THE ROLE OF HUMAN CAPITAL IN THE DIGITAL TRANSFORMATION ECONOMY

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ABSTRACT

This paper aims to study the role of human capital accumulation in the growth of the digital transformation economy by investigating the interplay between human capital formation and the effects of tax policies from government spending on human beings. The research methodology is based on endogenous growth theory with an overlapping generation model and homogeneous economic agents. The main finding is that public investment in enhancing the efficiency of workers results in the economic growth of the digital transformation economy. Another is that two effects of taxation are noteworthy: (i) taxes reduce households' income, lowering their investment in physical capital, which hurts output; (ii) taxation raises the public spending on human capital, thus enhancing the efficiency of labor capacity, consequently, increasing economic growth in digital transformation economy. The study's conclusion is that the long-run growth rate is fueled by the investment in human capital, and the government may levy taxes on labor income and capital returns to finance this public investment.

VAI TRÒ CỦA VỐN CON NGƯỜI TRONG NỀN KINH TẾ CHUYỂN ĐỔI SỐ

Trần Nhật Thiện
Trường Đại học Đà Lạt

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TỪ KHÓA

Vốn con người
Tăng trưởng nội sinh
Tăng trưởng kinh tế
Chuyển đổi số
Nền kinh tế số

TÓM TẮT

Bài viết này nhằm mục đích nghiên cứu vai trò của tích lũy vốn con người đối với sự tăng trưởng của nền kinh tế chuyển đổi số bằng cách nghiên cứu mối tương tác giữa việc hình thành vốn nhân lực và tác động của chính sách thuế từ chi tiêu của chính phủ đối với con người. Phương pháp nghiên cứu dựa trên lý thuyết tăng trưởng nội sinh với mô hình thế hệ chồng chéo và các cá nhân đồng nhất. Phát hiện chính của nghiên cứu là khi tăng đầu tư công vào việc nâng cao hiệu quả của người lao động sẽ thúc đẩy tăng trưởng kinh tế của nền kinh tế chuyển đổi số. Một kết quả khác đó là có hai tác động đáng chú ý của thuế: (i) thuế làm giảm thu nhập của hộ gia đình, giảm đầu tư vào vốn vật chất, làm tổn hại đến sản lượng; (ii) thuế làm tăng chi tiêu công cho vốn con người để nâng cao hiệu quả năng lực của lao động, từ đó thúc đẩy tăng trưởng kinh tế trong nền kinh tế chuyển đổi số. Kết luận của nghiên cứu là tốc độ tăng trưởng dài hạn được thúc đẩy bởi đầu tư vào vốn con người và chính phủ có thể đánh thuế trên thu nhập lao động và lợi tức vốn để tài trợ cho khoản đầu tư công này.

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1. Introduction

The relationship between human capital and economic growth progress was re-awakened in the late 50s and early 60s of the twentieth century. Horvat [1, p. 748] introduces the concept of human capital and the important of "human factor". Horvat [1, pp. 751-752] also asserts that a human stock depends on four elements: "personal consumption, health, knowledge, and economic and political organization". The embodiment of the "human factor" into the concept of capital is also explained by Kiker [2], and Spengler [3]. These authors indicate that the investment in human capital raises productivity and thus adds to "national wealth."

The workhorse model of Solow [4], [5] has afforded a point of starting from which to explore the contribution of human capital in the context of endogenous growth as an input in production process. This context has become known as the human capital-extended Solow's model as revisited by Mankiw et al. [6], using the production function with three input factors: physical capital, human capital and labor. These findings then introduces the standard of the skeletal seminal model of Lucas [7] to highlight one of the most popular evolutions of human capital within the economic growth process.

Research on human capital formation and its impacts on economic growth is shed light on the seminal article of Lucas [7]. According to Lucas's contribution, human stock is represented as the nature of capital and the attribute of externalities generated by human stock accumulation. In particular, education and training would affect the productivity not only of the individuals accumulating knowledge but also of their co-workers as a social capital in an economy. Thenceforth, human capital accumulation is placed at the center of economic growth progress [7] – [11]. More recently, Lucas [12] again emphasizes the role of human capital accumulation and its impact on the economic growth process, along with external sources, like new technology.

