. The ratio of new enrollments at the three levels was 44.1: 48.3: 7.6 in 2011. Figure 1 shows changes in the proportion of new enrollment at each of the three levels. When it comes to scale and proportion of enrolled students, according to Figure 2, the overall trend since the reform and opening-up is that the proportion of enrolled undergraduate students fell while the proportions of junior college students and postgraduate students rose year by year; among others, the junior college level saw the largest growth while the postgraduate level grew slowly and stably.

As to economic growth, China’s economy has developed swiftly since the reform and opening-up. National GDP and GDP per capita, which was RMB 364.52 billion and RMB 381 in 1978, reached RMB 47,156.4 billion and RMB 35,181 respectively in 2011, counted at prices at that time (NBSC, 2012). Figure 3 shows growth rate of total number of students enrolled for higher education and economic growth rate of China during this period. Before enrollment expansion in 1999, the growth rate of total number of students enrolled for higher education dropped to troughs of wave in 1982, 1990 and 1996, and the economic growth rate also dropped to troughs of wave in 1981, 1990 and 1999. After enrollment expansion in 1999, the growth rate of total number of students enrolled for higher education reached the peak of wave in 2001 before falling continuously, while economic growth rate remained mostly stable. Structural proportions taken by the primary, the secondary and the tertiary industries in total output values were 28.2%, 47.9% and 23.9% respectively in 1978. In the process of economic development, the proportion of the primary industry slipped gradually, that of the secondary industry remained mostly unchanged and that of the tertiary industry rose gradually at a stable pace. The same structural proportions changed to 10.0%, 46.6% and 43.4% respectively in 2011, where the industrial structure was shifting gradually from “secondary, primary and tertiary” to “secondary, tertiary and primary”, shown as in Figure 4. Industrial structure has been optimized gradually.

In a previous empirical study by Liu (2004) on scales of higher education and economic levels of different countries around the world, it has been concluded that there is a relatively strong staged linear relation between scale of higher education and economic development, with GDP per capita of China being USD 5,432 in 2011. In an empirical study by Chi et al. (2010) about the relation between the hierarchy of higher education and economic development from 1998 to 2007, which was the key period of swift development of China’s higher education, it has been concluded that in that period it was a significant linear relation, changes in different levels of higher education adapted basically to economic development. Based on research of changes in adjustments of hierarchy of higher education and economic growth since the reform and opening-up in this dissertation, the following hypotheses were proposed:

H$_1$: There is a significant correlation between adjustments of hierarchy of higher education and economic growth of China since the reform and opening-up.

H$_2$: Adjustments of hierarchy of higher education of China adapted to economic growth of the country since the reform and opening-up.
3. Research Design

3.1 Method
Since indices for variable of hierarchy of higher education and variable of economic growth differ in dimensions and multicollinearity may exist, impacts of the differences in dimensions and multicollinearity must be eliminated by selection of study method. Besides, linear correlation analysis cannot be used directly, because it is not certain yet whether the relation is a linear correlation before any conclusion comes out of this study. For such reasons, in this study, principal component analysis was used first, where principal components was extracted from a correlation matrix, synthesis score models for the hierarchy of higher education and for economic growth was built and synthesis indices thereof were calculated; then a scatter diagram was drawn based on the synthesis indices of the two groups of variables and regression analysis was performed accordingly, to identify further relation and to verify the two hypotheses mentioned above.

3.2 Selection of Measurement Indices

3.2.1 Adjustments of Hierarchy of Higher Education
In previous studies, changes in the hierarchy of higher education were mostly measured by the numbers of graduates, new enrollment and enrolled students at each level of higher education over years. Chi (2010) and some other scholars thought that, the number of new enrollment at each level should be used as a measurement index because it could better reflect social demands and direction of national policies, and the changing trend of the hierarchy of higher education should be measured by the ratio of junior college level to undergraduate level and the ratio of postgraduate level to undergraduate level. However, in this study, flow, stock and structural proportion of each level of higher education were taken as indices and used in conjunction with the changing trend of each level to reflect all the changes in the hierarchy of higher education. Hence, the number of new enrollment (x₁ for junior college, x₂ for undergraduate and x₃ for postgraduate) and structural proportion taken by it (x₄ for junior college, x₅ for undergraduate and x₆ for postgraduate) and the number of enrolled student (x₇ for junior college, x₈ for undergraduate and x₉ for postgraduate) and structural proportion taken by it (x₁₀ for junior college, x₁₁ for undergraduate and x₁₂ for postgraduate) at each of the three levels over years should be selected as measurement indices to reflect adjustments in the hierarchy of higher education.

