International Proceeding of Economics Development and Research
IPEDR vol.86 (2016) © (2016) IACSIT Press, Singapore

Research on the Structure Optimization of Regional Heterogeneous Human Capital

Wanming Chen, Shengyuan Wang[+]

College of Economics and Management, Nanjing University of Aeronautics & Astronautics, Nanjing, Jiangsu 210016

Abstract. This paper uses the differences of education level to measure the heterogeneity of human capital. Study on the cross-section data of the provincial area in 2013.Screen the heterogeneity human capital index for economic growth with stepwise regression method. The heterogeneous human capital and material capital, which has a significant effect on economic growth, is taking as the input index. Take economic growth as an output indicator. Analyze the efficiency of heterogeneous human capital in different regions with data envelopment analysis method. Determine the heterogeneous human capital structure adjustment direction based on the input redundant data. The research results show that the vast majority of the provinces in China are in the non DEA effective state because of heterogeneous human capital. Redundancy occurs mainly in the junior middle school education human capital. The path of optimizing the structure of human capital is to increase the investment of high school education (high school and secondary vocational education), and transfer the elementary human capital to the medium human capital.

Keywords: Human Capital, Heterogeneity,Structure Optimization

1. Heterogeneous human capital and its measurement

China is the world's second largest economy, but China's economic development has been in uneven phenomenon. The role of human capital in the process of economic development is no doubt, but the effect of the human capital on economic development is not the same, the marginal revenue of human capital is different. In the process of economic development, which human capital has played a role in promoting economic growth? What role is not obvious? How does the heterogeneity of human capital structure adjustment? These problems will be analyzed in this paper.

Human capital heterogeneity refers to the differences in the skills, education, and social status and so on. Human capital in different regions is different in quantity, quality and structure, so the marginal return of human capital is different in different regions. The classic literature on human capital has been a lot of argumentation.

The specialization of human capital promotes the division of labor and technological progress, improve the efficiency and realize the increasing scale returns (Schultz ，1961[1]；Becker，1985[2]).Heterogeneity of human capital, such as technological knowledge capital, has a marginal revenue increase, can generate revenue growth model (Lucas，1988[3]；Romer，1990[4]).

In the domestic research, heterogeneous human capital in different regions is generally measured by three methods: cost method, income method and education index method. The cost method is a measure of human capital, which is related to the development of human capital. For example, the human capital stock is calculated from the cost of human capital investment (Qian Xueya, Liu Jie, 2004[5]).Income law is a measure of the value of human capital in terms of the present value of the lifetime of a person's life. For example, to estimate the value of human capital in terms of income (Zhu Pingfang, Xu Dafeng, 2007[6]).The education index method is to measure the difference among the different levels of human capital by the education level. Common approaches to using average years of education as a measure of human capital index (Hu Angang,

[+] Corresponding author. Tel.: (+8615851863012).
E-mail address: (56439976@qq.com).

2002[7]; Ouyang Yao, Liu Zhiyong （2010）[10]; Jun Xu Zhou, Jiang Qi (2012) [11]; Cai Wu, Chen Guanghan (2013) [12]);Or use the middle school students' school enrollment rate, college enrollment rate and government financial investment to represent the human capital stock (Lai Ming Yong 2002 [8]);Can also be used to measure the difference of human capital by using the evaluation of the comprehensive index of education (Yue Shujing, 2002 [8]).

From the perspective of the selection of indicators, the above methods have some shortcomings in the analysis of heterogeneous human capital. The income method and cost method are methods to measure the heterogeneity of human capital, which is based on the measurement of human capital stock. The average level of education can not reflect the problem of extreme value, and the level of education is unable to reflect the difference of regional human capital in the overall number and quality. From the perspective of the heterogeneous human capital, it is mainly focused on the mechanism on the economic growth done by heterogeneous human capital. And try to use panel data regression method to fit the relevant production function, and analyze the parameters in the function.

2. Regional heterogeneous human capital empirical analysis

2.1 Data selection

In view of the above problems, a single panel data analysis method is difficult to distinguish human capital heterogeneity features of time series. And regression processing for the data of time series can get a good degree of separation.