Many famous quantitative studies have also demonstrated the importance of human capital for economic growth and development. Schoellman [13, p. 411], in the investigation of schooling quality, indicates that "differences in education quality are roughly as important as differences in year of schooling in accounting for the difference in output per worker across countries". Manuelli [14], using data on schooling and age-earnings profile, discovers that differences in quality of human capital rather than differences in levels of the "total factor productivity" better explain differences between countries in "average income." Galor and Moav [15, p. 1004] also suggest that the physical and human capital may compete with each other in order to be the source of economic growth.

This research is in the spirit of Aghion, Akcigit & Howitt [16] who discover the "Schumpeterian growth theory" by developing models based on this theory. These models shed light on many aspects of the economic growth process: (i) the role of "competition and market structure"; (ii) "firm dynamics"; (iii) the nexus between "growth and development" with the role of institutions; (iv) the relationship between growth process and "long-term technological waves". This article will relate to the fourth aspect where the growth of digital transformation economy results from innovation via the investment in human capital.

The main idea runs as follows. The research considers an overlapping generation model with homogeneous economic agents. The agents live in two periods: Young agent is denoted by date t, Old agent by date $t+1$. Agents work when young with inelastic working time. Young agents make decision on consumption and investment in physical capital and consume what they get from savings when old. Besides, this study is also in line with the model of Barro [9], where the fund of public investment in human capital for the economic growth of digital transformation economy financed by collecting taxes from labor and capital income.

The main finding is that by increasing the fraction of public investment in enhancing the efficiency of workers via enhancing the economic growth of digital transformation economy. Another is that two effects of taxation are noteworthy: (i) taxes reduces households' income,

lowering their investment in physical capital, which has a negative impact on output; (ii) taxation raises the public spending on human capital, thus enhancing the efficiency of labor capacity, consequently, increasing economic growth in digital transformation economy.

The remainder of the paper proceeds as follows. Section 2 shows the research methodology. Section 3 is the results and discussion by indicating the balance of growth path finding and the fiscal policy placed into overlapping generations economy. Section 4 is the conclusion.

2. Research methodology

This study considers an economy with overlapping generations model where at each time t, the population of the newborn cohort is N_t. The demographic growth rate is assumed to be a constant $n = \frac{N_{t+1}}{N_t}$ and $n > 1$.

This model allows for physical and human capital accumulation. It turns out that young agents work and spend their labor income on consumption and investment in physical capital accumulation. Old agents do not work but only consume.

2.1. Production

In each period, a representative firm uses physical capital and labor to maximize profit. The economy's technology is launched by the Cobb-Douglas production function: $F(K_t, L_t) = AK_t^{\alpha} L_t^{1-\alpha}$, where the share of α is between zero and one; K_t and L_t are respectively the demand of firm for capital and labor. A is the productivity.

A representative firm chooses K_t and L_t to maximize its profit

$$\max\left\{[AK_t^{\alpha} L_t^{1-\alpha}] - R_t K_t - w_t L_t\right\} \quad (1)$$

At optimum, the prices of capital and labor of the economy are

$$w_t = (1-\alpha) AK_t^{\alpha} L_t^{-\alpha} \quad (2)$$

$$R_t = \alpha AK_t^{\alpha-1} L_t^{1-\alpha} \quad (3)$$

2.2. Consumers

Suppose that N_t new borns at each date t, with $N_t = nN_{t-1}$, $n > 1$. Each individual maximizes her intertemporal utility with the function $\ln c_{i,t} + \beta \ln d_{i,t+1}$, under the following constraints

$$c_t + s_t \le (1-\tau) w_t h_t,$$

$$d_{t+1} \le (1-\tau_k) R_{t+1} s_t,$$

where c_t, d_{t+1} are respectively consumption of an individual when young and old; s_t is her saving for investment in capital, h_t is her labor supply when young. τ, τ_k are respectively the constant taxation rates on labor income and capital returns.

Lemma 2.1. For each agent, the economy yields

$$c_t = \frac{1}{1+\beta}(1-\tau) w_t h_t, \quad (4)$$

$$s_t = \frac{\beta}{1+\beta}(1-\tau) w_t h_t, \quad (5)$$

$$d_{t+1} = (1-\tau_k) R_{t+1} s_t. \quad (6)$$

Proof.

The Lagrange equation is given by

$\ln c_t + \beta \ln d_{t+1} - \lambda_t (c_t + s_t - (1-\tau) w_t h_t) - \mu_t (d_{t+1} - (1-\tau_k) R_{t+1} s_t)$.

