

The Impact of The Second Demographic Transition on Human Capital Accumulation

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Abstract: China's "demographic dividend" is gradually disappearing in the context of an aging population, and according to previous studies, China is between the second and third stages of the demographic transition. As the basis of human capital accumulation, the transformation of population has great significance for human capital accumulation. This paper uses the Cobb Douglas production function as a mathematical model, in which the population transition takes the population age structure as the core explanatory variable, and adds industrial transformation, economic growth, The education level of the household income level of the school-age labor force is used as the control variable, and using the interprovincial panel data from 2000 to 2020, the empirical results show that the second population transition has an obvious positive effect on human capital accumulation, and human capital has a first-order lag, which itself has an accumulation effect, and education investment does not have a positive effect because education expenditure accounts for less share of GDP, in addition, industrial transformation, economic growth, and household income level will promote human capital accumulation.

Keywords: Demographic dividend, Demographic transition, Human capital accumulation.

1. Introduction

The phenomenon of "demographic transition" has been "hiding" in Europe since the 19th century, more than 200 years ago, and spread worldwide during this period. The first systematic proposal of the theory of population transition was the American demographer Nottestein put forward the "three-stage theory" of population transformation: the first stage is a high birth rate and high death rate; the second stage is the population in transition, the birth rate and death rate have begun to decline, but the mortality rate has fallen faster and the population has grown rapidly; the third stage of birth rate and death rate have dropped to a low level.

With the release of the results of the seventh national census, the issue of Chinese population transformation has once again become a hot topic of discussion in all walks of life. According to the seventh national census, the proportion of China's population over 60 years old has reached 18.7%, and the population over 65 years old has reached 13.5%[1]. In the past ten years since the sixth national census, the structural transformation of the Chinese population has been rapid and wide-ranging, which has triggered our thinking about various policies to deal with China's overall aging society. On June 26, 2021, the Central Committee of the Communist Party of China and the State Council issued the Decision of the Central Committee of the Communist Party of China and the State Council on Optimizing Fertility Policies and Promoting Long-term Balanced Population Development, which pointed out: "It is expected that China's population will enter a stage of moderate aging during the 14th Five-Year Plan period, and enter a stage of severe aging around 2035, which will have a far-reaching impact on all fields of economic operation, all aspects of social construction, and social and cultural aspects"[2]. On the one hand, this statement means that since the reform and opening-up, one of the main driving forces of China's economic growth, the abundant labor advantage endowment is being lost, the demographic dividend window period is gradually closing, and the labor resource "assets" enjoyed during the

demographic dividend period are gradually transformed into the "debt" of the high-dependency population in the period of population aging.

The international standard for measuring population aging is that the proportion of the population over 60 years old exceeds 10%, or the proportion of people over 65 years old exceeds 7% [3]. From the data point of view, China has entered the aging society since 1999, for more than ten years; in 2014, the proportion of China's population over 65 years old in the total population reached 10.1%, which has penetrated into the aging society. It is precisely because the family planning policy implemented in the late decade of the last century has reduced the birth rate and total fertility rate, accelerated the aging of the Chinese population, and China has gradually begun to face the embarrassing situation of "getting old before getting rich". According to the latest population projections of the United Nations, the number of elderly people over 65 years old in China will continue to rise in the next 40 years, and the proportion of elderly people over 65 years old will reach 15%-17% by 2030, which is a very surprising figure. With the aging of China's population, the working-age population has begun to decrease, and if we do not seek ways to improve the quality of labor, then the sustainable development of our economy will not be guaranteed[1]. However, in recent years, European and American scholars have exaggerated the negative effects of population aging and pointed to the demographic dividend that promotes China's economic growth.

2. Theoretical Basis and Propagation Mechanism

2.1. Human Capital Theory

Early theories of human capital, including W. Petty's Theory of Taxation and A-Smith's The Nature and Causes of National Wealth, noted labor resources and skills, but did not propose a complete concept of human capital. In 1960, Theodore Schultz published "On Human Capital Investment", which established a systematic theory of human capital,