The high quality human capital with the higher marginal revenue should show high efficiency.

This study uses the level of education to explain the heterogeneity of human capital investment in different regions and measures the regional fixed asset stock as material input, uses GDP as the output indicator. This study uses the CPI index for the past years to get the price adjustment GDP data.

Calculate the stock of fixed assets using the perpetual inventory method. A capital stock equal to last year stock minus depreciation, and add the new increase in the capital.

Reference Jing Xue Qing (2013) [13], is estimated using the perpetual inventory method that province fixed assets stock estimates in 2013. The depreciation rate is 10%.

2.2 Model construction

The relationship between human capital, material capital and output can be expressed by the production function:

$$Y=AK^{\alpha}H^{\beta} \tag{1}$$

Consider the heterogeneity of human capital:

$$H=H_1+H_2+H_3+\ldots\ldots+H_n \tag{2}$$

$$\text{so：}\quad Y=AK^{\alpha}H_1^{\beta 1}H_2^{\beta 2}H_3^{\beta 3}\ldots\ldots H_n^{\beta N} \tag{3}$$

Natural logarithm of both sides of the equation:

$$\ln Y=\ln A+\alpha\ln K+\beta_1\ln H_1+\beta_2\ln H_2+\beta_3\ln H_3+\ldots\ldots+\beta_N\ln H_n \tag{4}$$

The regression method is used to reduce the dimension of the input index in 2013, Analysis of regional human capital efficiency by using data envelopment analysis. This parametric method (regression analysis) and non parametric method (Data Envelopment Analysis) can be combined with the method, which can eliminate the irrelevant factors from the input index system, improve the pertinence of the data envelopment analysis method.

First, do a logarithmic processing to the original data. Then do regression analysis on the data of 2013 with the stepwise regression method. Data process with software Eviews7.2. Regression results in function 5. The variables are: CZ(Junior middle school education),GZ(Senior middle School education),DZ(College degree or above),GD(Fixed assets).

$$\begin{aligned}\text{LnGDP}=&-0.558-0.435\text{LnCZ}+0.443\text{LnGZ}+0.183\text{LnDZ}+0.900\text{LnGD}\\&(-2.770)^{**}\quad(2.324)^{**}\quad(1.873)^{*}\quad(7.305)^{***}\end{aligned} \tag{5}$$

Note: * * *, * *, * Were expressed respectively in 1%, 5% and 10% levels. Inner brackets are t statistics. The regression results are shown in Table 2.

Table1 2013 regional human capital and GDP output in the provincial area

Area	Primary school education (million)	Junior middle school education (million)	Senior middle School education (million)	College degree or above (million)	Fixed assets (100 million yuan)	GDP(100 million yuan)
Beijing	206	547	404	834	27191	19501
Tianjin	230	516	302	325	31627	14370
Hebei	1679	3279	1028	524	75023	28301
Shanxi	777	1597	592	367	33506	12602
Inner Mongolia	598	1019	399	239	47735	16832
Liaoning	779	1856	673	842	75186	27078
Jilin	614	1167	480	305	34253	12982
Heilongjiang	812	1674	648	451	34203	14383
Shanghai	323	859	471	572	28398	21602
Jiangsu	1767	3001	1380	1029	120809	59162
Zhejiang	1378	1877	782	908	71404	37569
Anhui	1584	2304	753	509	54529	19039
Fujian	1064	1374	541	311	48913	21760
Jiangxi	1108	1632	918	393	37776	14339
Shandong	2301	3904	1522	906	122751	54685
Henan	2207	3967	1323	700	81701	32156
Hubei	1225	2030	1220	645	57020	24669
Hunan	1741	2615	1105	528	51892	24502
Guangdong	2224	4504	2036	811	79443	62164
Guangxi	1385	1872	552	332	40942	14379
Hainan	160	386	164	72	8183	3147
Chongqing	924	1032	444	263	32218	12657
Sichuan	2710	2572	1009	803	61534	26261
Guizhou	1093	1184	343	294	20318	8007
Yunnan	1795	1415	425	336	30079	11721
Tibet	111	34	12	7	2700	808
Shaanxi	805	1475	649	421	42714	16045
Gansu	821	845	343	218	18259	6268
Qinghai	186	147	62	67	6877	2101
Ningxia	174	222	95	68	7965	2565
Xinjiang	633	815	261	264	22920	8360

Data source: according to the "China Statistical Yearbook 2014" calculation.