From first order conditions, we have

$\frac{1}{c_t} = \lambda_t$,

$\frac{\beta}{d_{t+1}} = \mu_t$,

$\lambda_t = (1-\tau_k) R_{t+1} \mu_t$, which leads to

$\frac{\lambda_t}{\mu_t} = \frac{d_{t+1}}{\beta c_t} = (1-\tau_k) R_{t+1}$. Moreover, the budget constraints are now binding, thus

$d_{t+1} = (1-\tau_k) R_{t+1} s_t$, and then $\beta c_t = s_t$.

Since $c_t + s_t = (1-\tau) w_t h_t$, one has $\frac{1}{\beta} s_t + s_t = (1-\tau) w_t h_t$, which implies

$s_t = \frac{\beta}{1+\beta}(1-\tau) w_t h_t$, $c_t = \frac{1}{1+\beta}(1-\tau) w_t h_t$, and $d_{t+1} = (1-\tau_k) R_{t+1} s_t$.

Market clearing conditions are as follows:

- In the physical capital market:

$$K_{t+1} = N_t s_t \tag{7}$$

- In the labor market:

$$L_t = N_t h_t \tag{8}$$

Then the equilibrium in all market is $A K_t^{\alpha} L_t^{1-\alpha} = N_t c_t + N_t s_t + N_{t-1} d_t + G_t$, where the total collected tax is expressed:

$$G_t \equiv \tau w_t h_t N_t + \tau_k R_t s_{t-1} N_{t-1} \tag{9}$$

2.3. Public investment in human capital for digital transformation economy

This subsection illustrates the mechanism the fund of public investment in human capital for the economic growth of digital transformation economy is financed by collecting taxes from labor and capital income.

If we denote the physical capital per capita, $k_t \equiv K_t / N_t$; the output per capita, $y_t \equiv Y_t / N_t$, with $Y_t \equiv A K_t^{\alpha} L_t^{1-\alpha}$ and the government spending per capita in human capital, $g_t \equiv G_t / N_t$, then we have

$$s_t = n k_{t+1}, \tag{10}$$

$$w_t h_t = (1-\alpha) y_t, \tag{11}$$

$$R_t k_t = \alpha y_t, \tag{12}$$

$$g_t = [\alpha \tau_k + (1-\alpha)\tau] y_t. \tag{13}$$

Also, the education process for the accumulation of human capital in digital transformation economy is supposed to be governed by

$$h_{t+1} = B g_t^{\gamma} h_t^{1-\gamma} + (1-\delta) h_t \tag{14}$$

In technical equation (14), h_{t+1} and h_t are human capital in digital transformation economy at date $t+1$ and date t, respectively; δ is the depreciation of human capital accumulation; and B is the parameter or productivity or quality of human capital accumulation.

Definition 2.1. An equilibrium is a positive sequence $(w_t, c_t, d_{t+1}, L_t, K_t, G_t)$ *satisfying the equations from (2) to (10).*

2.4. Equilibrium system

Equation (5) becomes

$$nk_{t+1} = \frac{\beta}{1+\beta}(1-\tau)(1-\alpha)y_t \tag{15}$$

or equivalently

$$nk_{t+1} = \frac{\beta}{1+\beta}(1-\tau)(1-\alpha)Ak_t^{\alpha}h_t^{1-\alpha} \tag{16}$$

Equations (13) – (16) will form the equilibrium system.

3. Results and discussion

3.1. Balance growth path (BGP) finding

Proposition 3.1 (global dynamics)

i) There exists a unique equilibrium. In the equilibrium, the global dynamic system is given by

$$\frac{k_{t+1}}{k_t} = \frac{h_{t+1}}{h_t} \equiv \rho.$$

ii) The growth rate of the economy ρ *is given by* $\rho = \mathcal{C}\phi^{-1}\left[\psi(\tau, \tau_k)\right]$, *where*

$$\psi(\tau, \tau_k) = [(1-\tau)(1-\alpha)]^{\alpha}[(1-\alpha)\tau + \alpha\tau_k]^{1-\alpha},$$

$$\mathcal{C} = A\frac{1}{n^{\alpha}}B^{\frac{1-\alpha}{\gamma}}\left(\frac{\beta}{1+\beta}\right)^{\alpha}.$$

Proof.

i) The equilibrium system is given by (2) - (10). Also, according to (13) - (14) and we have the result to prove.

ii) Suppose $\frac{k_{t+1}}{k_t} = \frac{h_{t+1}}{h_t} = \rho$, then from (14) gives $h_t = (\frac{B}{\rho - 1 + \delta})^{\frac{1}{\gamma}} g_t$

