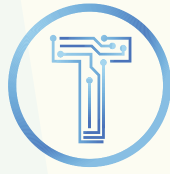

TECHNIUM

SOCIAL SCIENCES JOURNAL

Vol. 8, 2020

A new decade for social changes

www.techniumscience.com

Technium Social Sciences Journal
Vol. 8, 229-248, June 2020
ISSN: 2668-7798
www.techniumscience.com

Health Human Capital Investment and Economic Growth

Lili Zheng[1], **Yuan Lu**[2]

[1 2] School of insurance, Central University of Finance and Economics, Beijing, China

zhengll@cufe-ins.sinanet.com[1], 1269645306@qq.com[2]

Abstract. Economic growth depends on factor inputs, and health human capital investment is a very important factor input. We set up a three-period overlapping generation model of personal health investment and government public health investment in the formation of physical capital and human capital and its impact on economic growth. Our findings show that health human capital investment can increase economic growth. We also conducted empirical research on the relationship between health human capital investment and economic growth by using China's provincial panel data from 1999 to 2016. The robustness test of endogenous and interactive term regression confirms our results. We found that individual health investment has the greatest impact on economic growth. Therefore, China's health strategy is consistent with the policy of economic growth. China should further expand health investment and optimize the structure of health investment to promote its economic growth.

Keywords. health human capital, health investment, economic growth

I. Introduction

China's economy has been transitioning from a phase of rapid growth to a stage of high-quality development, which is a pivotal stage for transforming growth models, improving economic structure, and fostering new drivers of growth in China. Currently, China is in a critical period of economic transformation, and the growth rate of capital factor supply is declining. It has mainly relied on low-cost investment, cheap and abundant labor and the use of natural resources to support growth, and it now facing a number of challenges. The Chinese government has attempted to rebalance its economy to achieve a "new normal" of slower but more sustainable economic development, including growth rate shift, structural adjustment and power transformation. Accordingly, China should seek drivers of economic growth that emphasize factor input.

There is a close relationship between health in human capital investment and economic growth. The human capital generated by health investment has special production functions and is an indispensable prerequisite and input factor for the production process. Health investment does not only affect an individual's labor productivity, but it also affects the production time and the reward of education investment that influences the individual's effective working time. Further, it impacts labor supply by affecting mortality and life expectancy, which impinges on the production function. Also, it affects the health human capital and, in so doing, affects the

individual. According to utility function (Grossman, 1972), health human capital investment has an influence on economic growth by affecting human capital and physical capital. Therefore, it is realistic and operational to improve human capital investment and promote economic growth.

The development of a "Health China" is central to the Chinese government's agenda for health and development. Following the National Health Conference, China's leaders ensured that health became an explicit national political priority with the approval of the Health China 2030 Planning Outline by China's Central Party Committee and the State Council. China has incorporated the implementation of the Health China Strategy into the national development and national health plans under the status of "national prosperity and national prosperity and strength." National health is considered an important indicator of the country's sustainable development ability. According to the 2013 Human Development Report, which is released by the United Nations: "From the perspective of human development, health is the means to promote economic growth." It can be seen that health is not only directly related to people's livelihood and well-being, but is also related to economic development and has great strategic significance.

Recently, China's investment in health has been increasing. Since the launch of a new round of medical reform in 2009, China has invested heavily in health infrastructure: the coverage of the basic medical insurance system has covered more than 95% of population, which is the world's largest social medical insurance network. The percentage of total health expenditure to GDP increased from 4.89% in 2010 to 6.2% in 2016, although it is still lower than the global average of 10.5%, the growth rate is larger than before. The market size of the health industry increased from 1.9 trillion yuan in 2010 to 5.6 trillion yuan in 2016; the global ranking of medical quality and accessibility increased from being 110th in the world in 1999 to being 48th in 2016.

Given the momentum of implementation of health strategy and the transformation of growth in China, research on the impact of health on human capital investment in economic growth and its mechanism is important. The research helps to explore the momentum of economic growth from the perspective of health in human capital. It helps the government formulate more reasonable policies to achieve goals; it helps link health investment with macroeconomic strategies and it promotes coordinated development of health human capital and macroeconomics. We constructed a three-generation overlapping model of health in human capital investment and economic growth by analyzing the behavior of the three sectors in economic activities. We derived the relationship between the variables in the model and performed comparative static analysis. To reveal the relationship between health in human capital investment and economic growth on China, we selected agent variables for reproductive health investment, individual health investment and government public health investment and conduct empirical analysis by using Chinese provincial panel data.

The structure of the following sections shows that the second part reviews the relevant literature on the relationship between health in human capital investment and economic growth. The third part constructs a theoretical model that sets the model framework for individual behavior, corporate behavior, and government behavior and solves market equilibrium and the balanced growth path of the economy. The fourth part discusses the design and results of the empirical research by using the provincial panel data from 1999 to 2016. The hypothesis and inference from the third part are tested in this fourth part. The conclusion containing policy implications and further research directions makes up the fifth part.

TECHNIUM SOCIAL SCIENCES JOURNAL
Technium Social Sciences Journal
Vol. 8, 229-248, June 2020
ISSN: 2668-7798
www.techniumscience.com

2. Literature Review

The research on the relationship between health investment and economic growth is predominantly based on theory and experience. The theoretical research considers the analysis framework of endogenous economic growth, explaining the endogenous economic growth mechanism with health human capital. The empirical research draws from a sample of different countries and regions and examines the impact of health investment on economic growth.

Health human capital plays a very important role in the theory of endogenous economic growth. Mushkin (1962) used health as a component of human capital and emphasized the investment perspective of health human capital for the first time. Lucas (1988) introduces health as a production factor directly into the production function, and believes that economic growth comes from the accumulation of human capital. The accumulation speed of different human capital is the main reason for understanding the different economic growth rates and the cross-border income gap. Ehrlich and Lui (1991) used human capital as a driving force for growth and a link between intergenerational material and spiritual emotions to analyze the impact of parental health investment on human capital. Muysken et al. (1999) introduced the health accumulation function to the Cass-Koopmans optimal growth model; endogenous health can be analyzed to determine the impact of optimal health care spending on economic steady growth and transformation dynamics. Zon and Muysken (2001, 2003) discussed the characteristics of health production and the intergenerationality of human capital accumulation in an endogenous growth framework, and concluded that the average health level of the population is linearly positively correlated with steady state growth. Hosoya (2002, 2003) introduced the skill-driven technology shift effect (SDTC) into the model of Zon and Muysken (2001, 2003) and found that if the skill-driven technology shift effect is considered, the economy with health investment will continue to grow. Aisa and Pueyo (2006) argue that government public health spending in developing countries promotes economic growth. Agenor (2008) studied the impact of government health expenditure on economic growth based on the endogenous growth model and believed that government health spending affects output and utility. Dihai (2012) found that economic growth is related to the growth rate of health investment and is related to the stock of health human capital in a model comprising the Arrow-Romer production function and the Grossman (1972) utility function. Accordingly, Dihai suggested that health investment can always promote economic growth if the health investment is excluded from the squeeze effect of physical capital. Maame et al. (2014) found that joint private and government health investments can maximize economic growth.

The empirical research focused on the role of population health or health investment in national and regional economic growth by using quantitative analysis to predict the role of health expenditure in economic growth. Many studies show that health in human capital investment is a huge boost to national economic growth (Barro, 1996; Sachs and Warner, 1997; Bloom and Williamson, 1998; Bhargava et al, 2001; Bloom et al, 2004; Beheshti and Sojoudi, 2008; Pablo et al, 2015).

