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INTRODUCING EDUCATIONAL REFORMS IN THE NEOCLASSICAL MODEL[5]

This paper extends the neoclassical model of economic growth by introducing human capital into production function and studies the impact of educational reform on economic performance. In the author's model, the government taxes consumption to reallocate the resources to educational needs, which is one of the most prominent ingredients of human capital. The tax increase has costly consequences for the economy in the short-run, regarding the slowdown of economic activity, and the consumption loss. Thereafter, the increase in education builds additional human capital, making people more productive, recovering economic activity and stabilizing consumption at even higher levels in the long run. Thus, in the longer term, it is beneficial for the economies with low human capital to devote resources in favour of educational reforms, even though it carries the risks of political capital loss due to short-run economic costs. In the short run political capital decreases as a result of the implemented reform costs, which, on the other hand, indicate the cumulative loss of consumption. In the long run, however, the policymaker regains its political capital. Governments with low reputation cannot implement structural reforms. Besides, the authors compare the impact of low-efficient educational reforms with the impact of highly effective ones and come to the conclusion that consumption is formulated at a lower level in the former case.

Keywords: neoclassical growth; fiscal policy; education expenditures; education reform
JEL: E13; E62; H52; I28

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1. Introduction

The term "Human Capital" was first mentioned in 1961 by Nobel-prize winner economist Theodore W. Schultz, in his article ''Investment in Human Capital''. Human capital includes many indicators such as education, health, skills, training, life expectancy and many others. Various theoretical and conceptual approaches have been used to explore the relationship between human capital and economic performance. There is a considerable amount of literature, which claims that human capital, in its all forms, has a positive impact on the economy. Human capital includes many indicators such as education, health, skills, training, life expectancy and many others. Being one of the prominent ingredients of human capital, education is a key determinant of economic well-being (Hanushek and Woessmann, 2010). In this article, the authors extend the standard real business cycle model by introducing the Government, which can tax consumption and allocate these resources to education financing. Spending on education increases human capital or productivity with a lag, because some time is required to accumulate skills. As a result, educational reforms increase human capital after almost 8 years. In this sense, the work relates to a class of endogenous growth models, more specifically, the model first introduced by Uzawa (1965) and Lucas (1988), known as the Uzawa-Lucas model. Solow (1956) constructs it like the neoclassical model of growth, where total output depends on physical and human capital and the saving rate is not exogenous but endogenously determined by the preference and technology parameters. Human capital in the Uzawa-Lucas model is built up by devoting time to education where the growth rate of human capital is a linear function of the time spent on education. In the model represented in this paper, the current consumption decreases, because of the reform in the education sphere, but later stabilises at a higher level. The short-run costs of the educational reforms make the low forward-looking people oppose them. As the less forward-looking public cannot see the long-run beneficial effects of reforms, the implementation of reforms and the uncertainty stemming from it decreases the government's political capital in the short run.

Political capital is generally used to describe the electorate's level of "trust" in policymaker politicians. Besides policy's long-run economic benefits, policymaker also takes into account political costs and benefits regarding applied policy. It is assumed that the policymaker has initial political capital which degrades during its political activity.

If the policymaker has initially high political capital, it can afford itself to implement tight economic policy by generating much more favourable results in the long run. As authorities govern for a short period of time and they are afraid of losing their political capital as a result of such reforms, the probability of implementation of this kind of policy is debatable. In the case of low initial capital, the most effective economic policies become almost impossible, leading to economic trade-offs. In these circumstances politicians may hold back on reforms, fearing they will be penalized and the only possible policy remains the accumulation of government debt or, in other words, surprise inflation, which creates short-run beneficial results by expanding economic activity.