Combining (13) and (15) we get $g_t = n\frac{1+\beta}{\beta}\frac{1}{(1-\tau)(1-\alpha)}[(1-\alpha)\tau + \alpha\tau_k]k_{t+1}$

Then, combining the two equations above, we have

$h_t = n(\frac{B}{\rho - 1 + \delta})^{\frac{1}{\gamma}}\frac{1+\beta}{\beta}\frac{1}{(1-\tau)(1-\alpha)}[(1-\alpha)\tau + \alpha\tau_k]k_{t+1}$

Combining (15) and the latter equation, we receive

$$nk_{t+1} = \frac{\beta}{1+\beta}(1-\tau)(1-\alpha)An^{1-\alpha}k_t^{\alpha}\left(\frac{B}{\rho - 1 + \delta}\right)^{\frac{1-\alpha}{\gamma}}\left\{\frac{1+\beta}{\beta}\frac{1}{(1-\tau)(1-\alpha)}\left[(1-\alpha)\tau + \alpha\tau_k\right]\right\}^{1-\alpha}k_{t+1}^{1-\alpha}$$

$$n = An^{1-\alpha}\left(\frac{B}{\rho - 1 + \delta}\right)^{\frac{1-\alpha}{\gamma}}\left[\frac{\beta}{1+\beta}(1-\tau)(1-\alpha)\right]^{\alpha}[(1-\alpha)\tau + \alpha\tau_k]^{1-\alpha}\rho^{-\alpha}$$

$$\rho^{\alpha}(\rho - 1 + \delta)^{\frac{1-\alpha}{\gamma}} = An^{-\alpha}B^{\frac{1-\alpha}{\gamma}}\left[\frac{\beta}{1+\beta}(1-\tau)(1-\alpha)\right]^{\alpha}[(1-\alpha)\tau + \alpha\tau_k]^{1-\alpha}$$

Next, taking the logarithm in two sides of the equation above, we get

$$\underbrace{\alpha\ln\rho + \frac{1-\alpha}{\gamma}\ln(\rho - 1 + \delta)}_{\phi(\rho)} = \ln A - \alpha\ln n + \frac{1-\alpha}{\gamma}\ln B + \alpha\ln[\frac{\beta}{1+\beta}\alpha]\underbrace{+\alpha\ln(1-\tau) + (1-\alpha)\ln[(1-\alpha)\tau + \alpha\tau_k]}_{\psi(\tau,\tau_k)}$$

Obviously, $\phi'(\rho)=\frac{\alpha}{\rho}+\frac{1-\alpha}{\gamma}\frac{1}{\rho-1+\delta}>0$. The function ϕ is strictly increasing, hence $\rho=\phi^{-1}\left[\psi(\tau,\tau_k)\right]$.

3.2. Fiscal policy

Lemma 3.1.

1. If $\tau_k>\left(\frac{1-\alpha}{\alpha}\right)^2$ *then* $\frac{\partial\phi}{\partial\tau}<0$, $\forall\tau$. *It turns out that when the government levies too much tax on capital return, the economy growth rate,* ρ *is decreasing in* τ.

2. If $\tau_k<\left(\frac{1-\alpha}{\alpha}\right)^2$ *then* $\frac{\partial\phi}{\partial\tau}=0$ *if* $\tau=(1-\alpha)-\frac{\alpha^2}{1-\alpha}\tau_k\equiv\tau^*(\tau_k)$.

Proof.
See Tran [17].

Proposition 3.2.

With given by τ_k, *if the optimal tax on labor income is given by* $\tau^*(\tau_k)=1-\alpha-\frac{\alpha^2}{1-\alpha}\tau_k$ *then the economy growth rate attains its maximum value at* τ^*.

Proof.
See Tran [17].

Assumption 3.1. $\frac{1-\alpha}{\alpha}>1$

Proposition 3.3.

If the ratio of taxes to GDP increases (decreases) 1 percent then the economy growth rate increases (decreases) $\frac{1}{\alpha}$ *percent.*

Proof.
See Tran [17].

4. Conclusion

This research considers an economy with physical and human capital accumulation where the laborers of the economy are perfect substitutes in production progress, and the engine of endogenous growth is public investment in human capital from the government tax revenue. The contribution shows that some tax policies are profitable for economic growth in a digital transformation economy. In particular, there is room for human capital investment that is increasing labor's capacity by improving the efficiency of unskilled workers without harming economic growth, consequently increasing economic growth in the digital transformation economy.

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