Sohn (2000) found that the increase in the labor force brought about by the improvement of health in human capital increased Korea's annual economic growth rate by 1%. In a study of 18 countries spanning 30 years, Mayer (2001) found a causal link between health and economic growth. Rivera and Currais (2004) analyzed the 20-year data for 17 regions in Spain and found that the coefficient of health investment on GDP per capita was 0.13. By using cross-sectional data from 44 countries in Africa from 2001, Murthy and Okunade (2009) found positive effects of health care spending on the economy. Rasaki (2011) found that health as an important part of human capital has had a significant effect on improving Nigeria's economy. Boussalem (2014) used Algerian data from 1974 to 2014 to find a long-term causal relationship between

TECHNIUM SOCIAL SCIENCES JOURNAL

Technium Social Sciences Journal
Vol. 8, 229-248, June 2020
ISSN: 2668-7798
www.techniumscience.com

public health investment and economic growth. Dihai (2016) found that differences in health investments across countries can significantly affect output gaps across countries by using an extended Ramsay model and empirical studies of two panel data. In a sample of African countries, Serge and Julius (2017) found that unit changes in health spending increased per capita GDP by 0.38 and 0.3 units respectively. In a study using Turkish data, Gizem (2018) found that health investments have a significant positive impact on per capita GDP.

Some scholars also used Chinese data to conduct empirical research. Luo Kai (2006) found a significant positive correlation between health in human capital and economic growth. For every one year of life expectancy, the GDP growth rate increased by 1.06% to 1.22%. Dihai et al. (2008) found that health investment can always promote economic growth by disregarding the exclusion effect of health investment on physical capital.

Although Schultz's (1961) research has long stated that health investment is one of the important aspects of human capital investment, research on health investment is clearly insufficient compared to research on education investment; existing research has focused on education and health in human capital. This paper has two contributions compared with the existing literature. First, the paper explores the principles and mechanisms of health investment affecting physical capital, human capital and economic growth from the perspective of health investment, especially distinguishing individual and government health investment. We choose the variables from the perspective of health investment and directly measure the impact of health investment on economic growth in China. We construct a three-generation overlapping model of endogenous reproductive health investment decision. The generational overlap model has advantages for intergenerational welfare analysis and can reflect the intergenerational nature of health investment.

3. The Model

We first analyze the mechanism of health human capital on economic growth by constructing a generational overlap model of endogenous reproductive health investment decision-making. The model includes three sectors: individuals, enterprises and governments. Health investment comes from government and individuals. Government uses the tax in two ways: the government's public health investment and other expenditures. Individuals make decisions on health investment and consumption, and the enterprise produces according to physical capital and human capital.

3.1 The model

3.1.1 The Individuals

It is assumed that the life of each representative individual is divided into three stages: youth, middle, and old. In one period, there are three generations of youth, middle, and old. The health human capital accumulated by young people is derived from the fertility health investment of middle-aged people. Middle-aged people earn income through labor and use the income for consumption and savings, while investing in reproductive health. The elderly use the last period of savings for consumption and health investments.

It is assumed that the individual's health level is affected by the initial health stock and the number of health investments. In life cycle terms, the parents' reproductive health investment can improve their genetic characteristics which will be reflected in their offspring, the initial health stock as a descendant. Accordingly, the model incorporates the biological specificity of health carriers into the analysis of health human capital and focuses on the intergenerational inheritance of health investments, in other words, the health stock determined by the impact of health investments on genetic traits. The individual's health level is also affected by the amount

TECHNIUM SOCIAL SCIENCES JOURNAL
Technium Social Sciences Journal
Vol. 8, 229-248, June 2020
ISSN: 2668-7798
www.techniumscience.com

of health investment. Therefore, the initial health stock and the government's public health investment together determine the human capital h_{t+1} of the younger generation. Building a health human capital function:

$h_{t+1} = Ehi_t^{\theta}(G_H/L_t)^{1-\theta}$ （1）

In (1) h_{t+1} indicates the health human capital of the t+1 generation, E indicates the efficiency of the health human capital investment, hi_t indicates the parent's reproductive health investment, and $G_H$indicates the public health investment from the government. G_H/L_t represents per capita government public health investment. $0 < \theta < 1$ is used to measure the effect of parental health investment on individual health human capital. $1 - \theta$ is used to measure the effect of government public health investment on health human capital.

The model assumes that the utility of a person's life depends on the consumption level c_t of the t period, the consumption level c_{t+1} in the old age and the health human capital level h_{t+1} of the child, assuming that the middle-aged person has $\rho(0 < \rho < 1)$ survives to the old age, and the utility is described by a separable additive logarithmic function. The form of the utility function is set to

$U(c_t, c_{t+1}, h_t) = lnc_t + \rho lnc_{t+1} + \delta lnh_{t+1}$ （2）

In (2) δ represents the weight of health human capital in the utility function.

Assuming that the labor income per unit of human capital is w_t, the labor income available in the individual work stage is $w_t h_t$. Further, assuming that the individual uses the proportion s_t in the labor income for saving, the individual income tax is paid at the tax rate τ_t, and the remaining income is used for consumption in t period and investment in the health of the children. The middle-aged people in the t period retired in the t+1 period and can no longer provide labor, the income for consumption comes from their savings and interest returns during the t period, μ represents the proportion of the elderly used for consumption, 1-μ means the proportion of the elderly used for health investment, the rate of return on savings is expressed by $1 + r_{t+1}$.

The budget constraints of representative individuals in middle age and old age are:

$(1 - \tau_t - s_t)w_t h_t = c_t + (1 + n)hi_t$ （3）

$(1 + r_{t+1})\mu s_t w_t h_t = c_{t+1}$ （4）

At the beginning of the t period, when n individuals grow into laborers, the population growth rate is $n = \frac{N_t}{N_{t-1}} - 1$

3.1.2 The Firm

Health in human capital enters the production function as a factor of production, so the production function includes physical capital, human capital, and labor input. According to the Cobb-Douglas production function, economic output depends on physical capital, human capital, and labor. Suppose that there is perfect competition in the goods sector. A representative firm has the following production function:

$Y_t = AK_t^{\alpha} {H_t}^{1-\alpha} = AK_t^{\alpha}(h_t L_t)^{1-\alpha}$ （5）

In (5) Y_t represents the final total output, A is a parameter indicating production technology, K_t represents physical capital, $h_t L_t$ represents total human capital stock, L_t is labor, $A > 0$, 0<α<1 measures the output elasticity of physical capital. 0<1-α<1 measures the output elasticity of health human capital. According to the model setting, due to the existence of health investment, the labor ability of the individual is no longer homogenous, and there is a difference in the quality of the labor force. The labor is that of the individual with the lowest labor quality in the society who provides labor for his whole life under normal conditions, that is, the

workload of the individual in the second period is the unit labor. So the higher the labor quality, the more the labor that individual can provide in his lifetime. $k_t = K_t/L_t$ is the unit labor physical capital, and the unit labor physical capital output is $y_t = Ak_t^{\alpha}{h_t}^{1-\alpha}$.

The function of the manufacturer to maximize profit is $\pi_t = AK_t^{\alpha}{h_t}^{\beta} - \delta K_t - w_t H_t$, δ represents the depreciation rate, w_t represents the price per unit of labor factor in the t period, and is also the wage rate, $1 + r_{t+1}$ represents the price of the t-term capital element, which is the interest rate.

