Health Investment Effect on the Income Gap among China's Provinces ——An Empirical Study Based on Provincial Panel Data

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ABSTRACT: This article based on the extended Solow model, deduces a theoretical relationship between physical capital investment, health and education investment on human capital and regional output; use inter-provincial panel data to make a regression analysis on the deduced theoretical relationship, then get the effects of health and education investment on regional income level. The results show that the effect of health investment on per capita GRP is significantly negative, while the education investment is significantly negative or indistinctive positive. Therefore, investment in physical capital is a major effect factor of China's regional income differences; the increase of regional health investment is just a consumer demand, caused by the regional income improvement; the impact of education investment on economic growth is not significant.
KEYWORD: Health Investment; Human Capital; Income Gap

1 INTRODUCTION

With the development of regional economic, health spending is becoming more and more important in the development of regional economic. On the one hand, after the raise of income level, the increasing demand for health of residents in all regions will undoubtedly make health spending proportion increased (Grossman, 1972a, 1972b, 1972c, 2000); on the other hand, health as a human capital, it also has an effect on improving the output (Schultz, 1961; Mushkin, 1962; Malenbaum, 1970). In the situation that the income gap among China's regions is increasing, whether the regional differences in health expenditures also contributes to the widening of income gap?

Existing literature on the relationship between health and economic growth and economic development, some are from the view of microscopic family (Thomas and Frankenberg, 2002; Schultz, 2002; Heinek,2004; Yong, 2005, 2007;Suhrcke et al 2005, 2006; Jack and Lewis, 2009, Husain, 2010; Ruger et al, 2012) and from a macro national perspective (Mayer et al, 2001;. Lorentzen et al, 2005; McDonald and Roberts, 2006; Acemoglu and Johnson, 2007; Ashraf, Lester and Weil, 2008; Acemoglu and Robinson, 2008) studied the health effects on income levels. Different from previous studies, this paper mainly studies the effect of health and education investment on regional output.

Paper is organized as following: The second part is the deduced process of the model. The third section describes the selection of proxy variable and data. Section 4 presents the regression results. The last section is the conclusion.

2 THEORY AND ECONOMETRIC MODEL

Consider an extended Solow (1956) model containing health and education human capital. Suppose the production function is a Cobb - Douglas production function form,

$$Y(t) = K(t)^{\alpha} E(t)^{\beta} H(t)^{\gamma} (A(t)L(t))^{1-\alpha-\beta-\gamma} \tag{1}$$

Denotes Y the total output, K the total physical capital, E education of human capital, H a healthy human capital, L labor, A the technical level, t time, $0<\alpha,\beta,\gamma<1$, $\alpha+\beta+\gamma<1$. Assuming a regional population L and A are the growth at a fixed rate n and g, respectively. That,

$$L(t) = L(0)e^{nt} \tag{2}$$

$$A(t) = A(0)e^{gt} \tag{3}$$

Assuming a regional physical capital, education and health human capital investment share of total output respectively s_k, s_e, s_h . Denote $\hat{y}, \hat{k}, \hat{e}, \hat{h}$

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respectively per capita effective output, per capita effective physical capital, per capita effective education human capital, per capita effective health human capital, namely $\hat{y}=Y/(AL)$, $\hat{k}=K/(AL)$, $\hat{e}=E/(AL)$ and $\hat{h}=H/(AL)$. Substitute into (1), then

$$\hat{y}(t)=\hat{k}(t)^{\alpha}\hat{e}(t)^{\beta}\hat{h}(t)^{\gamma} \quad (4)$$

Assuming physical capital, education and health human capital depreciation rate are $\delta_k,\delta_e,\delta_h$. According to the above assumes, then the dynamic equations are,

$$\dot{\hat{k}}=s_k\hat{y}-(n+g+\delta_k)\hat{k}=s_k\hat{k}^{\alpha}\hat{e}^{\beta}\hat{h}^{\gamma}-(n+g+\delta_k)\hat{k} \quad (5)$$[1]

$$\dot{\hat{e}}=s_e\hat{y}-(n+g+\delta_e)\hat{e}=s_e\hat{k}^{\alpha}\hat{e}^{\beta}\hat{h}^{\gamma}-(n+g+\delta_e)\hat{e} \quad (6)$$

$$\dot{\hat{h}}=s_h\hat{y}-(n+g+\delta_h)\hat{h}=s_h\hat{k}^{\alpha}\hat{e}^{\beta}\hat{h}^{\gamma}-(n+g+\delta_h)\hat{h} \quad (7)$$