Table 2 Stepwise regression results

Regression statistics			Coefficients	Standard error	t Stat	P-value
Multiple R	0.986	Intercept	-0.558	0.685	-0.814	0.423
R Square	0.973	LnCZ	-0.435	0.157	-2.770	0.010
Adjusted R2	0.969	LnDZ	0.183	0.097	1.873	0.072
Standard error	0.172	LnGD	0.900	0.123	7.305	0.000
Observation	31	LnGZ	0.443	0.191	2.324	0.028

According to the results of stepwise regression, the variables that are better explained GDP are fixed assets, junior middle school education human capital, senior middle School education human capital, college degree and above education human capital. The primary school education human capital is excluded from the model. This conclusion is similar to that of Liu Zhiyong et al. (2008) [14].

2.3 Data envelopment analysis

In order to get more information about the production efficiency and the efficiency of heterogeneous human capital in different regions, take the variables that explained GDP well, analysis using Data Envelopment Analysis (DEA) method.

DEA method is used to analyze the input and output efficiency of the Decision Making Unit (DMU) with linear programming. DEA method is to construct the production frontier by keeping the output or input of the DMU projection to the production frontier, and to evaluate their relative effectiveness by comparing the degree of DMU away from the DEA production frontier.

To determine whether the DMU is DEA effective, in essence, is to determine whether DMU is located in the production of a possible set of "production frontier". This requires that the input of the DMU is the lesser the better, and the output of the DMU is the larger the better. The input part of DMU more than "enough" is called "input redundancy", the output part of DMU less than "enough" is called "output deficiency ".

Take C^2R model as an example, Take n provincial areas as DMUs, The DMUs have the input index of M types and the output index of P types. Set the input vector is $X_j = (x_{1j}, x_{2j}, \cdots\cdots, x_{mj})$, the output vector is $Y_j=(y_{1j}, y_{2j}, \ldots\ldots, y_{pj})$.The relative performance of the j_0 DMU is constructed by the following DEA model:

$$\min \theta$$

$$\begin{cases} s.t.\sum_{j=1}^{n} X_j \lambda_j + S^- = \theta X_0 \\ \sum_{j=1}^{n} Y_j \lambda_j - S^+ = Y_0 \\ \lambda_j \geq 0 \quad j = 1,2,\cdots,n \\ S^+ \geq 0, S^- \geq 0 \end{cases} \tag{6}$$

X_0 is the input vector of the j_0 DMUs.Y_0 is the output vector of the j_0 DMUs. Solving the linear programming problem of model 6. Set the optimal value as θ *, if θ *=1, so the decision unit j_0 is a relatively effective unit of operation. S^- or S^+ in the model is a slack variable, can be used to reflect the input redundancy and output deficiency. If S- is more than zero, that is called the input redundancy. If the value of S^+ is more than zero, that is called the output insufficient.

$\sum \lambda_j$ can reflect the changing trend of scale returns of the DMU. If $\sum \lambda_j$ more than 1, so scale returns diminishing . If $\sum \lambda_j$ equal 1 ,so scale returns unchanged. If $\sum \lambda_j$ less than 1, so scale returns increasing .