Nevertheless, the benefits of such a policy are visible in the long run. When educational reforms have a positive impact after a while and build additional human capital, labour productivity is enhanced. Also, with the rise in labour not only does consumption and output recover from the implementation of reforms, but also consumption stabilises at a higher level

in the long run. Foreseeing the long-run beneficial effects of these reforms, high forward-looking people will require the government to implement this kind of policy. The authors also compare low effective educational reforms with baseline cases and conclude that when the efficiency of the reform in education is low, consumption is formulated at a lower level compared with the case of the highly efficient implementation of the reform. The rest of the paper is organised as follows: the second section presents the literature review; the third section introduces the model; the fourth section discusses results. Finally, the fifth section summarises all the above-mentioned.

2. Literature Review

Human capital plays a very important role in neo-classical literature featuring endogenous growth models. In contrast with the classical theory of economic growth where labour productivity is modelled exogenously and without taking into account the positive effect of education, the new literature models incorporate human capital into production function as an additional input. There is a large body of literature, implying that human capital impacts economic growth positively. Particularly, Syed Mohsin Kazmi, Kazim Ali and Ghamze Ali (2017) imply the long-run relationship between human capital and economic growth. Additional investment in the educational sector can maximize human capital, which leads to an increase in economic growth. Based on the study conducted in Indonesia for the period between 1984-2019, Widarni and Bawono (2021) have found a significant effect of human capital and technology on economic growth. According to them, human capital is effective in driving the economy in the long run with technology and labour as key factors driving economic growth. Moreover, according to Hess (2016), Human capital contributes also to an increase in GDP per capita and poverty reduction. Ricciardelli (2017) mentions human capital as a central driving force for the sustainable growth of the country. Vandenbussche (2004) constructs a model which shows that skilled labour has a higher growth-enhancing effect assuming that innovation is a relatively more skill-intensive activity compared to imitation. De la Fuente and Doménech (2000, 2006) obtain a positive significant correlation between production and human capital both in level and first-order differences. To explore the effect of education and training on individual earnings, Bundell et al (1999) believe that output growth depends on the rate of accumulation of human capital and innovation. By studying links between policy settings, institutions and economic growth from 1971 to 1998, Bassanini and Scarpetta (2001) obtained that a one-year increase in schooling raises GDP per capita by 6%. Michael Funke and Holger Strulik (2000) encompass an endogenous growth model in a standard neoclassical growth theory and build a model with physical and human capital. They obtain that while physical capital contributes to the growth of income per capita in the early stages of development, the accumulation of knowledge through continuous education and training leads to higher stages of growth. The proposed model shows the long-run beneficial effect of educational reform or human capital development on consumption and economic growth.

In the model, proposed by the authors, education plays a crucial role in the accumulation of human capital. There are many studies which support the idea that education is an important

mechanism in the formation of human capital (Ingsih et al., (2020), Mankiw, Romer, and Weil (1992), Lucas (1988), Burgess (2016), Calkin (2018), etc). Thus investing in education increases human productivity thus rising economic growth. Although educational reforms come with short-run costs which are often related to governments' political capital Furceri et. al (2019) argue that gains of reforms often take time to materialize and the associated electoral costs occur only when reforms are undertaken in the run-up to elections. This supports the idea that reforms are costly in the short run but are paid off in the longer horizon.

3. Methodology

The model economy is populated by households, who get the utility from consumption and leisure. On the expenditure side, they buy consumption and investment goods. On the other side, they supply labour and capital to firms and get wages and return on capital, respectively. Firms produce final goods by hiring labour and capital. Final goods are divided into consumption and investment goods. The authors introduce human capital into the model. The higher value of the human capital increases productivity and output. Besides, the government is also introduced into the model, which taxes consumption and spends those resources on education contributing to the accumulation of the human capital.