Economy will eventually converge to a stable equilibrium state($\hat{k}^*,\hat{e}^*,\hat{h}^*$),

$$\hat{k}^*=(s_k^{1-\beta-\gamma}s_e^{\beta}s_h^{\gamma})^{\frac{1}{\theta}}(n+g+\delta_k)^{-\frac{1-\beta-\gamma}{\theta}}(n+g+\delta_e)^{-\frac{\beta}{\theta}}(n+g+\delta_h)^{-\frac{\gamma}{\theta}} \quad (8)$$

$$\hat{e}^*=(s_k^{\alpha}s_e^{1-\alpha-\gamma}s_h^{\gamma})^{\frac{1}{\theta}}(n+g+\delta_k)^{-\frac{\alpha}{\theta}}(n+g+\delta_e)^{-\frac{1-\alpha-\gamma}{\theta}}(n+g+\delta_h)^{-\frac{\gamma}{\theta}} \quad (9)$$

$$\hat{h}^*=(s_k^{\alpha}s_e^{\beta}s_h^{1-\alpha-\beta})^{\frac{1}{\theta}}(n+g+\delta_k)^{-\frac{\alpha}{\theta}}(n+g+\delta_e)^{-\frac{\beta}{\theta}}(n+g+\delta_h)^{-\frac{\gamma}{\theta}} \quad (10)$$

Denote $\theta=1-\alpha-\beta-\gamma$ Substitute (8), (9), (10) into (4),

$$\begin{aligned}\ln y^*&=\ln A_0+gt+\frac{\alpha}{\theta}\ln s_k+\frac{\beta}{\theta}\ln s_e+\frac{\gamma}{\theta}\ln s_h\\&-\left[\frac{\alpha}{\theta}\ln(n+g+\delta_k)+\frac{\beta}{\theta}\ln(n+g+\delta_e)+\frac{\gamma}{\theta}\ln(n+g+\delta_h)\right]\end{aligned} \quad (11)$$

$y^*=Y^*/L^*$ per capita output in equilibrium state.

Equation (11) is a dynamic equilibrium equation, which determines per capita output. Referring the approaches of Mankiwetal (1992) and Romer (2002), Wang DiHai (2014), transform the equation (11) into a determining equation of its short-term economic development process.

First, define $\hat{y}^*=y^*/A$ per capita effective output in the dynamic equilibrium state. Near the equilibrium point, the convergence rate of per capita output

$$d\ln\hat{y}/dt=\lambda(\ln\hat{y}^*-\ln\hat{y}) \quad (12)$$

$\lambda=(n+g+\delta_k)(1-\alpha-\beta-\gamma)=(n+g+\delta_k)\theta$ [2]. According to (12), then

$$\ln\hat{y}(t_2)=(1-e^{-\lambda\tau})\ln\hat{y}^*+e^{-\lambda\tau}\ln\hat{y}(t_1) \quad (13)$$

Denote $\tau=t_2-t_1$, then,

$$\ln\hat{y}(t_2)-\ln\hat{y}(t_1)=(1-e^{-\lambda\tau})(\ln\hat{y}^*-\ln\hat{y}(t_1)) \quad (14)$$

transform (11) into form, then substitute it into (14)

$$\begin{aligned}\ln\hat{y}(t_2)-\ln\hat{y}(t_1)&=(1-e^{-\lambda\tau})[\frac{\alpha}{\theta}\ln s_k+\frac{\beta}{\theta}\ln s_e+\frac{\gamma}{\theta}\ln s_h\\&-\frac{\alpha}{\theta}\ln(n+g+\delta_k)-\frac{\beta}{\theta}\ln(n+g+\delta_e)-\frac{\gamma}{\theta}\ln(n+g+\delta_h)-\ln\hat{y}(t_1)]\end{aligned} \quad (15)$$

Since $\ln\hat{y}(t)=\ln y(t)-\ln A_0-gt$ according to (15), the decision equation the level of per capita output at any time t

$$\begin{aligned}&\ln y(t_2)=g(t_2-e^{-\lambda\tau}t_1)+(1-e^{-\lambda\tau})\ln A_0+e^{-\lambda\tau}\ln y(t_1)+\\&(1-e^{-\lambda\tau})\frac{\alpha}{\theta}\ln s_k+(1-e^{-\lambda\tau})\frac{\beta}{\theta}\ln s_e+(1-e^{-\lambda\tau})\frac{\gamma}{\theta}\ln s_h-\\&(1-e^{-\lambda\tau})\left[\frac{\alpha}{\theta}\ln(n+g+\delta_k)+\frac{\beta}{\theta}\ln(n+g+\delta_e)+\frac{\gamma}{\theta}\ln(n+g+\delta_h)\right]\end{aligned} \quad (16)$$

Define $x=n+g+\delta$ per capital effective depreciation rate, refer to Wang DiHai (2014) deal with the health and education human capital, the equation can be simplified to the following econometric regression model:

$$\begin{aligned}\ln y_{i,t}&=\alpha_0+\alpha_1\ln y_{i,t-1}+\alpha_2\ln s_{ki,t}+\\&\alpha_3\ln s_{ei,t}+\alpha_4\ln s_{hi,t}+\xi\ln x_{i,t}+\varepsilon_{i,t}\end{aligned} \quad (17)$$

i represent different regions, t time, α_i (i=0,1,2,3,4), and ξ are all parameters to be estimated, ε indicating random items. According to this theory the model equation (16), we expect the regression coefficients α_i (i=0,1,2,3,4) should be positive, ξ should be negative. Compared with Mankiw et.al(1992) model, equation (17) only added health human capital, so it is called extended Mankiw et.al(1992) model.