Profit maximization and perfect competition require that all factors are paid at marginal production, so labor and capital prices are determined by marginal production, respectively. Therefore, the function of per capita output is:

$w_t = A(1-\alpha)k_t^{\alpha}h_t^{-\alpha}$ （6）

$1 + r_{t+1} = \alpha A k_t^{\alpha-1}h_t^{1-\alpha}$ （7）

3.1.3 The Government

Assuming that the government's fiscal revenue comes only from income tax, the government's fiscal revenue is

$G = \tau_t w_t h_t L_t$ （8）

The government's fiscal expenditures are used for public health investments and other investments, namely G_H and G_I. Government public health investments receive the impact of fiscal revenue, and v represents the portion of total output that is used by the government to provide public health investments. Then the government's fiscal expenditure can be expressed as:

$G_H = v\tau_t w_t h_t L_t$ （9）

$G_I = (1-v)\tau_t w_t h_t L_t$ （10）

The budget of the government's financial department in the t period is:

$G = G_H + G_I$ （11）

3.1.4 Market Equilibrium

Assume that each period of physical capital comes from the previous period of personal savings and government physical capital investment, and the physical capital is fully depreciated in the current period. Thus, the capital market clearing conditions are:

$(1+n)k_{t+1} = \mu s_t w_t h_t + G_I/L_t = \mu s_t w_t h_t + (1-v)\tau_t w_t h_t$ （12）

3.2 Solving the model

3.2.1 Individual Optimization Behavior

Each representative individual maximizing the utility level of whole life under the constraint of by selecting middle-aged consumption c_t, old-age consumption c_{t+1}, savings ratio s_t and reproductive health investment hi_t:

$$max\ U(c_t, c_{t+1}, h_{t+1})$$

s.t. $(1-\tau_t - s_t)w_t h_t = c_t + (1+n)hi_t$

$(1 + r_{t+1})\mu s_t w_t h_t = c_{t+1}$ （13）

Solving the individual's optimization problem can obtain the first-order optimal conditions for representative individual investment in consumption, savings, and reproductive health:

$c_{t+1} = \rho\mu(1 + r_{t+1})c_t$ （14）

$$s_t = \frac{1 - \tau_t + \delta\mu(\tau_t + n)(1-\tau_t)}{\delta\mu[(\tau_t + n) + \delta\mu(1+n)]}$$

$$hi_t = \delta\mu c_t = \frac{\{(1-\tau_t)\delta\mu[(\tau_t+n)+\delta\mu(1+n)]-[(1-\tau_t)+\delta\mu(\tau_t+n)(1-\tau_t)]\}}{[(\tau_t+n)+\delta\mu(1+n)][1-\delta\mu(1+n)]} w_t h_t \quad (15)$$

（16）

It can be seen that one-unit product of the parents' investment in their children's reproductive health and reducing consumption is equal to the increased utility of the child's health human capital. Therefore, reproductive health investment does not reduce the individual's utility.

We define the individual birth health investment rate as $hir_t = hi_t / w_t h_t$, so the individual optimal reproductive health investment ratio at steady state

$$hir_t = \frac{\{(1-\tau_t)\delta\mu[(\tau_t+n)+\delta\mu(1+n)]-[(1-\tau_t)+\delta\mu(\tau_t+n)(1-\tau_t)]\}}{[(\tau_t+n)+\delta\mu(1+n)][1-\delta\mu(1+n)]} \quad (17)$$

3.2.2 Balanced Growth Path

Bring (15) into $h_{t+1} = E hi_t^{\theta}(G_H/L_t)^{1-\theta}$, I get

$$\frac{h_{t+1}}{h_t} = E(v\tau_t)^{1-\theta}\delta\mu\Lambda^{-\theta}(1-\alpha)^{1-\theta}[1-\delta\mu(1+n)]^{\theta}(\alpha A)^{1-\theta}(\frac{k}{h})^{(\alpha\theta+\alpha-\theta)} \quad (18)$$

In（18）, $\Lambda = 1-\tau_t - \frac{1-\tau_t+\delta\mu(\tau_t+n)(1-\tau_t)}{\delta\mu[(\tau_t+n)+\delta\mu(1+n)]} = \frac{\delta\mu(\tau_t+n)(1-\tau_t)-(1-\tau_t)}{(\tau_t+n)+\delta\mu(1+n)}$。

Bring（6）、（7）into（12）, I get

$$\frac{k_{t+1}}{k_t} = \phi A(1-\alpha)(\frac{k}{h})^{\alpha-1} \quad (19)$$

Where, $\phi = \frac{1-\tau_t+\delta\mu(\tau_t+n)(1-\tau_t)+(1-v)\delta\mu[(\tau_t+n)+\delta\mu(1+n)]}{\delta(1+n)[(\tau_t+n)+\delta\mu(1+n)]}$

In steady state growth, $\frac{h_{t+1}}{h_t} = \frac{k_{t+1}}{k_t} = 1+g$, so combine (18) and (19) to obtain

$$E(v\tau_t)^{1-\theta}\delta\mu\Lambda^{-\theta}(1-\alpha)^{1-\theta}[1-\delta\mu(1+n)]^{\theta}(\alpha A)^{1-\theta}(\frac{k}{h})^{(\alpha\theta+\alpha-\theta)} = \phi A(1-\alpha)(\frac{k}{h})^{\alpha-1}$$

（20）

Solving (19) can be obtained

$$\frac{k}{h} = \phi^{\frac{1}{1+\theta(\alpha-1)}}[A(1-\alpha)\Lambda]^{\frac{\theta}{1+\theta(\alpha-1)}}(E\delta\mu)^{\frac{-1}{1+\theta(\alpha-1)}}(v\tau_t\alpha)^{\frac{\theta-1}{1+\theta(\alpha-1)}}[1-\delta\mu(1+n)]^{\frac{-\theta}{1+\theta(\alpha-1)}} \quad (21)$$

Thus, physical capital and human capital in steady state can be obtained:

$$k^* = \phi^{\frac{\alpha-1}{1+\theta(\alpha-1)}}[A(1-\alpha)]^{\frac{(\alpha\theta+1)(\alpha-1)}{1+\theta(\alpha-1)}}\Lambda^{\frac{\theta(\alpha-1)}{1+\theta(\alpha-1)}}(E\delta\mu)^{\frac{-(\alpha-1)}{1+\theta(\alpha-1)}}(v\tau_t\alpha)^{\frac{(\theta-1)(\alpha-1)}{1+\theta(\alpha-1)}}[1-\delta\mu(1+n)]^{\frac{-\theta(\alpha-1)^2}{1+\theta(\alpha-1)}}\left\{\frac{1-\tau_t+\delta\mu(\tau_t+n)(1-\tau_t)}{\delta[(\tau_t+n)+\delta\mu(1+n)]}+(1-v)\tau_t\right\} \quad (22)$$

$$h^* = \phi^{\frac{\theta\alpha-\theta+\alpha}{1+\theta(\alpha-1)}}[A(1-\alpha)\Lambda]^{\frac{1-2\theta+2\theta\alpha}{1+\theta(\alpha-1)}}(E\delta\mu)^{\frac{1-\alpha}{1+\theta(\alpha-1)}}(v\tau\alpha)^{\frac{(1-\alpha)(\theta-1)}{1+\theta(\alpha-1)}}[1-\delta\mu(1+n)]^{\frac{\theta-\alpha\theta}{1+\theta(\alpha-1)}} \quad (23)$$

Solving economic growth rate of the steady growth path g:

$$1+g^* = \phi^{\frac{\theta\alpha-\theta+\alpha}{1+\theta(\alpha-1)}}[A(1-\alpha)]^{\frac{2+\theta\alpha-\theta}{1+\theta(\alpha-1)}}\Lambda^{\frac{\theta(\alpha-1)}{1+\theta(\alpha-1)}}(E\delta\mu)^{\frac{1-\alpha}{1+\theta(\alpha-1)}}(v\tau\alpha)^{\frac{(\alpha-1)(\theta-1)}{1+\theta(\alpha-1)}}[1-\delta\mu(1+n)]^{\frac{\theta-\alpha\theta}{1+\theta(\alpha-1)}} \quad (24)$$

On the steady growth path, the relationship between steady state growth rates and the optimal proportion of reproductive health investments is:

$$1+g^* = \Psi(E hir_t^*)^{\frac{1-\alpha}{1+\theta(\alpha-1)}}[1-hir_t^*(1+n)]^{\frac{\theta-\alpha\theta}{1+\theta(\alpha-1)}} \quad (25)$$

In Equation (25), under the effect of maximizing individual utility, when the efficiency E of health human capital investment is high, reproductive health investment has a positive effect on economic growth rate.