1.1. The Model Environment

There is a representative household in the model environment, which maximises its lifetime utility given by the form.

$$\max_{\{C_t, N_t, I_t\}} \beta^j \left(\frac{C_{t+j}^{1-\sigma}}{1-\sigma} - \frac{N_{t+j}^{1+\varphi}}{1+\varphi} \right) \tag{1}$$

In equation (1) C_t is the consumption, N_t is the labour supply, β is the discount rate, σ is the consumption intertemporal elasticity of substitution or risk aversion, and φ is the inverse of Frisch labour supply elasticity. The household has the following budget constraint.

$$(1 + \tau_t^c)C_t + I_t = W_t N_t + R_t K_{t-1} + Div_t \tag{2}$$

In equation (2) τ_t^c is the consumption tax rate. In addition to consumption, the household invests in the capital(I_t). Income is the composition of wages (W_t) and the return on capital (R_t) from previously lent capital (K_{t-1}). As households are the owners of firms, firms transfer their dividends to households (Div_t). Households hold the capital as well and rent out to firms. The law of capital accumulation is given by the following.

$$K_t = (1 - \delta)K_{t-1} + I_t \tag{3}$$

In equation (3) δ is the depreciation rate of capital. Substituting the investment expressed as a function of capital to the household's budget constraint, the utility maximization problem becomes (household chooses the optimal values of consumption, capital and labour supply).

$$\mathcal{L}_{t+j} = \max_{\{C_t, N_t, K_t\}} \beta^j \left(\frac{C_{t+j}^{1-\sigma}}{1-\sigma} - \frac{N_{t+j}^{1+\varphi}}{1+\varphi} \right) - \lambda_{t+j}\left((1+\tau_{t+j}^c) C_{t+j} + K_{t+j} - (1-\delta) K_{t-1+j} - W_{t+j} N_{t+j} - R_{t+j} K_{t-1+j} - Div_{t+j} \right) \quad (4)$$

In the above problem, λ_t is the Lagrange multiplier or the shadow price of consumption. Then the first-order conditions are calculated.

$$\frac{\partial \mathcal{L}_{t+j}}{\partial C_t}: C_t^{-\sigma} - \lambda_t (1+\tau_t^c) = 0 \quad (5)$$

$$\frac{\partial \mathcal{L}_{t+j}}{\partial N_t}: -N_t^{\varphi} + \lambda_t W_t = 0 \quad (6)$$

$$\frac{\partial \mathcal{L}_{t+j}}{\partial K_t}: -\lambda_t + \lambda_{t+1}(1-\delta) + \lambda_{t+1} R_{t+1} = 0 \quad (7)$$

Derivative of the problem with respect to consumption in the t+1 period has the form.

$$\frac{\partial \mathcal{L}_{t+j}}{\partial C_{t+1}}: \beta C_t^{-\sigma} - \lambda_{t+1}(1+\tau_{t+1}^c) = 0 \quad (8)$$

Using the above derived first-order conditions and doing some mathematical operations, the authors get the following equations of the household problem.

$$W_t = N_t^{\varphi} C_t^{\sigma} (1+\tau_t^c) \quad (9)$$

$$\frac{1}{C_t^{\sigma}(1+\tau_t^c)} = \frac{\beta(R_{t+1} + (1-\delta))}{C_{t+1}^{\sigma}(1+\tau_{t+1}^c)} \quad (10)$$

Equation (9) shows the intratemporal substitution of consumption and labour, and equation (10) depicts the intertemporal Euler equation of consumption.

Thus, it is assumed that the Government taxes the consumption and uses these resources for education financing.

$$Educ_t = \tau_t^c C_t \quad (11)$$

The increase in spending on education results in an accumulation of human capital. The accumulation of the human capital stock (H_t) follows the process.

$$H_t = {H_{t-1}}^{\rho_H} + \vartheta Educ_{t-32} \quad (12)$$

The current value is the function of the previous period's human capital stock and the spending on education. Some time is needed for today's spending on education to become efficient human capital. That's why, in the proposed model, spending on education transforms into human capital in eight years (Educ_{t-32}). ϑ is the efficiency parameter of the spending on education, which shows how efficiently the educational financing transforms into human capital and increases productivity.