Table 3 DEA results

DMU	θ	$\sum \lambda$	S_1^- (LnCZ)	S_2^- (LnGZ)	S_3^- (LnDZ)	S_4^- (LnGD)	S_1^+ (LnGDP)	Scale return
Beijing	1.000	1.000						Unchanged
Tianjin	0.976	1.046		0.120				Decline
Hebei	0.949	1.011	0.298					Decline
Shanxi	0.941	0.936	0.220					Increasing
Inner Mongolia	0.959	1.048	0.036					Decline
Liaoning	0.942	1.053	0.279		0.077			Decline
Jilin	0.949	0.969	0.091					Increasing
Heilongjiang	0.947	0.938	0.221					Increasing
Shanghai	1.000	1.000						Unchanged
Jiangsu	0.968	1.079		0.002				Decline
Zhejiang	0.971	1.062	0.190					Decline
Anhui	0.938	0.984	0.320					Increasing

Fujian	0.973	1.035	0.072				Decline
Jiangxi	0.941	0.929		0.191			Increasing
Shandong	0.961	1.062	0.116				Decline
Henan	0.947	0.996	0.277				Increasing
Hubei	0.951	0.980		0.222			Increasing
Hunan	0.959	0.957	0.073				Increasing
Guangdong	1.000	1.000					Unchanged
Guangxi	0.943	0.975	0.385				Increasing
Hainan	0.957	0.874	0.138	0.109			Increasing
Chongqing	0,955	0.973	0.027				Increasing
Sichuan	0.947	0.985	0.220				Increasing
Guizhou	0.943	0.920	0.518				Increasing
Yunnan	0.947	0.962	0.439				Increasing
Tibet	1.000	1.000					Unchanged
Shaanxi	0.944	0.967	0.047				Increasing
Gansu	0.931	0.890	0.144				Increasing
Qinghai	0.946	0.927	0.032		0.266		Increasing
Ningxia	0.943	0.904	0.044				Increasing
Xinjiang	0.944	0.968	0.396				Increasing

DEA model results show that, relatively effective DMUs are Beijing, Shanghai, Guangdong, Tibet. Scale efficiency in most provinces showed an increasing state except Tianjin, Hebei, Inner Mongolia, Liaoning, Jiangsu, Zhejiang, Fujian, Shandong provinces (city). Study the input redundancy (S_1-、S_2-、S_3-、S_4-) and the output value (S_1+) can found out that the main reason of the non DEA effective is the redundancy of the heterogeneous human capital. Most of the provinces have redundant human capital in junior middle school education, only a few provinces have redundant human capital in senior middle school education human capital and college and above education human capital.

Liaoning and Qinghai have redundancy in college degree or above education human capital. Tianjin, Jiangsu, Jiangxi, Hubei, Hainan have redundancy in the senior middle school education human capital.

The regional structure adjustment of the heterogeneous human capital can be referred to the redundant information. Redundant human capital can flow in two directions. One way is the human capital flow to other levels (by means of additional human capital investment). Another way is the human capital flow to other regions.

The human capital has the characteristic of one direction in the flow of different levels. The lower human capital can change to advanced human capital with the help of human capital investment. But the promotion of human capital can not leapfrog complete, need to realize step by step, and the way is through all kinds of education at all levels of human capital investment.

In addition to Beijing, Shanghai, Guangdong, Tibet, Tianjin, Jiangsu, Jiangxi, the main task of other provinces is to strengthen the investment of high school education (ordinary senior high school and the corresponding level vocational education), to realize the transformation of human resources to the high level heterogeneous human capital.

The problems of college education (college degree and above) in recent years, especially the employment problems of college graduates, draw people' attention away from middle school education, especially the attention on the secondary vocational education.

The research shows that the senior middle school education (ordinary high school and the corresponding level vocational education) is the effective way to solve the redundancy of the human capital investment in most provinces. 23 provinces emerge redundancy in the junior middle school education human capital. In the 23 provinces, only Hainan emerges redundancy in the senior middle school education human capital, other provinces have the space for human capital to flow in from other regions. In addition, from the perspective of human capital regional flow, the feasible way is that the human capital flows from the region with input

redundancy in human capital to other regions.

