ISSN 1749-3889 (print), 1749-3897 (online)
International Journal of Nonlinear Science
Vol.23(2017) No.1, pp.58-64

Research on Technology Variation Mechanism of Coordinated Development between Higher Vocational Education and Regional Economy

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(Received 3 November 2016, accepted 12 February 2017)

Abstract: Using the LGA model to analyze the technology variation of genovariation in the coordinated development between higher vocational education and regional economy, it reveals the variation mechanism is the independent innovation mechanism for the coordinated development between higher vocational education and regional economy. Original innovation, integrated innovation and secondary innovation are all realized through technology variation. Only through interaction between higher vocational education and regional economy and continuous gene variation, as technology, new active ingredients can be injected to the coordinated development of higher vocational education and regional economy.

Keywords: higher vocational education; regional economy; variation mechanism; technology variation

1 Introduction

With the transition of the world economy from the industrial economy to cyber-economy, the process of personnel training and technology innovation is increasingly networked and complex. Higher vocational education with higher vocational colleges as the main body and the enterprises as the mainstay of the regional economy are very difficult to complete the personnel training and technology innovation of a region by oneself. There is complementarity between them. There are genes to promote as well as factors to hinder the development. The practice of the coordinated development between higher vocational education and regional economy in China shows the existence of "fragmentation" phenomenon between higher vocational education and regional economy. They lack effective communication platform. Running system of higher vocational education is "closed single" and enterprises have been excluded from the higher vocational education system for a long time [1]. According to the biological evolution principle, higher vocational education and regional economy only through interaction to realize continuous genes variation, such as in technology, talent and culture, etc., new active ingredients can be injected to the coordinated development [2] − [12]. Research on the variation mechanism and its law of higher vocational education and regional economy coordinated development is the key to realize the coordinated development [13]. In this paper, we will focus on the study of technology variation of the variation mechanism.

2 Research Methods

2.1 The Characteristics of Coordinated Variation Between Higher Vocational Education and Regional Economy

Synergy, complementarity and heterogeneity are the characteristics of coordinated variation between higher vocational education and regional economy. Through active two-way flow between higher vocational colleges and enterprises, knowledge and technology achieve collaborative innovation. Cooperation between subject heterogeneity, which is one of the internal logic of higher vocational colleges and enterprises, is an important impetus for the higher vocational education and regional economy coordinated development[14][15]. The characteristics of coordinated variation reveals the methods

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IJNS.2017.02.15/947

that should be used in the process of study the coordinated variation law between higher vocational education and regional economy.

2.2 Latent Growth Analysis

Latent Growth Analysis, referred to as LGA, is to use the same subject received multiple measurements, analyze the size and type of the average change in potential traits within an individual, or analyze the differences of these changes among individuals.

According to SEM (Structural Equation Modeling) definition, LGA is a special case of the SEM average structure analysis or multi-level analysis (Multilevel models). In statistical and research design, LGA needs to meet six basic rules, five operational principles and four basic requirements.

(1) LGA needs to meet six basic rules[16]:

Firstly, the variance of all independent variables is the model parameter;

Secondly, all covariance between all independent variables is the model parameter;

Thirdly, all load capacity of factors connecting latent variables and related indicators is the model parameter;

Fourthly, all regression coefficient connecting predictive variables and criterion is the model parameter;

Fifthly, The variance and covariance between all dependent variables (or independent variables and dependent variables) are model parameters;

Sixthly, the measurement unit of each latent variable in the model must be set.

(2) LGA needs to meet five operational principles [17]:

Firstly,

$$Cov(X, X) = vAR(X)$$

Secondly, $Cov(aX + bY, cY + dU) = acCov(X, Z) + adCov(X, U) + bc(Y, Z) + bdCov(Y, U)$;

Thirdly,$Var(aX + bY) = a^2Var(X) + b^2Var(Y) + 2abCov(X, Y)$, if X, Y has relevance;

Fourthly,$Var(aX + bY) = a^2Var(X) + b^2Var(Y)$if X, Y correlation equals 0;

Fifthly,$Mean(aX \pm bY) = aMean(X) \pm bMean(Y)$.