Investing in education disrupts consumption from its steady state. We refer to the cumulative loss of consumption as the cost of educational reforms which is given by the following equation:

$$Refcost_t = \gamma_R \sum (C_t - C^{SS}) \tag{13}$$

Political capital, which can be described as the electorate's level of trust towards policymakers, follows an AR(1) process, simultaneously being a decreasing function from the cost of reforms. Moreover, it is assumed that policymakers have some initial level of political capital which depreciates through the course of their political activity if they don't commit to reform policies. Reform implementation on the other hand decreases policymaker's political capital in the short run following the reduction of consumption. The political capital is given by the following equation:

$$K_{p,t} = K_{p,initial} - \gamma_k K_{p,t-1} - \rho_k Refcost_t \ , \qquad \gamma_k > 0, \ \ \rho_k > 0 \tag{14}$$

The production is expressed by the Cobb-Douglas production function of the following form.

$$Y_t = A_t K_{t-1}^{\alpha} (H_t N_t)^{1-\alpha} \tag{15}$$

In equation (13) A_t is the exogenous productivity, which is modelled as a first-order autoregressive process ($A_t = {A_{t-1}}^{\rho_A} + \varepsilon_t^A$), α is the share of capital. $H_t N_t$ is the effective labour, which is the combination of human capital and labour. Firms maximise their profits by choosing the optimal values of labour and capital.

$$\max_{\{K_{t-1}, N_t\}} Div_t = Y_t - W_t N_t - R_t K_{t-1} \tag{16}$$

Then authors substitute the production function into the maximization problem and calculate first-order conditions. As a result, the following equation is represented.

$$\frac{\partial Div_t}{\partial K_{t-1}}: \alpha A_t K_{t-1}^{\alpha-1} (H_t N_t)^{1-\alpha} - R_t = 0 \tag{17}$$

$$\frac{\partial Div_t}{\partial N_t}: (1-\alpha) A_t K_{t-1}^{\alpha} (H_t N_t)^{-\alpha} - W_t = 0 \tag{18}$$

After some transformations, the authors get the following equations.

$$R_t = \frac{\alpha Y_t}{K_{t-1}} \tag{19}$$

$$W_t = \frac{(1-\alpha) Y_t}{N_t} \tag{20}$$

Equations (19) and (20) show that GDP is divided into two components, i.e. return on capital and total wage.

Market clearing condition requires that production equals expenditures. It is represented by the following equation (21).

$$Y_t = C_t + I_t + Educ_t \tag{21}$$

1.2. Analytical solution of the model's steady state

The deterministic steady state of the model assumes that all the variables are stable and constant over time. In the steady state, it is assumed that the tax rate is 0 ($\tau^{c,ss} = 0$), and the value of productivity is 1 ($A^{ss} = 1$).

Writing down the Euler equation in a steady state, the following one is presented.

$$\frac{1}{C^{ss^{\sigma}}(1+\tau^{c,ss})} = \frac{\beta(R^{ss}+(1-\delta))}{C^{ss^{\sigma}}(1+\tau^{c,ss})} \quad (22)$$

After some simple math, the authors stay with the return on capital in the steady state, which is a function of the economy's structural parameters.

$$R^{ss} = \frac{1}{\beta} - (1-\delta) \quad (23)$$

As it is not explicit for this model to write down the steady state, some techniques for the calculation are used. The authors take the capital return equation and write it in a steady state.

$$R^{ss} = \frac{\alpha Y^{ss}}{K^{ss}} \quad (24)$$

Substituting the production function ($Y^{ss} = A^{ss}K^{ss^{\alpha}}(H^{ss}N^{ss})^{1-\alpha}$) in equation (22), the following one is represented.

$$R^{ss} = \frac{\alpha A^{ss}K^{ss^{\alpha}}(H^{ss}N^{ss})^{1-\alpha}}{K^{ss}} \quad (25)$$

Some simple math allows us to have the capital/labour ratio in a steady state the following.

$$\frac{K^{ss}}{N^{ss}} = \left(\frac{\frac{1}{\beta}-(1-\delta)}{\alpha}\right)^{\frac{1}{\alpha-1}} \quad (26)$$