The redundant human capital should flow from the original region. There are special requirements for the inflow regions: Firstly, the region that the human capital wants to flow into can not be redundant in human capital. Secondly, the region that the human capital wants to flow into must be in the stage of increasing returns to scale. Otherwise, continue to increase investment in human capital will lead to the redundancy of human capital investment in the region, and can not improve the efficiency of human capital investment. Moreover, because of the difference between the regional social economy and cultural development, there is not too many places can meet such conditions for the smooth flow. Therefore, solving the problem of human capital investment is mainly depends on changing the level of human capital in this region, but not depending on changing the region of human capital.

3. Conclusion

This study found that the combination of stepwise regression analysis and data envelopment analysis can effectively improve the validity of data envelopment analysis. The stepwise regression method removed data of little relevance from the input data system and optimized the regression model.

According to the results of stepwise regression, the variables that explained GDP better are fixed assets, junior middle school education human capital, senior middle School education human capital, college and above degree education human capital. The primary school education human capital is erased from the production function model, which means that the contribution of primary school education human capital in economic growth is weak.

DEA analysis shows that the regional human capital is obviously different, heterogeneity of human capital investment and output efficiency is generally not high. Only a few areas achieve the heterogeneous human capital input and output DEA effective. The DEA evaluation of the heterogeneous human capital shows that the input redundancy mainly because of the junior high school education human capital. In the regression model, the coefficient of human capital of the junior high school education is negative, and the negative effect of the level of human capital on the output is also explained. The directions of heterogeneous human capital structure optimization mainly are human capital flow to other levels or flow to other regions.

And the main way is promote a large number of junior middle school education human capital improve to a higher degree human capital, that is to improve the level of human capital of the junior middle school education through higher education or vocational education, so as to meet the actual needs of the industrial structure transformation in China at present.

References

［1］SCHULTZ W． Investment in Human Capital［J］． *American Economic Review*，1961，51(3) : 1－17．

［2］BECKER G，MURPHY K． The Division of Labor，Coordination Cost and Knowledge［J］． *The Quarterly Journal of Economics*，1992，107(4) : 1137－1160．

［3］LUCAS R． On the Mechanics of Economic Development［J］． *Journal of Monetary Economics*，1988，22(1) : 3－42．

［4］ROMER P． Endogenous Technological Change［J］． *Journal of Political Economy*，1990，98(5) : 71－102．

［5］Qian Xueya, Liu Jie. Empirical research on the level of human capital in China [J]. *Statistical study* 2004(3):39-45.

［6］Zhu Pingfang, Xu Dafeng. Estimation of urban human capital in China [J] *Economic research*. 2007(9):84-95.

[7]Hu Angang. From population country to human capital:1980-2000[J] *Chinese Population Science*,2002(5) : 1-10.

［8］Lai Mingyong, Baoqun, Yang Xiaoxiao. Absorptive capacity of foreign direct investment: Theoretical and empirical studies in China[J], *Shanghai Economic Research* ,2002(6):9-17.

[9]Yue Shujing. Comprehensive evaluation and dynamic analysis of human capital in the provincial area of China[J]. *Modern management science*,2008(4): 36-37.

［10］Ouyang Yao ,Liu Zhiyong, Human capital’s comprehensive advantages and economic growth in large developing countries-----Research Based on heterogeneity and adaptability［J］ *China industrial economics*,2010（11）26-35

［11］Zhou Junxu, Jiang Qi. Influence of Quality and Heterogeneity of Human Capital on FDI Location Choice［J］ *East China Economic Management* .2012（8）44-47.

［12］Cai Wu ,Chen Guanghan. Heterogeneous human capital spillover, "labor flow and income gap between urban and rural areas ［J］*Journal of Yunnan University of Finance and Economics* 2013 （6）24-32
［13］Jing Xueqing Estimation of material capital stock in China:1952-2010［J］*Guangdong Social Sciences* 2013（2）:46-55.
［14］Liu Zhiyong, Hu Yongyuan, Yi Xianzhong. Testing for the Mechanism of Impacts of Heterogeneous Human Capital on Economic Growth［J］ *Quantitative economic technology and Economic Research* 2008(4): 86-96.
［15］Wei Quanling. Data envelopment analysis［M］Beijing: Science Press, 2004.