3.3 Comparative static analysis

3.3.1 Change of Individual Health Investment

The impact of changes in individual health investments on physical capital:

$$\frac{\partial k}{\partial \mu} = \mathcal{F}_1 \mu^{\frac{\theta-\alpha-\theta\alpha}{1+\theta(\alpha-1)}} + \mathcal{F}_2 \mu^{\frac{-\theta(\alpha-1)^2-1-\theta(\alpha-1)}{1+\theta(\alpha-1)}} + \mathcal{F}_3 \frac{\delta(\tau_t+n)(1-\tau_t)-\delta^2(1+n)}{\{\delta[(\tau_t+n)+\delta\mu(1+n)]\}^2} \quad (26)$$

Proposition 1: As μ decreases, individual health investment increases, and physical capital decreases, indicating that individual health investment will crowd out physical capital.

The impact of changes in individual health investments on human capital:

$$\frac{\partial h}{\partial \mu} = \mathcal{H}_1 \mu^{\frac{\theta-\alpha-\theta\alpha}{1+\theta(\alpha-1)}} - \mathcal{H}_2 \mu^{\frac{2\theta-\alpha-2\theta\alpha}{1+\theta(\alpha-1)}} \quad (27)$$

Proposition 2: $0 < \alpha < 1$, $0 < \theta < 1$, so $\frac{2\theta-\alpha-2\theta\alpha}{1+\theta(\alpha-1)} > \frac{\theta-\alpha-\theta\alpha}{1+\theta(\alpha-1)}$, , presumed $\frac{\partial h}{\partial \mu} < 0$, so as μ decreases, individual health investment increases, human capital will increase, indicating that individual health investment will increase human capital.

The impact of changes in individual health investments on economic growth:

$$\frac{\partial g}{\partial \mu} = \Gamma_1 \frac{1-\alpha}{1+\theta(\alpha-1)} \mu^{\frac{\theta-\theta\alpha-\alpha}{1+\theta(\alpha-1)}} + \Gamma_2 \frac{\theta\delta(\alpha-1)(1+n)}{1+\theta(\alpha-1)} [1-\delta(1+n)]^{\frac{2\theta-2\alpha\theta-1}{1+\theta(\alpha-1)}} + \Gamma_3 \frac{\theta(\alpha-1)}{1+\theta(\alpha-1)} \Lambda^{\frac{-1}{1+\theta(\alpha-1)}} \times \frac{\delta\mu(1+n)(\tau_t+n)(1-\tau_t)(1-\delta)+(\tau_t+n)^2(1-\tau_t)+\delta\mu(1+n)(1-\tau_t)}{[(\tau_t+n)+\delta\mu(1+n)]^2} + \Gamma_4 \frac{\theta\alpha-\theta+\alpha}{1+\theta(\alpha-1)} \phi^{\frac{2\theta-1-2\theta\alpha}{1+\theta(\alpha-1)}} \times \frac{\delta(1+n)\{(\tau(\tau_t+n)^2(1-\tau_t)+\delta(1-v)_t+n)[(\tau_t+n)+\delta\mu(1+n)]+\delta(1-\tau_t)(1+n)[\mu(\tau_t+n)-1]\}}{[(\tau_t+n)+\delta\mu(1+n)]^2} \quad (28)$$

Proposition 3: The impact of individual health investment on economic growth depends on the relationship between individual health investment, tax rate τ_t and population growth rate n. The relationship between individual health investment and the sum of tax rate and population growth rate is "inverted U". Individual health investments promote economic growth when individual health investment is higher than the reciprocal of the sum of the tax rate and the population growth rate.

3.3.2 Changes of Government Public Health Investment

The impact of changes in government public health investment on physical capital:

$$\frac{\partial k}{\partial v} = \mathrm{F}_1 \frac{(\alpha-1)(\theta-1)}{1+\theta(\alpha-1)} v^{\frac{\alpha}{1+\theta(\alpha-1)}} - \mathrm{F}_2 [1-\delta\mu(1+n)]^{\frac{-\theta(\alpha-1)^2}{1+\theta(\alpha-1)}} - \frac{\mu}{1+n} \mathrm{F}_3 \phi^{\frac{\alpha-1}{1+\theta(\alpha-1)}} \quad (29)$$

Proposition 4: The impact of government public health investment on physical capital is influenced by the effect of individual parents' reproductive health investment on individual health human capital θ and human capital's output elasticity α, if $\mathrm{F}_1(\alpha-1)(\theta-1)/1+\theta(\alpha-1)$ is very small, then $\partial k/\partial v < 0$, as the government's public investment v increases, the physical capital k decreases, indicating that the government's public health human capital investment will occupy physical capital investment.

The impact of changes in government public health investment on human capital:

$$\frac{\partial h}{\partial v} = \mathcal{B} \frac{(1-\alpha)(\theta-1)}{1+\theta(\alpha-1)} v^{\frac{2\theta+\alpha-2\theta\alpha-2}{1+\theta(\alpha-1)}} \quad (30)$$

Proposition 5: As the government's public health investment increases, human capital increases, indicating that government public health investment will increase human capital.

The impact of changes in government public health investment on economic growth:

$$\frac{\partial g}{\partial v} = \Gamma_5 \frac{(\alpha-1)(\theta-1)}{1+\theta(\alpha-1)} v^{\frac{2\alpha\theta-\alpha-2\theta+2}{1+\theta(\alpha-1)}} - \Gamma_6 \mu \frac{\theta\alpha-\theta+\alpha}{1+\theta(\alpha-1)} \frac{(\tau_t+n)+\delta\mu(1+n)}{(1+n)(\tau_t+n)+\delta\mu(1+n)} \phi^{\frac{\alpha-1}{1+\theta(\alpha-1)}} \quad (31)$$

Proposition 6: The impact of government public health investment v on economic growth is vague. If government public health investment v and individual health investment 1-μ are at a higher level, then

TECHNIUM SOCIAL SCIENCES JOURNAL

Technium Social Sciences Journal
Vol. 8, 229-248, June 2020
ISSN: 2668-7798
www.techniumscience.com

$$\Gamma_5 \frac{(\alpha-1)(\theta-1)}{1+\theta(\alpha-1)} v^{\frac{2\alpha\theta-\alpha-2\theta+2}{1+\theta(\alpha-1)}} > \Gamma_6 \mu \frac{\theta\alpha-\theta+\alpha}{1+\theta(\alpha-1)} \frac{(\tau_t+n)+\delta\mu(1+n)}{(1+n)(\tau_t+n)+\delta\mu(1+n)} \phi^{\frac{\alpha-1}{1+\theta(\alpha-1)}} \quad (32)$$

I can conclude that government public health investment v will promote economic growth.

4. Empirical Analysis

The theoretical model shows that individual health investment and government public health investment can promote economic growth under certain parameter assumptions, and parameters such as human capital output elasticity, tax rate, population growth rate and exogenous variables such as technological progress and efficiency of health human capital investment also affect economic growth. We use economic growth as an explanatory variable. The variables of individual health investment, parental reproductive health investment and government public health investment are used as explanatory variables. We also use other parameters and exogenous variables in the model before as explanatory variables. We use panel data of 31 provinces (municipalities) in China from 1999 to 2016. The main purpose of empirical research is to test the proposition derived from the theoretical model.