As the return on capital is already expressed as a function of structural parameters, the capital/labour ratio can be written as follows.

$$\frac{K^{ss}}{N^{ss}} = \left(\frac{R^{ss}}{\alpha}\right)^{\frac{1}{\alpha-1}} \quad (27)$$

The authors use the above ratio in the proceeding steps for the calculation of the model's deterministic steady state. Then the wage equation is taken ($W^{ss} = \frac{(1-\alpha)Y^{ss}}{N^{ss}}$). After some mathematical steps, wage in the steady state is expressed by the following.

$$W^{ss} = (1-\alpha)\left(\frac{K^{ss}}{N^{ss}}\right)^{\alpha} \quad (28)$$

Using the capital accumulation equation, investment in a steady state is equal to the depreciated capital $I^{ss} = \delta K^{ss}$. Then authors take the market clearing condition.

$$Y^{ss} = C^{ss} + I^{ss} + Educ^{ss} \quad (29)$$

Substituting the production function into it and doing simple transformations, the following expression is obtained.

$$C^{ss} + I^{ss} = \left(\frac{K^{ss}}{N^{ss}}\right)^{\alpha} N^{ss} \tag{30}$$

Deriving both sides of the equation by N^{ss} and using the investment equation ($I^{ss} = \delta K^{ss}$), authors get the consumption/labour ratio as a function of an already known expression.

$$\frac{C^{ss}}{N^{ss}} = \left(\frac{K^{ss}}{N^{ss}}\right)^{\alpha} - \delta \frac{K^{ss}}{N^{ss}} \tag{31}$$

The consumption/labour intratemporal equation written in the steady state has the following form.

$$W^{ss} = N^{ss\varphi} C^{ss\sigma} (1 + \tau^{c,ss}) \tag{32}$$

Further, the authors express the consumption from the above equation ($C^{ss} = \left(\left(\frac{K^{ss}}{N^{ss}}\right)^{\alpha} - \delta \frac{K^{ss}}{N^{ss}}\right) N^{ss}$), and put it into the consumption/labour equation. In addition, using the wage equation in steady state authors end up with the following expression.

$$(1-\alpha)\left(\frac{K^{ss}}{N^{ss}}\right)^{\alpha} = N^{ss\varphi}\left(\left(\frac{K^{ss}}{N^{ss}}\right)^{\alpha} - \delta \frac{K^{ss}}{N^{ss}}\right)^{\sigma} N^{ss\sigma}) \tag{33}$$

After some transformation, labour in a steady state is expressed as a function of structural parameters.

$$N^{ss} = \left[\frac{(1-\alpha)\left(\frac{K^{ss}}{N^{ss}}\right)^{\alpha}}{\left(\left(\frac{K^{ss}}{N^{ss}}\right)^{\alpha} - \delta \frac{K^{ss}}{N^{ss}}\right)^{\sigma}}\right]^{\frac{1}{\varphi+\sigma}} \tag{34}$$

At this point, there is sufficient information for the calculation of the steady state for the remaining variables of the model. Capital in steady state is expressed as a capital/labor ratio multiplied by labor($K^{ss} = \frac{K^{ss}}{N^{ss}} N^{ss}$). Steady states of other variables are below.

$$C^{ss} = \frac{C^{ss}}{N^{ss}} N^{ss} \tag{35}$$

$$I^{ss} = \delta K^{ss} \tag{36}$$

$$Y^{ss} = C^{ss} + I^{ss} \tag{37}$$

1.3. Calibration

The model's parameters are calibrated using the values commonly used in RBC literature. The model is in quarterly frequency. The discount parameter (β) is 0.99, which corresponds to a 4% annual real interest rate. The Frisch elasticity of labour supply (φ) is calibrated to 1.5 following Justiniano and Preston (2010) and the risk aversion parameter (σ) is also set to 1.5, considering the diverse estimates emerging from macro and micro studies (Christiano et al. (2011) use a logarithmic form of utility meaning that $\sigma = 1$ and Devereux et al. (2006) sets $\sigma = 2$. The share of capital in the production function (α) is 0.35, this is a conventional value, which is typically lower for advanced countries and higher for emerging economies.