(3) LGA needs to meet four basic requirements:

Firstly, at least to test more than three times at different time;

Secondly, the measured variables must have properties of isometric measurement at least;

Thirdly, each measurement must be measured in the same trait, not standardized;

Fourthly, all subjects accept measurement at each collection time point.

LGA mainly includes single factor LGA, double factor LGA, multi factor LGA and other forms. According to the characteristics of coordinated variation between higher vocational education and regional economy, and with the requirements of LGA in statistics and research design, this paper adopts double factor LGA to analyze the variation mechanism. The double factor LGA includes the analysis of measuring level factor and the change of shape factor, which is suitable for the analysis of the variation mechanism.

2.3 Data Sources

In sample selection, the research on the variation mechanism of higher vocational education and regional economy coordinated development is carried out in Jilin, Jiangsu , Henan and Shanxi Province in China and 300 samples were selected in these 4 provinces respectively. The survey issued a total of 1200 questionnaires. At the end of the survey, removing the invalid questionnaire which is a total of 309, because of data loss or information contradiction, a total of 891 valid questionnaires were taken back with the effective recovery rate of 74.25%.

As far as the sample is concerned, among the successful survey samples, 210 people are from Jilin Province, accounting for 23.57% of the total number of effective questionnaires;190 from Jiangsu, accounting for 21.32%;240 from Henan, accounting for 26.94%and251 from Shanxi, accounting for 28.17%.

The sample area structure and industry structure are basically consistent with the research hypothesis, this survey can be considered representative and can be used to study the variation mechanism.

3 Research Design

The technology variation model of higher vocational education and regional economy coordinated development is a kind of double factor LGA model. According to the growth rule of double factor LGA model, we measure the latent variable "higher vocational college technology" and "enterprise technology" respectively by comparing the technical variability in different years after higher vocational colleges and enterprises cooperation. In order to ensure the quality of research, the questionnaire was first investigated in 30 surveys. Test results show when the technical cooperation between higher vocational colleges and enterprises is 5 years, the research result are better. Use "technology variability in 1^{st} cooperation year", "technology variability in 2^{nd} cooperation year", "technology variability in 3^{rd} cooperation year", "technology variability in 4^{th} cooperation year" and "technology variability in 5^{th} cooperation year" to test the variation degree of "higher vocational college technology" and "enterprise technology". Five-point Likert scale was used to measure the variation degree in each year after higher vocational colleges and enterprises cooperation, as 1 point represents "smaller variation", 2 represents "small variation", 3 represents "moderate variation", 4 represents "large variation" ,5 represents "larger variation".

4 Model Construction

UT and ET are used to represent the latent variable "higher vocational college technology" and "enterprise technology"; $X_1X_2X_3X_4X_5$ are used to represent "technology variability in 1^{st} cooperation year", "technology variability in 2^{nd} cooperation year", "technology variability in 3^{rd} cooperation year", "technology variability in 4^{th} cooperation year", and "technology variability in 5^{th} cooperation year"; $H_1H_2H_3H_4H_5$ are used to represent the path coefficient of latent variable "higher vocational college technology" to measurement variable "technology variability in 1^{st} cooperation year", "technology variability in 2^{nd} cooperation year", "technology variability in 3^{rd} cooperation year", "technology variability in 4^{th} cooperation year" and "technology variability in 5^{th} cooperation year"; $I_1I_2I_3I_4I_5$ are used to represent the path coefficient of latent variable "enterprise technology" to measurement variable "technology variability in 1^{st} cooperation year", "technology variability in 2^{nd} cooperation year", "technology variability in 3^{rd} cooperation year", "technology variability in 4^{th} cooperation year" and "technology variability in 5^{th} cooperation year";

In the process of technology variability, the role of higher vocational colleges and enterprises is mutual. According to the definition of the double factor LGA model, If the "higher vocational college technology" to each measurement variable path coefficient is defined as initial value 1, i.e.$I_1 = 0 I_5 = 1$the technology variation LGA model of higher vocational education and regional economy coordinated development can be expressed as:

$$\begin{aligned} X_1 &= 1.0 * UT + 0 * ET + e_1 \\ X_2 &= 1.0 * UT + I_2 * ET + e_2 \\ X_3 &= 1.0 * UT + I_3 * ET + e_3 \\ X_4 &= 1.0 * UT + I_4 * ET + e_4 \\ X_5 &= 1.0 * UT + 1 * ET + e_5 \end{aligned}$$

