ISSN 2706-6827 Vol. 3, Issue 12: 35-40, DOI: 10.25236/IJFS.2021.031206

The Interaction between Health Capital Stock and Economic Growth

Wanting Zhang

Shanghai University, Shanghai 200000, China

Abstract: *The health of citizens affects their labor ability. The labor ability of the whole society determines the labor output, and the physical output will bring economic growth, that is, the health of citizens will indirectly affect the economic growth of the whole society. This paper uses the data of public health investment, per capita GDP and fixed capital stock of ten developing and developed countries from 1980 to 2016 to explore the different degrees of interaction between health capital stock and economic growth between developing and developed countries, as well as the possible causal relationship between health capital and economic growth. After unit root test and cointegration test to test the stationarity of the data and ensure that there is no pseudo regression, OLS regression is carried out on the data. The regression results confirm or partially confirm three hypotheses: the promotion degree of health capital to the economic growth of developed and developing countries is significantly different, and the promotion degree of health capital to developing countries is higher; In the long run, the promoting effect of health capital on economic growth is weakened; There is a causal relationship between health capital and economic growth.*

Keywords: *Health capital stock, Human capital, Economic growth*

1. Introduction and Literature Review

Economic growth is one of the four goals of macroeconomics, and it is also an issue that will never fail in the field of economics. In the study of economic growth, the positive role of human capital in promoting economic growth has been widely proved, and many extension problems based on the two have been proposed and solved by researchers. Bian Yajing and Shen Lisheng (2004) believe that human capital is of decisive significance in the early stage of regional economic development, which is also an important factor hindering the economic development of Western China; Du Wei, Yang Zhijiang and Xia Guoping (2014) believe that human capital will have a direct or indirect impact on economic growth, which depends on the level of economic development of a region. In the research, human capital is usually divided into health and education. This paper focuses on the part of health, namely "health capital (stock)" in this paper.

The great impact of COVID-19 on the global economic, political and financial situation at the beginning of 2020 is a proof of the impact of citizens' life and health on social and economic growth in a society. Population health is a key factor in economic growth. Healthier workers are more energetic physically and mentally and have higher production efficiency, which is particularly evident in developing countries. The proportion of labor force in developing countries is much higher than that in industrial countries. Liu He, vice premier of the State Council, pointed out at the 12th Lujiazui forum that we should pay more attention to human life and health, promote national economic and social development and scientific and technological innovation, and pay more attention to the harmonious coexistence of human and nature. The increase of health stock and the prolongation of population life span are conducive to economic growth and economic development. Firstly, the increase of health stock is manifested by the increase of health time and the decrease of "sick time", that is, the increase of labor time and labor input is conducive to the increase of output; Secondly, having a relatively sound body and a relatively strong physical strength to put into production can improve human hour labor productivity and work efficiency; Third, the extension of people's life expectancy provides additional incentives to obtain more education. Parents are willing to invest in their children, especially in their children's intelligence, which will promote the improvement of labor productivity in the future.

Most literatures have proved that the increase of health capital stock has a positive effect on economic growth. Seema Narayan (2010) and paresh Kumar Narayan (2010) conducted an empirical study on the health and economic growth of five Asian countries. They found that health, R&D, export

ISSN 2706-6827 Vol. 3, Issue 12: 35-40, DOI: 10.25236/IJFS.2021.031206

and investment have positive contributions to economic growth, and Asian countries can achieve higher economic growth by investing more funds in these areas. By constructing the production function model, David E. bloom and David Canning (2003) believe that good health has a significant positive impact on the total output under the control of labor experience; But in the context of different levels of national income, the role of promotion or inhibition may be different. Kuan min wanga and Yuan Ming Lee (2018) believe that health shock will stimulate economic growth at high income level, but at low income level, health shock will make economic growth stagnate. Weil (2007, P. 1295 and 2005, P. 153-161) also shows that health has the strongest positive impact on GDP in poor countries. For rich countries, the existing empirical evidence on whether health capital formation will stimulate GDP growth is mixed.

1.1. Hypothesis 1: There is a Significant Difference in the Promotion of Health Capital to Economic Growth between Developed and Developing Countries.