which was later called the "father of human capital". Theodore Schultz began to study human capital because, in analyzing the relationship between economic growth and social development, the statistical research of World War II found that the growth rate of national income was much faster than the growth rate of national investment in resources, so the phenomenon of productivity increase in economic production cannot be explained by physical capital and labor factors alone. He also argues that the most important determinant of social progress is human capital, which contributes far more to economic growth than all other forms of capital production combined combined[4]. However, the process of acquiring human capital requires the consumption of other capital without investment, and the return on investment is the knowledge and skills added by the labor force, so we can regard human capital as a special kind of capital. It turns out that people have been spending huge amounts of money on their own investments. In 1964, Gary published the book "Human Capital", which described in detail the channels through which human capital is formed and the subsequent benefits generated by human capital. His contribution lies in his analysis of human capital down to the microeconomic level, not only arguing that households are related to human capital, but also emphasizing that training and education are the main ways to form human capital. In 1988, Lucas identified human capital accumulation as a key factor in maintaining economic growth and promoting industrial upgrading, and analyzed biochemical human capital in the model. He believes that human capital accumulation is generally obtained through two ways: one is to receive formal and informal schooling that has nothing to do with production, and the other is to accumulate experience by learning by doing or conducting practical training in the course of production[5]. Chinese economists have also done a lot of relevant research on human capital, but there are not many innovation theories, mainly to spread human capital theory and use it to explain past or current economic phenomena, such as economic growth rate and income distribution; there are also some bold theories, such as research on human capital property rights, but overall there are many lacking.

2.2. The theory of human capital accumulation and its impact mechanism

Human capital accumulation usually refers to the accumulation of human capital in a country or region over a period of time, which is often manifested as the stock and increase of human capital[6]. The size of human capital stock affects the level of labor productivity in economic production, and investing in human capital can increase the stock of human capital and thus improve labor productivity; human capital investment increase calculates the flow rate per unit of time, representing the rate of artificial capital increase. The use of stock alone cannot measure the development and change of human capital in a certain period of time; only increments cannot describe the level of human capital accumulation during this period. The stock changes with the increase, and the increment also depends on the increase of the stock, and a dispatch effect will be generated to stimulate the stock in the process of the increase change. In short, the process of accumulating human capital is actually a series of processes in which the stock and increment of human capital change[7].

People accumulate human capital through investment in

human capital, so this paper believes that the investment method is the way of human capital accumulation, and the influencing factors of human capital accumulation can be roughly listed as labor wages, labor age, macroeconomic development level, national income distribution, etc. Among them, the level of workers' wages is a key factor affecting people's enthusiasm for accumulating human capital, the higher the salary, the more willing workers are to invest in human capital; secondly, labor for age is also an important factor affecting people's investment in human capital, although workers will be more unwilling to invest in human capital because of age, but the older the laborers skillfully save the impact of China's population transformation on the accumulation of human capital experience, so workers in the working age are constantly investing and accumulating human capital; in addition, The research on the relationship between economic development level and human capital accumulation and the relationship between national income distribution and human capital accumulation show that these two factors will promote the increase of artificial capital stock through certain channels[4].

3. Model Building and Indicator Selection

3.1. Model building

Because human capital is an investment in labor, it is related to the macroeconomic environment and people's income level, so we add per capita GDP to "other factors"; per capita income level education is a key factor in the formation of human capital, so it should also be included; in the process of industrial transformation, resource redistribution of production factors will be carried out. Changes in the structure of the tertiary industry will also lead to new requirements for the level of human capital of the individual and overall labor force, so the study of human capital accumulation needs to consider the impact of industrial transformation; therefore, other formulas that affect human capital accumulation in addition to demographic transition factors can be listed:

$$Y_{it}=A_{it}(AG_{it})^{\beta} \quad (1)$$

Among them, Y_{it} represents the level of human capital in the table t period, A_{it} represents other factors affecting the level of human capital in the t period, and A, G_{it} represents the change in the age structure of the population in the t period, and β is the coefficient. where A_{it} adds a control variable:

$$A_{it}=\exp(gdp_{it}+income_{it}+edu_{it}+indust_{it}+u_i+\varepsilon_{it}) \quad (2)$$

In turn, add in A the impact of human capital, gdp_{it} represents the economic growth level in the t period, $income_{it}$ represents the per capita income level of residents in the t period, edu_{it} represents the level of government financial investment in education in the t period, and $indust_{it}$ represents the level of industrial transformation in the t period, taking into account the dynamics and time lag of human capital accumulation, add the lag I and lag II of human capital in formula (2).

$$\ln(Y_{it})=C+\beta_1*age_{it}+\beta_2*gdp_{it}+\beta_3*income_{it}+\beta_4*edu_{it}+\beta_5*indust_{it}+u_i+\varepsilon_{it} \quad (3)$$

3.2. Indicator selection

3.2.1. Core explanatory variables:

At present, there are many types of indicators on age population structure, some studies use birth rate and death rate, total fertility rate, median age, life expectancy as indicators of population age structure for measurement, but some indicators are only one aspect of the population age structure depiction, so small and large is not scientific. In fact, each age group has a degree of contribution to the accumulation of human capital, and the scientific measurement method should be weighted according to the proportion of the contribution of different age groups to the accumulation of human capital and then multiplied by the population of the corresponding age group, but considering that the contribution of each age group cannot be defined and measured, the ratio of the working-age labor force with the highest contribution to the accumulation of human capital to the total population is used as the measurement index of the age population structure. The data related to this indicator are derived from the China Statistical Yearbook and the Chinese and Employment Statistical Yearbook.