4.1 Empirical Methodology

The empirical model is set as follows:

$$\ln\mathrm{PGDP}_{nt}(or\ \mathrm{GPGDP}_{nt}) = z_0 + \sum_{i=1}^{2} z_i\alpha_{it} + \sum_{j=1}^{4} z_j\alpha_{jt} + \sum_{k=1}^{3} z_k\alpha_{kt} + \sum_{m=1}^{n} r_m\alpha_{mt} + \varepsilon_{nt}$$

（33）

Where n is the province, t is the time, and *LnPGDP* 和 *GPGDP* represents the logarithm and growth rate of GDP per capita in each province; the variable of the model that is to be interpreted is the variable representing the investment in health human capital, $\sum_{i=1}^{2} z_i\alpha_{it}$ Representing the individual health investment. We selected the variables from the perspective of investment for recovering from illness. Consequently, per capita health care expenditure and the premium income of the per capita health care expenditure are taken as the proxy variable; $\sum_{j=1}^{4} z_j\alpha_{jt}$ represents the reproductive health investment. As the family-level reproductive health investment data is difficult to obtain, we use the pre-marital check rate, prenatal checkup rate, infant mortality rate and infants with birth weight less than 2500 grams as the proxy variables. Infant mortality and infant with birth weight less than 2500 grams weight can be used as output variables for reproductive health investment; $\sum_{k=1}^{3} z_k\alpha_{kt}$ represents government public health investment, which is public spending on health in the public finance framework, including improving the public health environment, increasing public health facilities, and eliminating epidemics. Three variables including government health care spending, the government subsidy on health care and subsidies for medical and health services accounted for the annual expenditure can be used. The formula, $\sum_{m=1}^{n} r_m\alpha_{mt}$ representing control variables that affect economic growth, which include fiscal expenditures on education, fixed-asset investment as a proportion of government fiscal expenditure, physical capital stock, labor, per capita consumption, urbanization rate, old-age dependency ratio, technical level, and industrial structure. All variables are continuous variables and ε_{nt} is the error term.

We use panel data from 30 provinces, from 1999 to 2016. The data on the fixed assets investment ratio and the physical capital stock are from the China Statistical Yearbook. The financial subsidy data for the medical and health comes from the fiscal yearbook. The per capita health care expenditure comes from the National Health and Wellness Committee. Health expenditure and reproductive health investment data come from the "Health Statistics

Technium Social Sciences Journal
Vol. 8, 229-248, June 2020
ISSN: 2668-7798
www.techniumscience.com

Yearbook". Similarly, the personal insurance premium income comes from the "China Insurance Statistics Yearbook".

4.2 Empirical analysis and results

4.2.1 Summary Statistics

Table 1 is the result of descriptive statistics for all data. It can be seen that, China's per capita GDP was 2, 7610.6 yuan, an average annual increase of about 10.27% from 1999 to 2016. China's per capita health care expenditure has increased from 1999 to 2016, and there is an imbalance in the per capita health care expenditures of urban and rural residents. China's per capita personal insurance premiums were 268.66 yuan per person per year from 1999 to 2016, whereas the provinces with the highest premiums reached an average of 730.34 yuan per person per year, showing the development of an imbalance in the different regions. The pre-marital check rate is low, and fluctuates significantly over the years in the provinces. However, since 2001, the prenatal check rate has been high in most provinces, exceeding 90%. The infant mortality rate and infants with birth weight less than 2500 grams (%) has declined from 2000 to 2016. China's annual average financial subsidy for medical and health services is 13.624 billion yuan, accounting for 5.64% of the final fiscal expenditure. The government's medical and health expenditures generally show a growing trend, but the gap between the regions is large.

We use a logarithmic form for variables with large standard deviations, including per capita GDP, per capita health care expenditure, per capita personal insurance premiums, financial subsidies for medical and health services, government health expenditures, fiscal expenditures on education, physical capital stocks, per capita consumption, and patent grants for the stability of the variables.

Table 1 Descriptive Statistics

Variables	Mean	Standard deviation	Variables	Mean	Standard deviation
GDP Per capita	27610.6	22632.54	Government health expenditure (100 million yuan)	1963.5	1403.52
GDP Per capita growth rate	10.27	2.84	Financial expenditure on education (100 million yuan)	476.08	450.93
health care expenditure Per capita	1393.08	903.92	Fixed assets investment ratio (%)	0.37	0.19
Per capita personal insurance premium (yuan)	268.66	298.96	Physical capital stock (100 million yuan)	7153.08	8765.01
Pre-marital check rate (%)	95.22	18.27	Labor share (%)	0.56	0.23
Prenatal checkup rate (%)	25.44	1.36	Per capita consumption (yuan)	12708.47	6314.9
Infant mortality rate (%)	11.29	5.49	Urbanization rate (%)	0.48	0.15
Infants with birth weight less than 2500 grams（%）	2.39	0.47	elderly population dependency ratio (%)	12.46	2.61
Financial subsidies for medical and health	136.24	166.48	Number of patent grants (pieces)	19613.86	40761.18

services (100 million yuan)					
The ratio of financial subsidies to medical and health services (%)	5.64	1.85	The proportion of tertiary industry output (%)	0.41	0.08

4.2.2 The Regression Results

We use a fixed utility model to conduct a regression analysis of the relationship between health investment and economic growth. In the empirical study on economic growth, some factors of economic growth are easily ignored or difficult to measure, and these factors do not change with time and are related to other influencing factors. Accordingly, we chose the fixed utility model of panel data to control the non-observed factors of "time fixed," which can solve the problem of missing variable bias to some extent.

Table 2 Empirical Regression Results

variables	lnPGDP	GPGDP
health care expenditure Per capita	0.177*** （5.28）	0.193*** （4.28）
Per capita personal insurance premium (yuan)	0.097** (2.84)	0.068 (1.89)
Pre-marital check rate (%)	0.002* （2.08）	0.005 （1.26）
Prenatal checkup rate (%)	0.006** （2.93）	0.011* （2.12）
Infant mortality rate (%)	-0.016*** （4.38）	-0.039*** （5.74）
Infants with birth weight less than 2500 grams（%）	-0.035 (1.36)	-0.052 (0.94)
Financial subsidies for medical and health services (100 million yuan)	0.004*** (12.73)	0.049*** (5.65)
The ratio of financial subsidies to medical and health services (%)	-0.005*** (-10.16)	-0.073*** (-5.03)
Government health expenditure (100 million yuan)	0.113*** (4.91)	0.446*** (5.38)
Financial expenditure on education (100 million yuan)	0.047*** (0.109)	0.084*** (0.116)
Fixed assets investment ratio (%)	0.001*** (4.21)	0.043*** (5.10)
Physical capital stock (100 million yuan)	0.518*** (14.15)	0.414*** (19.98)
Labor share (%)	-0.069*** (-3.33)	-0.030*** (-3.97)

Per capita consumption (yuan)	0.185*** (3.50)	0.363** (-3.18)
Urbanization rate (%)	0.020 (0.38)	0.372 (1.00)
elderly population dependency ratio (%)	0.004 (1.35)	-0.062 (-0.72)
Number of patent grants (pieces)	0.216*** (4.49)	0.384*** (3.63)
The proportion of tertiary industry output (%)	0.604*** (-6.41)	0.206* (-2.21)
Constant	5.646*** （15.25）	88.340*** （9.20）
F	1183.573	1340.586

Note: * indicates a 10% significance level, ** indicates a 5% significance level, *** indicates a 1% significance level

The results of individual health investment affecting economic growth show that per capita health care expenditure positively affects economic growth at a confidence level of 1%, and the impact on PGDP and GPGDP is 17.7% and 19.3%, respectively. The relationship between per capita personal insurance premium and PGDP is positive and significant at the 1% confidence level. So, for every 1% increase in personal insurance premiums, PGDP will increase by 9.7%. It can be seen that per capita health expenditure and per capita personal insurance premiums contribute to the formation of health human capital. A relatively sound body has more energy and sufficient energy to invest in production: it improves people's labor productivity and work efficiency, reduces the labor time lost due to illness, increases the effective labor time and the continuity of labor to improve the work efficiency of workers and, thus, promotes economic growth.