The economic growth of the whole society depends not only on human capital, but also on physical capital. The excessive increase of the stock of health capital may crowd out the growth space of physical capital. In the long run, it may reduce or reverse the promotion effect of health capital on economic growth, or even bring slight negative effects on economic growth. For example; Liutang Gong and Hongyi Li (2003) use the extended Ramsey model of arromer production function and Grossman (1972) utility function to think that health level has a positive impact on economic growth rate by improving labor production efficiency, but excessive health investment may affect the accumulation of tangible capital and thus have a negative impact on economic growth; Jochen Hartwig (2010) does not support the view that health capital promotes long-term economic growth in OECD countries, but does not rule out that developing countries have different conclusions; The empirical study of Jose A. Tapia Granados (2008) shows that the economic growth of Sweden in the 19th century is positively related to the healthy progress, but this relationship completely reversed in the second half of the 20th century. Therefore, we propose a second hypothesis

1.2. Hypothesis 2: In the Long Run, the Promoting Effect of Health Capital on Economic Growth May Weaken or Reverse.

Economic growth has a negative impact on healthy progress. However, there are few studies on the reverse causality between health capital and economic growth. Human capital in society can be increased by increasing the stock of citizens' health capital, which brings about the improvement of social productivity and economic growth. Economic growth represents the increase of gross national product and the improvement of people's income. Can economic growth in turn provide more health expenditure for the society and promote the increase of health capital stock of the whole society? On the issue of whether health promotes income (growth) or whether income (growth) promotes health, Jochen Hartwig (2008) uses the evidence from five OECD countries to support the "income view" rather than the "health view". He believes that the increase of income drives the increase of health capital stock, rather than the increase of health capital stock drives economic growth, But applying data from other countries may have different results. Considering the possible mutual causality between the two, this paper decides to explore the strength of causality in two directions

2. Data and Methods

How to measure health capital? In the field of health economics, Newhouse (1977) proposed that HCE (health care expenditure) is the most important and the only reliable explanatory variable; Jochen Hartwig (2008) also pointed out that 60% of the existing studies on the role of health in promoting the macro-economy rely on different measures of life expectancy or adult survival rate, and nearly one third of the studies choose medical expenditure (HCE) as the measurement standard. The stock of health capital is closely related to the innate physical quality of citizens and their investment in health capital. Among them, the investment in health capital after tomorrow can be divided into the public health expenditure of the state on citizens and the personal expenditure of citizens to protect their own health. This paper selects the public health expenditure of the state on citizens divided by the total number of citizens in that year as the per capita government public health expenditure. Therefore, this paper takes HCE as a key variable to explore the two-way causal relationship between health capital and economic growth.

In terms of data selection, developed countries selected the United States, the United Kingdom,

ISSN 2706-6827 Vol. 3, Issue 12: 35-40, DOI: 10.25236/IJFS.2021.031206

Spain, Australia and Japan, while developing countries selected China, India, South Africa, Brazil and Turkey. The data of per capita government public health expenditure comes from the OECD database, and all of them use the CPI data over the years to eliminate the inflation factor of currency, and get more real data. The CPI data comes from the database of the United Nations Department of trade and development. Per capita GDP comes from the world bank's current dollar data, so there is no need to exclude the price effect. Some auxiliary data sets, such as the ratio of public education expenditure to GDP, the ratio of government public health expenditure to GDP, the total number of labor force (million people) and the percentage of fixed capital to GDP, are from the world bank database. All data span from 1980 to 2016. Due to some missing data in different countries, different data categories and spans are used to test different hypotheses. For the first two hypotheses, this paper first tests the stationarity of time series data with unit root test, then uses cointegration test to confirm that there will be no pseudo regression, and then uses OLS regression; For the third hypothesis, Granger causality test is carried out on the test results based on the stationarity of the above data.

3. Empirical Results

3.1. Unit Root, Cointegration test

Most of the existing studies start from the production function to explore the relationship between health and economic growth. Based on Cobb Douglas production function, this paper constructs a production function model to explore the role of health capital in promoting economic growth in developing and developed countries:

$$y = AK^{\alpha}W^{\beta} \tag{1}$$

Among them, per capita GDP, total factor productivity, and the percentage of fixed capital in GDP; It is the compound human capital, which is determined by the formula. It is the human capital of workers in the form of health, expressed as the percentage of government public health expenditure in GDP; It is human capital in the form of education, expressed as the percentage of total public expenditure on education to GDP; It is the number of labor force in that year. After combining the formulas, the logarithms of the two sides are obtained:

$$\ln y = \ln A + \alpha \ln K + \beta_1 \ln e + \beta_2 \ln h + \beta_3 \ln l + \varepsilon \tag{2}$$

It is the model of health capital promoting economic growth. Now we do ADF unit root test on the time series data of ten countries to test the stationarity of the data series and prevent the occurrence of pseudo regression. When there is a unit root, the time series data is unstable.