3.2.2 Economic Growth
In previous studies, economic growth was measured mostly by indices which were internationally accepted, including gross indices like GDP and GNP and per capita indices thereof, total government revenue, proportions of added values of the three industries in GDP, urban per capita disposable income and rural per capital disposable income, etc. (Chi,2010). Taking data availability into consideration and referring to relevant domestic studies, this study measured economic growth by national GDP (y₁), GDP per capita (y₂), output values of the three industries (y₃ for the primary industry, y₄ for the secondary and y₅ for the tertiary) and their proportions in GDP (y₆ for the primary industry, y₇ for the secondary and y₈ for the tertiary).

3.3 Data sources
Data about the hierarchy of higher education came from previous publications including Statistical Communique on National Educational Development and China Statistical
Yearbook, Educational Statistics, and China Education and Research Network. Proportions taken by new enrollments and enrolled students at the three levels of higher education were calculated by the Author based on relevant data. Data about economic growth came from China Statistical Yearbook 2012.

4. Data Processing and Analysis

4.1 Principal Component Analysis

Principal Component Analysis uses linear combination to convert a set (numbering p) of original variables in data into a set (numbering k) of new uncorrelated variables, i.e., k principal components. This method can be used to establish diverse synthesis indices with different variables of measurement units.

4.1.1 Synthesis Indices of Adjustments of the Hierarchy of Higher Education

Selected data about adjustments of the hierarchy of higher education were processed with Spss20.0. As a result, there were 2 principal factors with eigenvalues >1, and total variance explained is 95.127%. The following synthesis score models were derived from factor score coefficient matrix, weight of variance contribution and relevance principle:

\[ F_1 = 0.170ZX_1 + 0.188ZX_2 + 0.185ZX_3 - 0.129ZX_4 + 0.111ZX_5 + 0.030ZX_6 + 0.182ZX_7 + 0.190ZX_8 + 0.188ZX_9 - 0.054ZX_10 + 0.048ZX_11 - 0.007ZX_12 \]

\[ F_2 = -0.045ZX_1 - 0.071ZX_2 - 0.067ZX_3 + 0.275ZX_4 - 0.264ZX_5 + 0.114ZX_6 - 0.062ZX_7 - 0.074ZX_8 - 0.071ZX_9 + 0.214ZX_10 - 0.210ZX_11 + 0.161ZX_12 \]

Where, \( ZX_i (i=1, 2, ..., 12) \) were standardized variables of the indices of the hierarchy of higher education.

The synthesis score model of the hierarchy of higher education was worked out based on the weight of variance contribution (\( \lambda_i, i = 1, 2 \)):

\[ F = \frac{\lambda_1}{\lambda_1 + \lambda_2} F_1 + \frac{\lambda_2}{\lambda_1 + \lambda_2} F_2 \]

\[ = 0.7954 F_1 + 0.2046 F_2 \]

4.1.2 Synthesis Indices of Economic Growth

Similarly, a principal component analysis of selected data about economic growth was conducted with Spss20.0. As a result, there were 1 principal factor with eigenvalue >1, and total variance explained is 83.022%. The following synthesis score model was derived from factor score coefficient, weight of variance contribution and relevance principle:

\[ F = 0.148ZY_1 + 0.148ZY_2 + 0.150ZY_3 + 0.148ZY_4 + 0.147ZY_5 + 0.137ZY_6 + 0.071ZY_7 + 0.130ZY_8 \]

Where, \( ZY_i (i=1, 2, ..., 8) \) were standardized variables of the indices of economic growth.

4.2 Regression Analysis

Synthesis scores in each year were calculated with Spss20.0 and a scatter diagram based on \((x, y)\) was drawn as shown in Figure 5, according to the synthesis score models mentioned above. Obviously, the scatter diagram showed that it was a nonlinear relation. Curve fitting was performed with Spss20.0 to select a model which had the highest goodness of fit.
Results showed that cubic curve had the highest goodness of fit. Figure 5 is a curve fitting chart.