The results of fertility health investment affecting economic growth show that the pre-marital check rate positively affects PGDP at a 10% confidence level, with an impact of 0.2%; the prenatal check rate is positively related to the economic growth rate at 5% and 10% confidence levels respectively and the impact on PGDP and GPGDP is 0.6% and 1.1% respectively. So, pre-marital inspection and the prenatal examination for fertility have a positive impact on economic growth. Infant mortality negatively affects economic growth at a 1% confidence level, with lower infant mortality rates there is greater impact on PGDP and GPGDP (1.6%, 3.9%). It can be seen that reproductive health investment has improved genetic traits and improved the health stock of future generations, thereby reducing infant mortality and having a positive impact on economic growth.

The results of government public health investment affecting economic growth show that the impact of fiscal subsidies on health and health services on PGDP and GPGDP is positive and significant at 1% confidence level, 0.4% and 4.9% respectively. The financial subsidies for health care on economic growth are negative and significant at the 1% confidence level. The subsidy ratio is increased by 1% resulting in PGDP and GPGDP reducing by 0.5% and 7.3% respectively, which indicates that the government's increased investment in health care will promote economic growth. However, an increase in the proportion of medical and health care expenditures will slow down the rate of economic growth as the physical capital will be constrained by medical and health care expenditures to a certain extent. The reduction of physical capital will have an adverse effect on economic growth. The impact of health care expenditure on PGDP and GPGDP is positive and significant at the 1% confidence level

Technium Social Sciences Journal
Vol. 8, 229-248, June 2020
ISSN: 2668-7798
www.techniumscience.com

(11.3%, 44.6%). The absolute value of government health care expenditure has increased, and the government's responsibility in the field of health care services has gradually increased, which will have a significant positive effect on economic growth.

The regression results of individual health investment, reproductive health investment, and government public health investment on economic growth are consistent with our theoretical analysis.

In terms of control variables, the impact of fiscal investment in education, fixed asset investment, physical capital stock, per capita consumption, patent grant ratio and tertiary industry output value on PGDP and GPGDP is positive and significant. The physical capital stock contribution to growth is the largest, indicating that China's economic growth mainly depends on the accumulation of physical capital, followed by the proportion of tertiary industry output value and patent grants. The development of tertiary industry and technological progress also significantly contributes to the growth in China's GDP. The effect of labor share on PGDP and GPGDP is negative and significant; China's long-term "demographic dividend" phenomenon has been difficult to maintain and drive high economic growth.

4.3 Robustness Test

4.3.1 The Lag Term

The causal simultaneous bias caused by two-way causality is a common endogenous source in the empirical study about economic growth. To avoid the biased results of endogenous problems, we draw on generalized moment (GMM) estimation to perform the dynamic panel regression proposed by Arellano and Bond (1991). In the GMM estimation, the hysteresis value of the interpreted variable is used as a tool variable to estimate the two-way causal relationship between the two. The model is designed as follows:

$$\ln\mathrm{PGDP}_{nt}(or\ \mathrm{GPGDP}_{nt}) = z_0 + z_b\ln\mathrm{PGDP}_{nt-1}(or\ \mathrm{GPGDP}_{nt-1}) + \sum_{i=1}^{2} z_i\alpha_{it-1} + \sum_{j=1}^{4} z_j\alpha_{jt-1} + \sum_{k=1}^{4} z_k\alpha_{kt-1} + \sum_{m=1}^{n} r_m\alpha_{mt-1} + \varepsilon_{nt} \quad (33)$$

Where, $\ln\mathrm{PGDP}_{nt-1}(or\ \mathrm{GPGDP}_{nt-1})$ is the explained variable of the lag phase and the other explanatory variables and control variables lag behind the first period.

The results of the regression show that the interpretation rates of PGDP and GPGDP in the previous period for the current PGDP and GPGDP are 51.3% and 49.2%.

In terms of individual health investment, the impact of per capita health care expenditure and per capita personal insurance premium on PGDP and GPGDP is positive and significant, indicating that individual health investment not only promotes the current economic growth, but also promotes the next phase of economic growth. It can be seen that individual health investment has a sustained impact on economic growth.

In terms of reproductive health investment, the pre-marital check rate positively affects PGDP (0.3%). The prenatal check rate positively affects the economic growth rate (0.7% and 1.2%), indicating that the pre-marital check rate and prenatal check rate in the previous period which lead to increase in health human capital will have a certain impact on the current PGDP and GPGDP. Infant mortality negatively affected economic growth at 1% confidence level by 1.5% and 3.7%. Infants with a birth weight less than 2500 grams had a negative impact on PGDP and was significant at 10% confidence level by 3.7%. This finding indicates that the decrease in the proportion of infants with a previous infant mortality rate and infants with birth weight less than 2500 grams is positively related to the current economic growth. Therefore, the optimization of the health stock brought about by reproductive health investment has a continuous impact on economic growth.

In terms of government public health investment, the impact of fiscal subsidies on medical and health services in the previous period on the PGDP and GPGDP in the current period is

TECHNIUM SOCIAL SCIENCES JOURNAL

Technium Social Sciences Journal
Vol. 8, 229-248, June 2020
ISSN: 2668-7798
www.techniumscience.com

positive and significant at the 1% and 5% confidence levels. Fiscal subsidies for health care in the previous period compared to the PGDP and GPGDP in the current period is negative and significant. Government health expenditure in the previous period on the PGDP and GPGDP in the current period is positive and significant at the 5% confidence level, indicating that public health spending also has a sustained impact on economic growth.

The results of the systematic GMM estimates indicate that the results of the empirical part are robust.

Table 3 Results of GMM Test

variables	$\ln PGDP_t$	$GPGDP_t$
$\ln PGDP_{t-1}$	0.513*** （18.37）	
$GPGDP_{t-1}$		0.492*** （27.37）
health care expenditure Per capita$_{t-1}$	0.102*** （5.24）	0.115*** （4.21）
Per capita personal insurance premium$_{t-1}$	0.116** (3.04)	0.110** (2.71)
pre − marital check rate$_{t-1}$	0.003* （2.11）	0.006 （1.25）
Prenatal checkup rate$_{t-1}$	0.007* （2.06）	0.012* （2.10）
Infant mortality rat$_{t-1}$	-0.015*** （4.37）	-0.037*** （5.15）
Infants with birth weight less than 2500 grams$_{t-1}$	-0.037* (2.06)	-0.073 (1.34)
Financial subsidies for medical and health services$_{t-}$	0.037*** (4.36)	0.052** (2.94)
The ratio of financial subsidies to medical and health services $_{t-1}$	-0.061*** (-9.89)	-0.068* (-2.51)
Government health expenditure$_{t-1}$	0.157** (3.12)	0.142** (2.72)
Financial expenditure on education $_{t-1}$	0.131*** (0.0445)	0.091* (0.0478)
Fixed assets investment ratio$_{t-1}$	0.054* (2.05)	0.088 (-1.27)
Physical capital stock$_{t-1}$	0.561*** (5.95)	0.465*** (-5.78)
Labor share$_{t-1}$	-0.068*** (-3.64)	-0.010** (-3.06)
Per capita consumption$_{t-1}$	0.078 (1.34)	-5.955*** (-4.33)
Urbanization rate$_{t-1}$	0.027 （0.47）	1.507 （1.09）
elderly population dependency ratio$_{t-1}$	0.003 （0.82）	-0.023 （0.29）
Number of patent grants$_{t-1}$	0.107***	0.285***