The unit root test shows that most of the original variable series of ten countries are not stable, many of them become stable after first-order difference, and a few of them are stable, but not stable after first-order difference. South Africa's data series fully meet the first-order single integer, Turkey's data series and China's data series are stable, UK's data series and USA's data series meet the first-order single integer. We excluded Brazil and Spain from the data group of developing countries and developed countries respectively, leaving the remaining data set for regression.

3.2. OLS Regression

After the unit root and cointegration test, we conclude that most variables satisfy the first-order single integration, and there is a long-term stable relationship between the variables. Therefore, OLS regression can be used to get the relationship between health capital and economic growth in different countries.

The regression result set is as follows

Table 1: OLS Regression Results - Developed Countries

Australia			Britain			Japan			USA		
Variable	coefficient	P	Variable	coefficient	P	Variable	coefficient	P	Variable	coefficient	P
$\ln K$	0.190	0.746	$\ln K$	1.085**	0.043	$\ln K$	-1.986	-	$\ln K$	-	-
$\ln e$	-0.721	0.192	$d\ln e$	2.237**	0.045	$\ln e$	0.305	-	$\ln e$	-	-
$\ln h$	-3.509**	0.011	$d\ln h$	-0.305**	0.133	$\ln h$	-	-	$\ln h$	0.064	-
$\ln l$	6.474	0.000	$\ln l$	1.475***	0.005	$\ln l$	-	-	$d\ln l$	-	-

ISSN 2706-6827 Vol. 3, Issue 12: 35-40, DOI: 10.25236/IJFS.2021.031206

After excluding the data set of Spain, due to the lack of some data in Japan and the United States, the data available for reference in the developed countries group is very limited. In the regression data set of Australia, only the coefficient of the item is significant at the 95% confidence level, that is, when other variables remain unchanged, the proportion of public health expenditure in GDP increases by 1%, which will reduce the per capita GDP by 3.509%, indicating the reverse relationship between the proportion of public health expenditure in GDP and per capita GDP, which is not consistent with common sense, However, it confirms the research conclusion of joche (2009) on OECD countries. The significance of the regression results of the British data set is very good, and the four independent variables are at least significant at the 95% confidence level. The following regression equations can be listed:

$$\ln Y = 1.085\ln K + 2.237d\ln e - 0.305d\ln h + 1.475\ln l \quad (3)$$

The percentage of fixed capital in GDP, the percentage of total public expenditure on education in GDP and the number of labor force in that year are directly proportional to the per capita GDP, and the proportion of public expenditure on education in GDP contributes the most to the per capita GDP. The coefficient of the UK data set before the proportion of public health expenditure in GDP is as negative as the Australian data set, because the public health variable adopts the first-order difference, so the absolute value is small, which can be explained that when other variables remain unchanged, the growth rate of public health expenditure in GDP increases by 1%, which will reduce the per capita GDP by 0.305%. The former coefficient of the ratio of public health expenditure to GDP in the US data set is 0.064, but the reliability of the coefficient is not strong due to the lack of data.

Table 2: OLS Regression Results - Developing Countries

India			Turkey			South Africa			China		
Variable	coefficient	P	Variable	coefficient	P	Variable	coefficient	P	Variable	coefficient	P
$\ln K$	-0.327	0.827	$\ln K$	1.680***	0.010	$\ln K$	1.486***	0.000	$\ln K$	1.762	0.570
$\ln e$	1.108	0.177	$\ln e$	-0.378	0.503	$\ln e$	1.381**	0.025	$\ln e$	-0.399	0.818
$\ln h$	1.722*	0.094	$\ln h$	0.962**	0.031	$\ln h$	0.526*	0.074	$\ln h$	-1.033	0.660
$\ln l$	9.910***	0.005	$\ln l$	0.636	0.806	$\ln l$	1.956	0.001	$\ln l$	79.245	0.239

After excluding the data set of Brazil, the regression results of developing countries are better than those of developed countries. In the Indian data set, the coefficients of the ratio of public health investment to GDP and the number of labor force in that year are significant at the 90% and 99% confidence levels respectively. When other variables are kept unchanged, the per capita GDP will increase by 1.722% for every 1% increase in the ratio of public health investment to GDP. The coefficients of the ratio of fixed capital to GDP and the ratio of public health investment to GDP in Turkey's data set are positive, and they are significant at the confidence level of 99% and 95% respectively, which are statistically reliable. That is to say, when other variables are kept unchanged, when the ratio of public health investment to GDP increases by 1%, the per capita GDP increases by 0.962%. In South Africa, the data is 0.526%, It was significant at 90% confidence level. In the regression of Chinese data sets, P values are relatively large, which is not statistically significant. The coefficient is not explained in the economic sense here.