Turn the above equations into matrix, we obtain:

$$\begin{bmatrix} X_1 \\ X_2 \\ X_3 \\ X_4 \\ X_5 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} + \begin{bmatrix} 1 & 0 \\ 1 & I_2 \\ 1 & I_3 \\ 1 & I_4 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} UT \\ ET \end{bmatrix} + \begin{bmatrix} e_1 \\ e_2 \\ e_3 \\ e_4 \\ e_5 \end{bmatrix}$$

According to the variance, covariance and average operation principle, we obtain:

$$Mean(X_1) = 1.0 * Mean(UT) + Mean(e_1)$$

As $Mean(e_1) = 0$so $Mean(X_1) = Mean(UT)$
While

$$Mean(X_5) = 1.0 * Mean(UT) + 1.0 * Mean(ET) + Mean(e_5), i.e.,$$

$$Mean(X_5) = Mean(X_1) + Mean(ET)$$

Then we obtain:$Mean(ET) = Mean(X_5) - Mean(X_1)$
In addition$Mean(X_2) = 1.0 * Mean(UT) + I_2 * Mean(ET) + Mean(e_2)$
So we obtain:

$$I_2 = \frac{Mean(X_2) - Mean(X_1)}{Mean(X_5) - Mean(X_1)}$$

$$I_3 = \frac{Mean(X_3) - Mean(X_1)}{Mean(X_5) - Mean(X_1)}$$

$$I_4 = \frac{Mean(X_4) - Mean(X_1)}{Mean(X_5) - Mean(X_1)}$$

By the same way, if the "enterprise technology" to each measurement variable path coefficient is defined as initial value 1, i.e.$H_1 = 0 H_5 = 1$then we obtain:

$$H_2 = \frac{Mean(X_2) - Mean(X_1)}{Mean(X_5) - Mean(X_1)}$$

$$H_3 = \frac{Mean(X_3) - Mean(X_1)}{Mean(X_5) - Mean(X_1)}$$

$$H_4 = \frac{Mean(X_4) - Mean(X_1)}{Mean(X_5) - Mean(X_1)}$$

By using Amos software to simulate the sample data, setting the higher vocational colleges as the initial value, we get the technology variation LGA model of higher vocational education and regional economy coordinated development (as Fig.1)

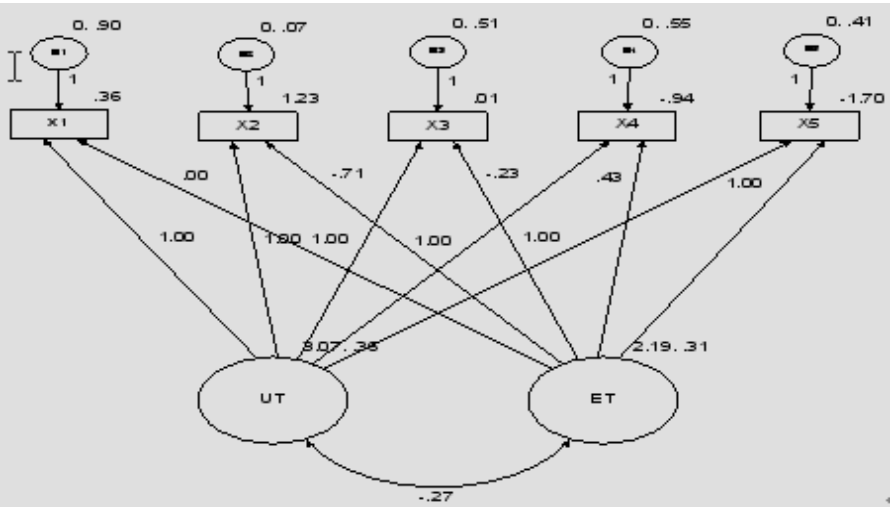

Figure 1: The technology variation LGA model of higher vocational education and regional economy coordinated development

By testing the model, $CMIN/DF = 2.17, NFI = 0.903, CFI = 0.918, RMSEA = 0.039$. The main fitting parameters have passed the test, which shows that technology variation model of higher vocational education and regional economy coordinated development we constructed has better goodness of fit.