3 THE PROXY VARIABLES AND DATA DESCRIPTION

3.1 *Selection of the proxy variable*

The regression equation in (17), involves five variables: real per capita GRP(lny), investment rate (S_k), education investment rate (S_e) and health investment rate (S_h), as well as the sum of population growth, depreciation rate and rate of technological progress (namely the lnX items in(17)).The data of real per capita GRP(RGRP) can be easily obtained. For the investment rate, use the

[1] Since the above equation is a function of time t, in order to simplify, omitted time variable t.

[2] About (12) the derivation process, please refer to Barro & Sala-i-Martin (1995, pp. 87-88)

actual investment proportion of regional GRP as a proxy variable. Depreciation rate and the rate of technological progress follows Mankiw et.al(1992) approach, all regions take the unified value 0.05, the population growth rate is regional population growth. The total costs of the regional education spending proportion of GRP as education investment rate's proxy variable, health expenditure share of GRP as a health investment rate's proxy variables.

3.2 *Data Description*

The data of real per capita GRP, fixed investment, education investment share of GRP is calculated based on "China Statistical Yearbook"; financial health spending data comes from China's National Bureau constitute of regional expenditure. Data on health care spending, the National Bureau of Statistics released the data since 2007, so the time of the panel data of this paper series from the 2007-2012.

4 RESULTS

4.1 *Estimation Method*

Make a Hausman test for the panel data, the result refuses the assumption of fixed effects. Therefore, this paper uses panel data regression models with random effects, actually estimating equation (17) is a form of the following dynamic panel data model:

$$y_{i,t} = a + v_i + \gamma y_{i,t-1} + \beta x_{i,t} + \mu_{i,t}, i=1,\ldots N, t=1,\ldots T \quad (18)$$

Denote N and T the number of region and total time periods, γ a scalar, β a vector parameter of 1*(K-1) vector, $x_{i,t}$ (K-1)*1 explanatory variables, v_i random variable, a common intercept.

4.2 *Estimation Results*

In table 1 there are four regression equations. Each regression equation contains Ln (RGRP-1), Ln (X), Ln (Sk) three variables. The first regression includes only three basic explanatory variables, the regression 2-4 adds the other two explanatory variable of human capital to the basic regression equation 1.

Table 1: the random effects regression results of provinces panel data

dependent variable: per capital GRP				
Independent variable	1	2	3	4
Ln(RGRP-1)	0.961*** (171.31)	0.956*** (170.57)	0.959*** (176.68)	0.955*** (164.82)
Ln(X)	-0.035*** (-3.04)	-0.023* (-1.97)	-0.027** (-2.35)	-0.022* (-1.92)
LN(Sk)	0.010 (0.99)	0.022** (2.09)	0.024** (2.10)	0.021* (1.86)
LN(Sh)		-0.035*** (-3.23)		-0.039** (-2.04)
LN(Se)			-0.015*** (-2.48)	0.002 (0.2)
CONSTANT	0.184*** (3.49)	0.162*** (3.21)	0.115** (2.00)	0.169** (2.66)
Adjust R2	0.9973	0.9975	0.9974	0.9975

Notes: (1) in the table below each coefficient values in parentheses are the coefficients of t-statistics; (2) ***, **, * are the 1%, 5% and 10% of the statistical significant level.

From the regression results in Table 2 show that the regression results of three core variables in all regression equations are consistent. Where the coefficients of per capita GRP lags and physical capital investment regression results are significantly positive; the effect of per capita effective depreciation rate on per capital GRP is significantly negative. Secondly, adding the two human capital proxy variables to the basic regression equation shows the results of regression (Table 2, from column 2 to column 4), the impact of health expenditure on per capita GRP is significantly negative, while education spending significantly negative or non-significant positive. These results suggest that the impact of education investments on regional economic growth is not significant, the economic growth in all regions mainly depends on investment in physical capital, the increase of regional health investment is just a consumer demand, caused by the regional income improvement.

5 CONCLUSIONS

With development of regional economic, the regions begin to increase spending continually for health. The increasing of health expenditure is associated with the health demand after regional income improves, but health as a kind of human capital, it also has a role in improving output. So, whether regional differences in health spending is also a cause of regional income gap? This paper focuses on the study of this issue. This paper constructs a simple Solow model with education and health human capital, based on this model we deduced a mechanism that how health and education investment in human capital affect output; and then through an extended Mankiw et.al (1992) econometric models, using a panel data including 29 provinces' data, from an empirical perspective verify the theoretical model. The empirical study shows that the impact of education investments on regional economic growth is not significant, the economic growth in all regions mainly depends on investment in physical capital, the increase of regional health investment is just a consumer demand, caused by the regional income improvement.

In this paper, the study on the government spending decisions also has practical significance. The current economic growth is still dependent on the accumulation of physical capital, but it is difficult to bring sustained economic growth. The regional sustainable economic growth should pay attention to the accumulation of human capital. Based on the conclusions of this paper, due to health investment is just consumer behavior, education has no significant positive impact on regions economic growth. Therefore each region should increase investment in education in order to accumulate the human capital, achieve the transformation of economic growth and promote regional economic coordination and sustainable development.

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