Based on the regression results of developing countries, we can find that the regression coefficients of the ratio of public health investment to GDP in developing countries are all positive, and all the coefficients are statistically significant at a significant level of at least 90%. This is in sharp contrast to the negative coefficient of developed countries. So far, we can verify the correctness of hypothesis 1: "there is a significant difference in the promotion of health capital to economic growth between developed and developing countries". In the period of 1990-2016, health capital represented by the proportion of public health investment in GDP has no promoting effect on the economic growth of developed countries, but has promoting effect on the economic growth of developing countries. However, this conclusion has some limitations, because the data set of developed countries has some deficiencies, only based on the consistent conclusion of two countries can not define all developed countries.

In order to test hypothesis 2, and the previous unit root test has proved that the data of these two countries meet the first-order single integer, we use the data of Turkey and South Africa from 1980 to 2016 to carry out the extract regression, and compare the regression results of 1980-2006 with those of 1980-2016:

ISSN 2706-6827 Vol. 3, Issue 12: 35-40, DOI: 10.25236/IJFS.2021.031206

Table 3: Comparison of Regression Results in Different Time Spans - South Africa

South Africa					
1980-2006			1980-2016		
Variable	Coefficient	P	Variable	Coefficient	P
$\ln K$	2.304754***	0.002	$\ln K$	1.486364***	0.000
$\ln e$	1.444174	0.122	$\ln e$	1.381407**	0.025
$\ln h$	2.286796**	0.024	$\ln h$	0.5262903*	0.074
$\ln l$	0.1217648	0.881	$\ln l$	1.955797***	0.001

Table 4: Comparison of Regression Results in Different Time Spans - Turkey

Turkey					
1980-2006			1980-2016		
Variable	Coefficient	P	Variable	Coefficient	P
$\ln K$	1.894778**	0.015	$\ln K$	1.6807788***	0.010
$\ln e$	1.028733**	0.047	$\ln e$	-0.3780457	0.503
$\ln h$	1.064335*	0.070	$\ln h$	0.9623561**	0.031
$\ln l$	0.776891	0.408	$\ln l$	0.6364567	0.806

It can be seen from the data of South Africa and Turkey that the regression coefficient of public health investment in GDP in 1980-2016 is smaller than that in 1980-2006, and both have statistical significance in the 90% confidence interval, that is, the promotion effect of health capital on per capita GDP will decrease with the increase of time, which is limited by the size of the data, It is not known here whether there will be a reversal effect in a longer period of time. This is partly consistent with the conclusion of Jose A. Tapia Granados (2008) on Sweden in the 19th-20th century. So far, we can verify that the second hypothesis "in the long run, the promotion effect of health capital on economic growth may weaken or reverse" is partially correct, and this hypothesis is applicable to South Africa and Turkey. It seems that it is not comprehensive to use two countries to represent developing countries. It can only show that the situation described in the hypothesis does exist.

4. Conclusion

The empirical results are subject to the true reflection of the data. Although it may be contrary to the previous research and common sense, we should still respect the empirical results and consider the deep reasons for the conclusion in combination with the economic background. The two hypotheses mentioned in the introduction of this paper have been confirmed to varying degrees. Although the conclusion drawn due to the lack of data may not be universal in the whole category of developing countries or developed countries, this paper at least confirms the existence of this phenomenon.