TECHNIUM SOCIAL SCIENCES JOURNAL

Technium Social Sciences Journal
Vol. 8, 229-248, June 2020
ISSN: 2668-7798
www.techniumscience.com

	(3.49)	(4.88)
The proportion of tertiary industry output$_{t-1}$	0.665*** (-4.78)	0.604 (0.80)
Constant	7.051*** (17.17)	8.180*** (9.17)
AR(1)_Prob	0.027	0.025
AR(2)_Prob	0.89	0.91
Sargan test	0.389	0.302

Note: * indicates a 10% significance level, ** indicates a 5% significance level, *** indicates a 1% significance level

4.3.2 The Interaction Item

To avoid the bias of the general missing variables, we do a robustness test without control variables and use the method of analyzing the regional economic gap and economic growth as proposed by Frank et al. (2005). We introduce the interaction of economic growth and health human capital investment. We also use the rate of change in health human capital investment and economic growth to reflect the effect of the differences in health investment on economic growth. Our model is designed as follows:

$$\mathrm{lnPGDP}_{nt}(or\ \mathrm{GPGDP}_{nt}) = z_0 + \sum_{i=1}^{2} z_i\alpha_{it} + \sum_{a=1}^{2} z_i\alpha_{it}\,\mathrm{lnPGDP}_{nt}(\mathrm{GPGDP}_{nt}) + \sum_{j=1}^{4} z_j\alpha_{jt} + \sum_{b=1}^{4} z_j\alpha_{jt}\,\mathrm{lnPGDP}_{nt}(\mathrm{GPGDP}_{nt}) + \sum_{k=1}^{3} z_k\alpha_{kt} + \sum_{c=1}^{3} z_k\alpha_{kt}\,\mathrm{lnPGDP}_{nt}(\mathrm{GPGDP}_{nt}) + \Delta\varepsilon_{nt} \quad (34)$$

$$\mathrm{ln}\Delta\mathrm{PGDP}_{nt}(or\Delta\ \mathrm{GPGDP}_{nt}) = z_0 + \sum_{i=1}^{2} z_i\Delta\alpha_{it} + \sum_{e=1}^{2} z_i\Delta\alpha_{it}\,\Delta\mathrm{lnPGDP}_{nt}(\Delta\mathrm{GPGDP}_{nt}) + \sum_{j=1}^{4} z_j\Delta\alpha_{jt} + \sum_{f=1}^{4} z_j\Delta\alpha_{jt}\,\Delta\mathrm{lnPGDP}_{nt}(\Delta\mathrm{GPGDP}_{nt}) + \sum_{k=1}^{3} z_k\Delta\alpha_{kt} + \sum_{g=1}^{3} z_k\Delta\alpha_{kt}\,\Delta\mathrm{PGDP}_{nt}(\Delta ln\mathrm{GPGDP}_{nt}) + \Delta\varepsilon_{nt} \quad (35)$$

The results of the interpretative variables PGDP and GPGDP show that per capita health care expenditure * PGDP, per capita personal insurance premium * PGDP, premarital check rate * PGDP, prenatal check rate * PGDP, infant mortality * PGDP, infants with birth weight less than 2500 grams *PGDP, and the proportion of financial subsidies to health care *PGDP on PGDP are positive and significant. Interactions of interpretative variables and GPGDP on GPGDP have a mostly positive and significant influence on economic growth. However, the impact value is small, indicating that the effect of health human capital investment on economic growth is affected by the level of economic growth itself. The impact of human capital investment on economic growth increases slightly as the level of economic growth increases.

Both the interpreted variable and the explanatory variable are rate of change and the interaction of the rate of change shows that △ Per capita health care expenditure * △lnPGDP, △ premarital check rate * △lnPGDP, △ prenatal check rate * △lnPGDP, △ infant mortality * △lnPGDP, △infants with birth weight less than 2500 grams *△lnPGDP and △ government health expenditure * △lnPGDP has a positive and significant impact on △lnPGDP; △ per capita health care expenditure * △ GPGDP, △ premarital check rate * △ GPGDP, △ prenatal check rate * △ GPGDP, △ infant mortality * △ GPGDP, △infants with birth weight less than 2500 grams * △ GPGDP on △ GPGDP is positive and significant. However, the effect of all the interactions is relatively small, indicating that impact of changes in health human capital investment on changes in economic growth is affected by changes in economic growth. The impact of changes in human capital investment on changes in economic growth increases slightly as the rate of change in economic growth increases.

Table 4 Results of Introducing Interactive Items

variables	lnPGDP	GPGDP	variables	△lnPGDP	△GPGDP
health care expenditure Per capita	0.104***（5.37）	0.115***（4.94）	△health care expenditure Per capita	0.109**（3.82）	0.106**（2.94）
Per capita personal insurance premium	0.053*** (19.38)	0.786 (1.56)	△Per capita personal insurance premium	0.073 (-1.80)	0.106 (0.49)
Pre-marital check rate	0.002*（2.08）	0.005（1.26）	△Pre-marital check rate	0.006（1.08）	0.009（1.68）
Prenatal checkup rate	0.006**（2.93）	0.011*（2.12）	△Prenatal checkup rate	0.011**（2.84）	0.018*（2.04）
Infant mortality rate	-0.016***（4.38）	-0.039***（5.74）	△Infant mortality rate	-0.014**（3.18）	-0.028*（2.11）
Infants with birth weight less than 2500 grams	-0.037 (1.36)	-0.052 (0.94)	△Infants with birth weight less than 2500 grams	-0.029* (2.16)	-0.048 (1.83)
Financial subsidies for medical and health services	0.0013*** (8.87)	0.0028*** (4.56)	△Financial subsidies for medical and health services	0.122 (-1.87)	0.038* (-2.21)
The ratio of financial subsidies to medical and health services	0.0135 (1.70)	0.0635 (0.44)	△The ratio of financial subsidies to medical and health services	-0.005 (-0.12)	0.051* (2.57)
Government health expenditure	0.111 (1.88)	-0.027** (-2.59)	△Government health expenditure	0.021** (2.95)	0.015 (0.05)
health care expenditure Per capita *lnPGDP	0.005*** (8.37)		△health care expenditure Per capita *△lnPGDP	0.008*** (8.34)	
health care expenditure Per capita * GPGDP		0.002*** (6.48)	△health care expenditure Per capita * △GPGDP		0.003*** (5.38)
Per capita personal insurance premium *lnPGDP	0.0006*** (8.18)		△Per capita personal insurance premium *△lnPGDP	0.0009 (0.70)	
Per capita personal insurance		0.001*** (6.83)	△Per capita personal insurance		0.0005 (0.74)

premium * GPGDP			premium * △GPGDP		
Pre-marital check rate *lnPGDP	0.0004*** (8.36)		△Pre-marital check rate *△lnPGDP	0.001*** (7.47)	
Pre-marital check rate * GPGDP		0.0007*** (6.93)	△Pre-marital check rate * △GPGDP		0.0005*** (6.37)
Prenatal checkup rate *lnPGDP	0.0005*** (9.03)		△Prenatal checkup rate *△lnPGDP	0.0004*** (8.02)	
Prenatal checkup rate * GPGDP		0.0004*** (7.18)	△Prenatal checkup rate * △GPGDP		0.0002*** (6.58)
Infant mortality rate *lnPGDP	0.00009*** (5.38)		△Infant mortality rate *△lnPGDP	0.0001*** (5.33)	
Infant mortality rate * GPGDP		0.0006*** (4.95)	△Infant mortality rate * △GPGDP		0.00005*** (5.29)
Infants with birth weight less than 2500 grams *lnPGDP	0.0004*** (8.02)		△Infants with birth weight less than 2500 grams *△lnPGDP	0.00009*** (7.49)	
Infants with birth weight less than 2500 grams * GPGDP		0.0007*** (4.38)	△Infants with birth weight less than 2500 grams * △GPGDP		0.00004*** (3.94)
Financial subsidies for medical and health services *lnPGDP	-0.00001*** (2.16)		△Financial subsidies for medical and health services *△lnPGDP	-0.00002 (1.16)	
Financial subsidies for medical and health services * GPGDP		-0.00007*** (-0.72)	△Financial subsidies for medical and health services * △GPGDP		-0.00003*** (-0.43)
The ratio of financial subsidies to medical and health services *lnPGDP	0.0005* (2.16)		△The ratio of financial subsidies to medical and health services *△lnPGDP	-0.00005 (-0.02)	