Cubic regression model:

\[ y = 0.239 + x - 0.842x^2 + 0.523x^3 \]

Shown as in Table 1, Table 2 and Table 3, multiple correlation coefficient (R) was as high as 0.976, R square was 0.952 and adjusted R square was 0.947. Values of F and probability from significance test also meant this model had a significant explanatory ability. Hence, a conclusion was drawn, saying that it was a significant nonlinear correlation between adjustments of the hierarchy of higher education and economic growth of China since the reform and opening-up according to curve fitting. \( H_1 \) was supported.

An auxiliary line \((y = x)\) was added in the Curve Fitting Chart, shown as the dotted line in Figure 5. Before 1992, all the points below the coordinates \((-0.57935, -0.68387)\) in 1991 gathered together under the dotted line, expressing such a geometrical meaning that development of higher education in China failed to meet needs of economic growth. After 1991, the points distributed above the dotted line, other than those for years from 2004 to 2006, saying that development of higher education boosted economic growth remarkably. From 2001 on, synthesis scores for the hierarchy of higher education turned from negative to positive, as the hierarchy was adjusted step by step. After that, the overall trend was good.

In fact, this just tells the exact status of adjustments of hierarchy of higher education and economic growth of China. China’s productivity was released further after the reform and opening-up in China but the hierarchy of higher education was extremely improper, calling for relevant adjustments to provide required talents for economic growth. Then the government issued a series of policies to expand education at junior college level and vocational education step by step. After Deng Xiaoping’s speeches during his tour to South China in 1992, status of socialist market economy was fixed further and economy developed fast, for which different levels of higher education provided various kinds of talents. The first round of merging and adjustment of colleges and universities since the reform and opening-up began in 1992, through which higher education management system was reformed in the principles of “co-building, adjustment, cooperation and merging” and specialties and levels were adjusted or merged, for the purpose of forming a better hierarchy of higher education for economic growth. Enrollment in colleges and universities was expanded in 1999, where the hierarchy of higher education was further adjusted by enhancing proportion of and investment in junior college level and strengthening postgraduate education. A large number of graduates, who were enrolled due to the expansion, graduated and worked as from 2001. Total human capital of the entire Chinese society increased, because of these graduates plus other talents trained at different levels of higher education over years. The synthesis score for the hierarchy of higher education turned from negative to positive. The curve fitting chart showed that, since the reform and opening-up, adjustments of the hierarchy of higher education of China had gone through a process of gradual modulation from poor adaption to good adaption. Accordingly, the relation between adjustments of hierarchy of higher education and economic growth was also a process of gradual modulation and adaption. Hence, \( H_2 \) was supported.

5. Conclusions

Higher education has developed fast in China since the reform and opening-up, where the hierarchy of higher education has been adjusted again and again to support economic growth. Major ways of adjustment were to enlarge the scale and proportion of education at junior college level, mainly higher vocational education at the later stage, and to stably
enlarge the proportion of education at undergraduate level. In this dissertation, adjustments of the hierarchy of higher education were measured by the scales and proportions of new enrollment and enrolled students at different levels of higher education while economic growth was measured by national GDP, GDP per capita, output values of the three industries and their proportions in GDP, then the synthesis score models were built via PCA and finally RA was conducted. It is concluded from this study that, since the reform and opening-up, there is a significant nonlinear correlation between adjustments of the hierarchy of higher education and economic growth of China as to scale and proportion, and this relation also manifests a process of gradual modulation and adaption. Results of such modulation are in line with opinions of Matin. Trow, a famous scholar: mass higher education should be focused on skills, just like higher vocational education is the focus of mass higher education in other developed countries. Therefore, at present, China must insist diversified development of education at levels of junior college, undergraduate and postgraduate, put more efforts in junior college education and expand postgraduate education stably, for the purpose of supporting the change of growth pattern and further boosting economic growth.
References


Appendices.

Figure 1. Proportion of New Enrollment at Each Level of Higher Education (1978~2011)

Figure 2. Proportion of Enrolled Students at Each Level of Higher Education (1978~2011)

Figure 3. Growth Rate of Total Scale of Higher Education and Growth Rate of GDP(1978~2011)
Figure 4. Structural Proportions of Three Industries (1978~2011)

Data source: www.stats.gov.cn

Table 1: Model Summary

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<th>R</th>
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<th>Adjusted R Square</th>
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The independent variable is x.

Table 2: ANOVA

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<tr>
<td>Total</td>
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<td>.231</td>
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The independent variable is x.

Table 3: Coefficients

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