The depreciation rate of capital (δ) is calibrated to 0.025, which corresponds to the 10% annual depreciation rate and is the standard value used in the macro literature, (Christiano et al. 2005). The persistence parameters of exogenous processes are set to 0.9.

4. Results and Discussion

To preserve the nonlinearities of the model, authors do not do any approximation and find the exact solution[6]. All the simulations start from a steady state. Starting from the 20th period, the Government started to implement the policy by taxing consumption and financing education (see Figure 1). As a result of the increase in tax, consumption reduces dramatically, households work less. The slowdown in economic activity results in a decrease in investments, which is insufficient to restore the depreciated capital and the stock of capital decreases. Spending on education starts to increase the human capital after 8 years from the implementation of the educational reform. Increasing human capital with the rise in labour increases effective labour, which starts to have a positive impact on GDP. Because of recovering economic activity, investments start to increase, accumulating more capital. Consumption returns to the pre-reform state and stabilises at a higher level distant future. Keeping the positive tax rate, spending on education and the accumulation of human capital accelerates in the long run as a result of the increasing consumption.

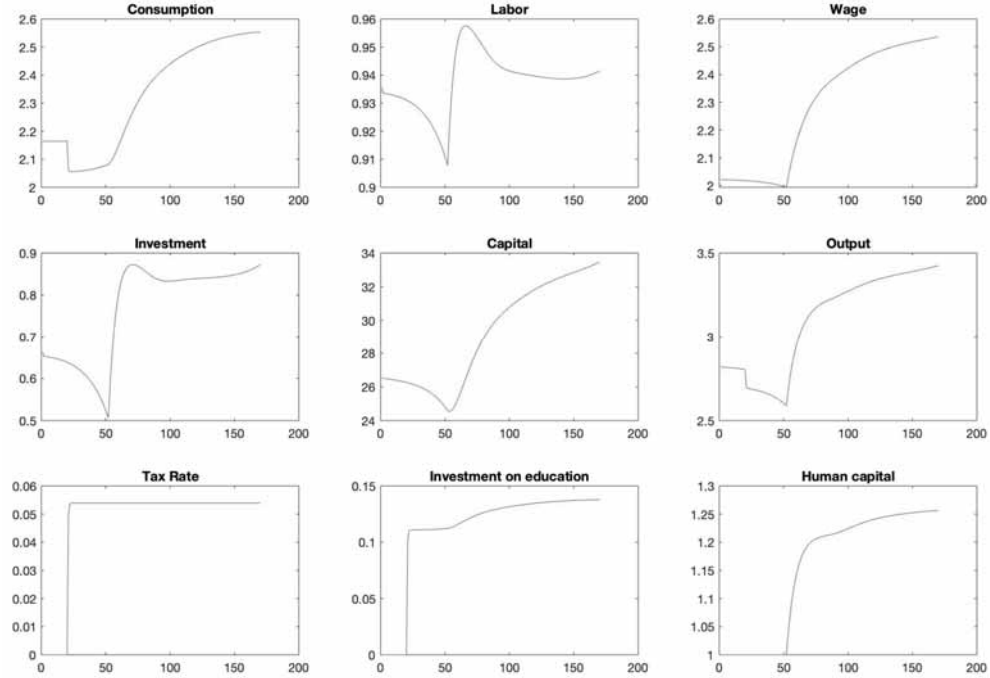
This policy yields an increase in long-term productivity, but decreases consumption in the short and medium runs, which means that it is not likely to be implemented by policymakers. Governments are selected for a short period of time, and they do their best to increase people's consumption to keep their reputation and to be elected again. Costly policies could be implemented by governments with very high political capital, which will not be depreciated significantly during the reform. On the other hand, societies with high forward-lookingness put pressure on the government to implement this kind of reform, because they see the potential future benefits of the reform and are ready to face lower consumption in the short run. Figure 1 presents how the model economy responds to the tax shock and education financing.