The ratio of financial subsidies to medical and health services * GPGDP		-0.0001 (-0.56)	△The ratio of financial subsidies to medical and health services * △GPGDP		-0.0001 (-1.38)
Government health expenditure *lnPGDP	0.0009 (0.14)		△Government health expenditure *△lnPGDP	0.00008*** (-4.02)	
Government health expenditure *GPGDP		0.0002 (1.11)	△Government health expenditure *△GPGDP		0.00006 (0.87)
Constant	5.837*** (34.90)	4.648** (2.61)	Constant	8.239*** (28.75)	-0.458 (-0.60)
F	1036.837	1193.475	F	1108.465	1136.930

Note: * indicates a 10% significance level, ** indicates a 5% significance level, *** indicates a 1% significance level

5. Results

The role of health in human capital investment in economic growth of a country is becoming increasingly important. The theoretical model shows that when the investment efficiency of health human capital is high, reproductive health investment has a positive correlation with economic growth. The model also shows that individual health investment and government public health investment constrains physical capital, but it can increase human capital, so the effect on economic growth is positive.

The empirical tests using China's provincial panel data show that individual health, reproductive health, and government public health investment all have a significant positive effect on economic growth, which also shows that the “health dividend” is an important driving force for China’s economic growth. Our study also found that individual health investment has the highest positive effect on economic growth. Consequently, the government should also encourage families to make health investments while it increases investment in health, thus generating optimal economic benefits. Therefore, China’s reform of implementing a Chinese health strategy and health investment is correct. China has entered a new stage of improving human capital through health investment, realizing the conversion of demographic dividends from quantity to quality which benefits the economy.

However, we also can see that although the individual’s health investment, reproductive health investment and government health care investment have a positive effect on economic growth, China’s problems ae that the level of health investment is small, the regional health investment gap is large and the imbalanced in development of health will significantly affect the development of regional health human capital and affect regional economic growth. As health in human capital investment will occupy physical capital to a certain extent, China should balance the relationship between its investment in the health of its human capital and its physical capital investment, optimizing the ratio of physical capital and health human capital investment. We found that reproductive health investment, individual health investment, and government public health investment have different effects on economic growth, compared

with reproductive health investment and government public health investment. Individual health investment plays the greatest role in economic growth, so China should adjust the relationship between government and individuals in health investment promote the optimization of health investment structure and maximize the impact of health human capital investment on economic growth.

Compared with the existing literature, the theoretical model of this paper relaxes some assumptions and considers the intergenerational inheritance of health investment, so the conclusions are more abundant. The complex impact mechanism of health in human capital investment on economic growth is the focus of the next research. Health in human capital investment can affect economic growth by increasing labor productivity and labor supply: it can also influence formation factors of production factors such as education in human capital and technological progress, as well as influence consumption and savings by affecting family decision-making, which has an impact on economic growth.

Acknowledgments

My research was funded by grants from National Science Foundation of China (71903209), and Basic Scientific Research Business Expenses of Central University (QL18008)

References

[1] Grossman, M., 1972, the Demand for Health: A Theoretical and Empirical Investigation [J], Columbia University Press.
[2] Arrow, K. J., 1963, Uncertainty and the Welfare Economics of Medical Care, The American Economic Review, 53(5):941-973.
[3] Chou S., M. Grossman, H, Saffer, 2002, An Economic Analysis of Adult Obesity: Results from the Behavioral Risk Factor Surveillance System, NBER Working Paper No. 9247.
[4] Wagstaff A, 2005, The bounds of the concentration index when the variable of interest is binary, with an application to immunization inequality, Health Economic, 14(4):429-32.
[5] North D., 1981, Structure and Change in Economic History, New York.
[6] Solow. R M A. Contribution to the Theory of Economic Growth, Quarterly [J]. Journal of Economics. 1956(70):165-194.
[7] Modigliani, F. and Brumberg, R.H., 1954 Utility Analysis and the Consumption Function: An Interpretation of Cross-Section Data. In: Kurihara, K.K., Ed., Post-Keynesian Economics, Rutgers University Press, New Brunswick, 388-436.
[8] Samuelson P. A., 1958, An Exact Consumption-Loan Model of Interest with or without the Social Contrivance of Money, Journal of Political Economy 66(6):467-482.
[9] Feldstein M., Social Security, Induced Retirement, and Aggregate Capital Accumulation, Journal of Political Economy, 82(5): 905-926.
[10] Kotlikoff L. 1988, Does the consumption of different age groups move together? A new non-parametric test of intergenerational atruism. NBER Working paper No. 2490.
[11] Chou S., J. Liu, J. K. Hammitt, 2006, Households' Precautionary Behaviors—The Effects of the Introduction of National Health Insurance in Taiwan, Review of Economics of the Household 4(4):395-421.
[12] Mu Huaizhong, 2001, Analysis on the economic effect of social security level, Chinese Journal of Population Science, 3.
[13] Romer, P. M., 1986, Increasing Returns and Long-Run Growth, The Journal of Political

TECHNIUM SOCIAL SCIENCES JOURNAL

Technium Social Sciences Journal
Vol. 8, 229-248, June 2020
ISSN: 2668-7798
www.techniumscience.com

Economy, 94(5): 1002-1037.
[14] Lucas, R. E., 1988, "On the Mechanics of Economic Development", Journal of Monetary Economics, 22: 3-42.
[15] Martin Fe Lucas, R. E., 1988, On the Mechanics of Economic Development[J], Journal of Monetary Economics, Vol.22, pp.3~42.
[16] Kemnita, A., and B. U. Wigger, 2000, Growth and Social Security: the Role of Human Capital. European Journal of Political Economy, (16): 673-683.
[17] Shen, Y. 2012, The Impact of Social Security on Human Capital and Its Economic Growth—Based on China's Data from 1989 to 2008. Soc. Secur. Res. 4, 69–76.
[18] Barro, R. J. and X. Sala-I-Martin, 1995, Economic Growth, NewYork, McGraw-Hill Inc
[19] Perotti, R., 1996, Growth, Income Distribution and Democracy: What the Data Say. Journal of Economic Growth, 1(2): 149-187.
[20] Ludo Cuyvers, Glenn Rayp, 1998, Social Dumping and Social Competition in the Global Economy, Intersentia Economische Wetenschappen, Editors: Ludo Cuyvers, Bart Kerremans, pp.13-47
[21] Bellettini G. and C. B. Ceroni, 2000, Social security expenditure and economic growth: an empirical assessment, Research in Economics, 54(3): 249-275.
[22] Zhang, J., Zhang, J., 2004, How does social security affect economic growth? Evidence from cross country data. Journal of Population Economics 17, 473–500.
[23] Lee C., C. Chang, 2006, Social security expenditure and GDP in OECD countries: A cointegrated panel analysis, International Economic Journal 20(3): 303-320.
[24] Wang Dihai, health human capital, economic growth and poverty trap [J], Economic Research Journal, 2012, 6: 144-155
[25] Diamond, P. A., 1977, A framework for social security analysis, Journal of Public Economics 8: 275-298.