5 Technology Variation Analysis

5.1 The Technology Variation Trends

Through the operation result of the technology variation LGA model of higher vocational education and regional economy coordinated development, we obtain that the average number of latent variable "ET" is 2.19, which means the average value of enterprise technology variation degree, and the amount of the variation is about 0.31. After the cooperation between higher vocational colleges and enterprises, the ratio of the change between the repeated measurement and the first measurement was -0.71, -0.23, 0.43, and 1, respectively.(as Table 1) The path coefficient data between enterprise technology and annual variation shows the direction of technology variation has changed after the 2^{nd} and 3^{rd} years' cooperation, while in the 4^{th} year, the technology variation still in the original direction(as Fig.2).

Table 1: Technology variation path coefficient of higher vocational education and regional economy coordinated development

Manifest Variable	sign	Latent Variable	Estimate	S.E.	C.R.	P
X1	$<---$	UT	1.000	— —	—	—
X1	$<---$	ET	.000	—	—	—
X2	$<---$	UT	1.000	— —	—	—
X2	$<---$	ET	-.708	.308	-2.295	.022
X3	$<---$	UT	1.000	— —	—	—
X3	$<---$	ET	-.235	.185	-1.767	.205
X4	$<---$	UT	1.000	— —	—	—
X4	$<---$	ET	.430	.129	3.324	***
X5	$<---$	UT	1.000	— —	—	—
X5	$<---$	ET	1.000	— —	—	—

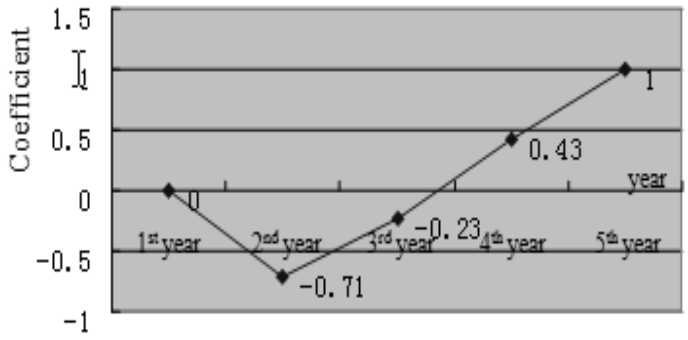

Figure 2: The technology variation trends of higher vocational education and regional economy coordinated development

The expected value of the technology variation of each year are as follows:

$$E(X_1) = 1 * E(Mean_{ut}) + E(Mean_{et}) * 0 \approx 3.07$$
$$E(X_2) = 1 * E(Mean_{ut}) + E(Mean_{et}) * (-0.71) \approx 1.52$$
$$E(X_3) = 1 * E(Mean_{ut}) + E(Mean_{et}) * (-0.23) \approx 2.57$$
$$E(X_4) = 1 * E(Mean_{ut}) + E(Mean_{et}) * (0.43) \approx 4.00$$
$$E(X_5) = 1 * E(Mean_{ut}) + E(Mean_{et}) * 1 \approx 5.26$$

The change trend of the expected value of each year's technology variation and the path coefficient of latent variable "enterprise technology" to each measured variable is basically the same. According to the design rules of technology

variation measurement index "five-point Likert scale", enterprise 1^{st} year's technology variation degree is moderate, 2^{nd} year's "small", 3^{rd} year's moderate, 4^{th} year's large, and 5^{th} year's larger.

Due to technology variation between higher vocational colleges and enterprises is mutual. If "enterprise technology" to each measurement variable path coefficient is defined as initial value 1, i.e. $H_1 = 0$,$H_5 = 1$ we found that the technology variation trend in higher vocational colleges is basically the same as that of enterprises.

5.2 Forms of Technology Variation

Technology is a kind of knowledge in nature. As to the form of knowledge, the technology variation between higher vocational colleges and enterprises is mainly manifested in two forms: the explicit technical variation and the implicit technical variation. The operation result of the technology variation LGA model of higher vocational education and regional economy coordinated development shows the coefficient between higher vocational college technology and enterprise technology is -0.267, which fully demonstrates the forms of technology variation is phase inverse in the process of technology variation.