Figure 2 plots the policymaker's political capital in the case of three different initial values along with the cost of reforms. The simulations were obtained based on the results of Figure 1. As mentioned above, the costs of reforms indicate cumulative loss of consumption compared to its initial steady state. Political capital, on the other hand, is a stock which degrades from its initial value during the policymaker's political activity. Reform implementation reduces political capital as a result of cumulative loss in consumption. The intersection of political capital and the cost of reforms is the point where policymakers resign due to public demand. Thus it is important to keep implementing reforms up to that point. Afterwards, policymakers gain political capital in the long run due to the implementation of reforms. The lower the initial political capital, the sooner the intersection with reform cost happens. Thus governments which initially have low political capital, are constrained in their

[6] The simulations are implemented within the Dynare software platform. All the Matlab and Dynare codes are available upon request.

abilities to create reforms. They usually hold back on reforms and use alternative policies such as the accumulation of government debt or the creation of surprise inflation. Those policies, however, create only short-run beneficial results contrary to the implementation of educational reforms, whose benefits are harvested in the long run. Therefore governments with high initial political capital should implement reforms right from the start of their political activity despite the reduction of political capital in the short run.

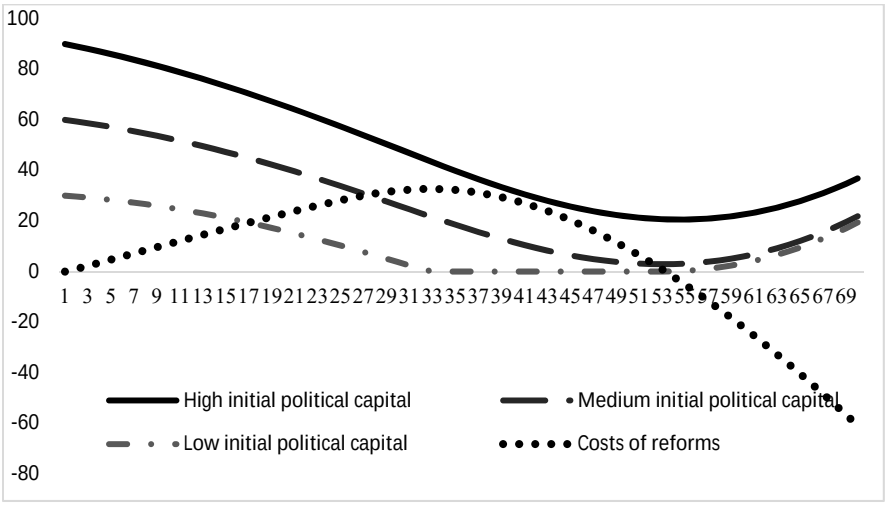
Figure 1. Impulse responses of the model variables to the tax shock and education financing



Source: Authors' calculations.