3.2.2. Control variables:

(1) The level of economic growth

The commonly used comprehensive indicators to measure economic growth are "per capita income", "gross domestic product", and "per capita gross domestic product", because this paper studies the impact of demographic transition on human capital accumulation. In order to eliminate the price factor, the annual GDP index is adjusted for the 2000 price level as the base period[5].

(2) Income level

Also in order to highlight the role of people, the income level is measured using the indicator of "per capita income", and the total population data are all from the China Statistical Yearbook

(3) Government investment in education

The data are all from the "China Statistical Yearbook", in which the 2012 educational institution expenditure data is missing, the value is closely related to the level of human capital obtained and the education level of the labor force calculated according to the growth ratio of 2010 and 2011, so the government's investment in education is an indispensable explanatory variable, and a more accurate measurement should be "local financial education expenditure / total local fiscal expenditure", representing the government's efforts in education investment. However, due to the lack of local education expenditure data, this paper uses the proportion of fiscal education expenditure to GDP to measure education investment, which is also a standard for most countries to measure education investment.

(4) Industrial transformation

There are different explanations for industrial transformation. One is relatively macroscopic, which refers to the direct or indirect adjustment of all aspects of the existing industrial structure of a country or region in a certain historical period according to the current situation and trend of international and domestic economic, scientific and technological development, through specific industrial, fiscal and financial policy measures. This article refers to the adjustment between the primary, secondary and tertiary sectors. Many existing studies use the proportion of tertiary industry in GDP to indicate the state of industrial structure, considering that the labor in the secondary industry is

relatively large, second only to the tertiary industry, so the sum of the proportion of the secondary industry and the tertiary industry in GDP is used as the standard to measure this explanatory variable. All data are from the corresponding China Statistical Yearbook.

4. Empirical Research

4.1. Static panel analysis

Table 1. Static panel estimation results

	Fixed effect	Random effects
Constant terms	0.2382*	0.2342*
	(1.92)	(1.88)
Age	0.2063***	0.2104***
	(7.12)	(7.32)
City	1,2249***	1.1837***
	(4.84)	(4.83)
gdp	3.09e-06	4.53e-06
	(1.33)	(1.98)
Indust	1.0245***	0.9956***
	(10.69)	(10.43)
Income	0.0000238***	0.0000229***
	(6.84)	(6.63)
Edu	0.2013***	0.1925***
	(2.70)	(2.57)
Hausman	18.130***	
	0.0059	

Note: 1. The t-values of the test are shown in parentheses under the regression coefficient in the table: *, ** and *** indicate the significance levels of 10%, 5% and 1%, respectively; 2. The Hausman test is used to determine what is better between fixed-effect and random-effects models.

From the results of the above table, we can see that the impact of population age structure changes on human capital accumulation is significant, but this static panel model does not take into account the lag of human capital accumulation and the endogenousness of the model. The accumulation of human capital in the process of population transition is not only related to the current population proportion change, but also related to the population proportion change in the previous period; and the accumulation of human capital is time-dependent, and the previous period of human capital will also have an effect on the current period of human capital accumulation. In addition, human capital accumulation also has an impact on population transition, that is, there is an endogenous problem, so we use a dynamic panel model for regression analysis.

Due to endogenous and time-lagging considerations, this paper further adds two lag terms of human capital accumulation to the econometric regression model, expressed as $Inhumancap_1$ and $Inhumancap_2$, respectively, to investigate the time lag of human capital accumulation, and at the same time eliminate the possible first-order autocorrelation of the residuals. GMM estimation is divided into two methods, differential GMM and systematic GMM, the former is easily affected by weak tool variables to obtain biased results; in order to solve this problem, Arellano and Bover proposed a systematic GMM estimation method, which can effectively overcome the problem of weak tool variables, so the equation is as follows:

$$\ln(\text{humancap})_{i,t} = C + \alpha_1 * \ln(\text{humancap})_{i,t-1} + \alpha_2 * \ln(\text{humancap})_{i,t-2} + \beta_1 * \text{age}_{it} + \beta_2 * \text{gdp}_{it} + \beta_3 * \text{income}_{it} + \beta_4 * \text{edu}_{it} + \beta_5 * \text{indust}_{it} + u_i + \varepsilon_{it} \quad (4)$$

In panel data, there may be either a homogeneous unit root or a heterogeneous unit root. To avoid "pseudo-regression", a unit root test is performed on each variable. According to the results, the data is stable, and the next relevant analysis can be further done.