Hypothesis 1: "there is a significant difference in the promotion degree of health capital to economic growth between developed and developing countries" has been clearly confirmed in the regression. Specifically, the coefficient in front of the variable of the ratio of public health expenditure to GDP in developed countries is negative, while the corresponding coefficient in developing countries is positive, That is to say, the promoting effect of health capital stock on economic growth in a country is only reflected in developing countries, but it has a negative weakening effect on developed countries. That is to say, under the background of low income level, paying attention to improving the health capital stock in society is more conducive to economic growth, In 2000, Alok Bhargava and Dean T. Jamison used adult survival rates (ASR) to measure health and its relationship with economic growth. They also proved that ASR of low-income countries has a positive impact on GDP growth. On the one hand, due to the different levels of healthy development between developing and developed countries, the utility increment of the new health capital in the proportion of public health investment to GDP on the whole society is not the same; Another important reason is how to measure health capital (stock).

Using HCE as an indicator to measure health is the mainstream choice of health and economic growth research, because citizen health is a kind of invisible human capital that needs to be maintained with money from time to time, which is essentially different from the education capital that can be retained for life by the education funds invested in a single citizen at one time. Therefore, the health level of the whole society, or health capital stock, is closely related to the money spent by the government on maintaining health for citizens. But for every citizen, the cost of maintaining health includes not only the public medical resources provided by the government for citizens, but also the

ISSN 2706-6827 Vol. 3, Issue 12: 35-40, DOI: 10.25236/IJFS.2021.031206

family expenditure that citizens pay for their own health. This part of private expenditure also has a positive effect on consolidating citizens' health capital, but this paper abandons it and does not measure it, And this part of private expenditure may be the reason that the promotion effect of developed countries and developing countries is opposite. In developed countries, the per capita income is higher, citizens have more income to buy health services for themselves, and the role of government public health investment is relatively small or even negative; The per capita income of developing countries is low, and citizens do not have much income to allocate to consolidate their own health capital stock, but rely more on the public health products provided by the government for citizens. Therefore, in developing countries, the government's public health investment can provide absolute positive promotion effect for citizens' health capital stock. Alok Bhargava, who uses ASR to measure health, has a similar view on the selection of indicators. He believes that ASR in poor countries reflects factors such as nutrition level, smoking prevalence, infectious diseases, health infrastructure and accidents leading to premature death, while ASR in middle and high-income countries may be affected by genetic factors, access to prevention and treatment health care and costs, Future research should compile more detailed indicators to measure health.

Hypothesis 2 "in the long run, the promotion effect of health capital on economic growth may weaken or reverse" has been partially confirmed in the empirical study - only the existence of weakening effect has been proved, which is reflected in the sample data of two countries, The former is greater than the latter in terms of "the ratio of public health investment to GDP" obtained by 26 year data regression and 36 year data regression. In fact, the definition of short-term and long-term concepts is not accurate. Limited to the data scale, the sample period of the two is only 10 years. In the study of Sweden in the 19th and 20th century, Jose A. Tapia Granados (2008) found that the strong positive correlation between economic growth and health progress in Sweden gradually weakened in the first half of the 19th century, and the relationship between them reversed to negative in the second half of the 20th century. This paper obtains the same result in the return of South Africa and Turkey. Here we propose a hypothesis: is the promotion effect of health capital on economic growth diminishing marginal utility? If so, is there a critical value between positive and negative promotion effect? This is an interesting problem worthy of further study.

References

[1] Fan Hongzhong, Chen pan. The impact of government health expenditure on economic growth and its regional differences [J]. China health economy, 2016,35 (09): 50-52

[2] Geng Jiachuan, Miao Junfeng. Economic growth effect of public health expenditure [J]. Social science research, 2008 (05): 59-62

[3] Han Hwei, Miao Yanqing. Empirical Study on efficiency accounting and influencing factors of local government health expenditure -- DEA Tobit analysis based on panel data of 31 provinces in China [J]. Financial research, 2010,36 (05): 4-15+39

[4] Huang Rong, Chen Yan. Research on the relationship between financial investment in public health services and economic growth [J]. China's health economy, 2015,34 (07): 51-52

[5] Li Hua, Yu Wei. The impact of government health expenditure on the health of rural residents in China [J]. China Social Sciences, 2013 (10): 41-60 + 205

[6] Liu Yongzheng, Zhang Kun. Empirical analysis of the economic growth effect of public health expenditure in China [j]. North economy, 2007 (24): 9-10

[7] Lou Zhengrong. Research on the efficiency of public service fiscal expenditure in China [D]. China University of mining and technology, 2008

[8] Luo Yongmin. Public health expenditure, health human capital and economic growth [J]. Southern economy, 2011 (04): 3-15

[9] China Health Statistics Yearbook, China Union Medical University Press, April 2019, Yearbook