The explicit technical variation is realized by explicit technical knowledge integration and implicit to be explicit. In the process of higher vocational education and regional economy coordinated development, technical knowledge higher vocational colleges offer to enterprises is mainly explicit which can be written in the drawings, CD-ROM, U disk and other media. The higher vocational colleges engage in technical research and development, in the process of which technical knowledge has two sources, one is from the other related technologies that have been formed, and the other is the technical needs of enterprises and users(as Fig.3). These two sources are not only an important basis but also an important driving force for technology variation in higher vocational colleges.

The implicit technical variation is realized by explicit technical knowledge socialization and explicit to be implicit. In the process of higher vocational education and regional economy coordinated development, technical knowledge enterprises offer to higher vocational colleges is mainly implicit which is creativity and demands of technology innovation and can't be written in the drawings, CD-ROM or other media. There are two channels for enterprises implicit technical knowledge sources: one is the socialization of user needs and the other is the original technology induced new demand. The above two sources are the important foundation and driving force of the enterprise implicit technical variation.

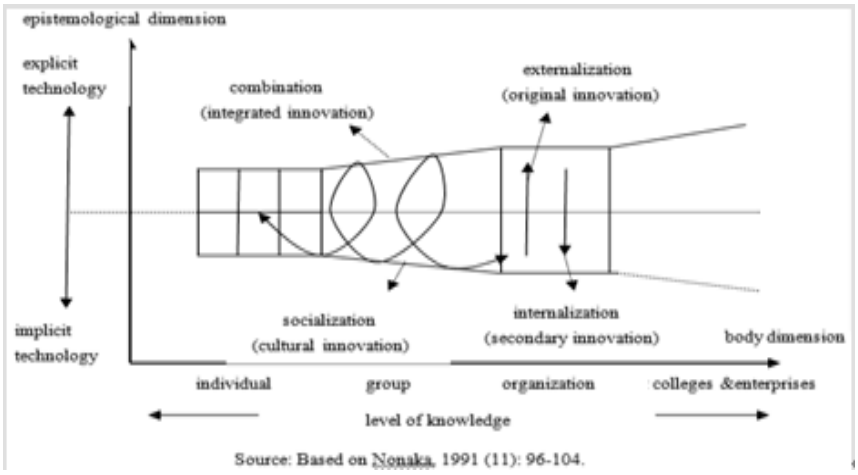

Figure 3: The technical variation model of higher vocational education and regional economy coordinated development

6 Conclusions and Prospect

In the process of higher vocational education and regional economy coordinated development, the result of technology variation is to cause technological innovation. Original innovation, integrated innovation and secondary innovation which are the main forms of independent technological innovation are all realized through technology variation.

Original innovation is the highest level of independent innovation. The original innovation of higher vocational technology is produced through enterprises implicit technical knowledge changing into higher vocational explicit technical knowledge. Product creativity and technical experts' repeated collision and integration of technical knowledge are the important condition for the original innovation. Therefore, the realization of the original innovation needs the deep cooperation between higher vocational colleges and enterprises.

Integrated innovation are the most common form of independent innovation. In the process of higher vocational education and regional economy coordinated development, in order to realize the integrated innovation, the higher vocational colleges and enterprises need not only integrate the explicit technical knowledge of each other, but also the relevant technical knowledge from other innovative subjects. On the integrated innovation between higher vocational colleges and enterprises, technical experts in higher vocational colleges and enterprises have their own good points of technical knowledge, that is, technical experts in higher vocational colleges stress theories, while technical experts in enterprises lay emphasis on application. So the combination of both is more conducive to the realization of integrated innovation.

Secondary innovation is the easiest form of independent innovation to implement. In the process of higher vocational education and regional economy coordinated development, in order to narrow the gap between the developed countries and regions, enterprises often import advanced equipment to absorb advanced technology embedded in the equipment to achieve innovation. How to understand the advanced equipment imported from the developed countries or regions and how to surpass through imports need cooperation between higher vocational colleges and enterprises. Deep cooperation promotes secondary innovation.

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