4.2. Dynamic panel analysis

Table 2. Dynamic panel estimation results

	SYSGM M1	SYSGM M2	SYSGM M3	SYSGM M4
Constant terms	- 0.4558** *	- 0.6156** *	- 0.4961** *	- 0.5434** *
	(-4.06)	(-4.77)	(-3.05)	(-3.01)
Lnhumancap-1	0.7062** *	0.7742** *	0.6834** *	0.6279** *
	(37.36)	(39.95)	(27.72)	(23.05)
Lnhumancap-2	0.0148	0.0159	0.0642	0.08215
	(0.30)	(0.31)	(1.04)	(1.35)
Age	0.2057** *	0.2117** *	0.1428** *	0.1498** *
	(15.48)	(8.99)	(6.74)	(6.57)
Gdp	8.69e-06***	1.24e-18***	1.74e-05***	1.74e-66***
	(2.72)	(4.17)	(4.20)	(3.84)
Indust		0.2104** *	0.4598** *	0.4637** *
		(2.01)	(3.80)	(3.01)
Income			1.49e-23***	1.53e-12***
			(6.83)	(5.62)
Edu				0.232
				(1.49)
AR(1)	-2.5810	-2.5474	-2.3783	-2.3656
	0.0099	0.0109	0.0174	0.0180
AR(2)	-0.4978	-0.5657	-0.6472	-0.5816
	0.6186	0.5657	0.5275	0.5609
Sargan test	28.8931	29.4281	28.1843	27.5809
	0.4038	0.4129	0.4079	0.4135
Obs	986	986	986	986

Note: 1. The t-values of the test are in parentheses under the regression coefficients in the table: *, ** and **** indicate the significance levels of 10%, 5% and 1%, respectively.

2. AR test is used to determine the autocorrelation of the residual term, determine the appropriate hysteresis as the tool variable, the original or false is whether there is no autocorrelation; the corresponding value represents the test statistic, and the P value of the test is in parentheses. The AR test of all old models shows that there is first-order autocorrelation but no second-order autocorrelation in the regression residual term. 3. The Sargan test is used to judge the rationality of the tool variable setting, and the corresponding value is the P value of the test.

In order to investigate the influence of each control variable on human capital accumulation and the robustness of its role,

this paper gradually adds each variable to the systematic GMM quantitative regression equation. It can be seen from the positive and negative coefficients and significance levels of the estimated variable coefficients given by the dynamic panel estimation results in Table 2 that the estimation results of each explanatory variable are generally significant at the significance level of 5%, and all of them have passed the AR(1) test, AR(2) test and sargan test. Compared with the previous fixed effects, the estimates are consistent except for the difference in GDP per capita and education input. In the systematic GMM model, the accumulation of human capital itself lags behind, and the proportion of working-age labor, industrial structure transformation, per capita GDP and per capita income have positive effects on human capital accumulation, while the correlation between education investment and human capital accumulation is not significant. However, in the fixed-effect model, the effect of per capita GDP on human capital accumulation was not significant, but there was a positive effect of education investment on human capital accumulation.

The manuscript should include a conclusion. In this section, summarize what was described in your paper. Future directions may also be included in this section. Authors are strongly encouraged not to reference multiple figures or tables in the conclusion; these should be referenced in the body of the paper.

5. Conclusion

First of all, the accumulation of human capital is indeed lagging, and both the current period and the lag period of human capital have a significant role in promoting the accumulation of human capital[8]. Secondly, China's population transition as a whole has a significant positive effect on the accumulation of human capital, and the change of the age structure of the population provides the number of labor for the promotion and accumulation of human capital. However, at present, China's aging population is serious, and it is facing the reality that the number of working-age labor is no longer increasing. The transformation of the tertiary industry, per capita GDP and per capita income of residents will all affect the accumulation of human capital and show a positive effect[9]. The development of industry is inseparable from labor, industrial transformation will lead to labor demand, and even determine human resource demand to a certain extent, so industrial upgrading will inevitably drive the accumulation of human capital. In addition, China's industrial structure itself has not evolved to a level corresponding to the current stage of economic development, which lacks the education and human capital progress necessary for the development of emerging industries, and the unreasonable labor employment structure is not conducive to the accumulation of human capital. Fourth, investment in education has not contributed to the accumulation of human capital as expected. Because of insufficient investment in education, compared with developed countries, China's investment in education is still very lacking, and education expenditure accounts for only 4% of GDP; this will inhibit the accumulation of human capital.

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