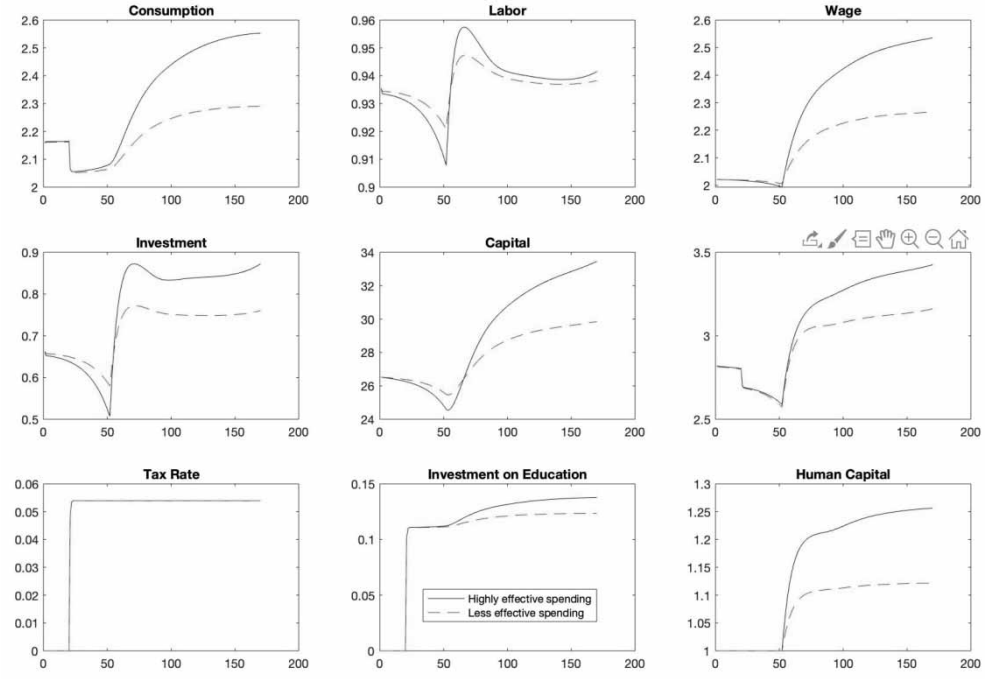
Figure 3 plots the comparison of the above-discussed scenario with the one with less effective reform. In the case of the less effective reform, consumption returns to the pre-reform level longer and stabilises at a low level compared with the case of the highly effective implementation of the reform. So, it is important to make effective spending and monitor that all the resources are targeted and contribute to the accumulation of knowledge.

Figure 2. Impulse responses of the costs of reforms and political capital to the tax reform and education financing



Source: Authors' elaboration.

Figure 3. Impulse responses to the high and low effective reforms



Source: Authors' elaboration

5. Conclusion

In this paper, a neoclassical model was built which relates to a class of endogenous growth models, specifically the famous Uzawa-Lucas model. The research introduces human capital as an input in the production function and explores its impact on economic performance. Similar to the existing large body of literature, this work also supports the idea that building human capital increases economic growth. This result operates through education, which happens to be one of the main contributors to human capital. Thus, the authors model human capital as a stock, which is an increasing function of education. By implementing the government's tax and allocating it to educational reforms, short-run economic costs are obtained. Particularly, tax increase reduces consumption sharply and a decrease in labour work slows economic activity. This leads to a decline in investments and as a result, capital stock decreases. These short-run economic costs carry the risk of loss in the government's political capital as people with low forward-lookingness will oppose these reforms. Particularly, by modelling the cost of reforms as a cumulative loss of consumption, we obtain the short-run increase of this cost. With the increase of reform costs electorates' trust level towards the policymaker starts to weaken, which is reflected in the reduction of the latter's political capital. Thus, it is unlikely that authorities willingly choose this kind of policy. Moreover, if the policymaker has initially a low level of political capital, it won't get the chance to create reforms and the only possible policy will remain the accumulation of government debt. Nevertheless, these short-run costs of educational reforms are paid-off in the long run and the economy ends up in a better place. Ultimately, increased education starts to have positive effects on building human capital. Along with an increase in productivity, the rise of labour brings economic activity back and consumption ends up at a higher level in the long term. And because of recovering economic activity, investments start to increase the accumulation of capital. People with high forward-lookingness can recognise the long-run benefits of this policy thus they require the government to implement reforms. Thus, it is essential for economies with the characteristics of low human capital to implement educational reforms, even though it carries the risks of loss in political capital due to short-run economic costs. Finally, comparing low effective reforms with the baseline case of highly effective reforms, authors conclude that in the first case, the economy recovers way slower and the main macroeconomic variables such as consumption, investment and output are formed at a lower level.

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