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Does inheritance taxation stimulate or hamper human capital accumulation?

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Abstract

Aim: The taxes imposed on inheritance can stimulate or hamper accumulation of human capital, but it is unclear which of these prevails.

Methodology: The study analysed the problem in the long run with the dynastic model using two approaches. In the first, human capital was approximated by wages, whilst in the second it constituted

a separate production factor. The former refers to the complementarity between two types of capital, while the latter refers to the substitutability.

Results: If wages approximate human capital, the inheritance tax decreases human capital accumulation. If, however, it is a distinct production factor, then the tax does not affect the accumulation rate but positively impacts the ratio of human to physical capital.

Implications and recommendations: Inheritance taxation can stimulate labour-intensive and environmentally friendly production without harming economic growth if human and physical capital are the substitutes. Future research should involve the empirical verification of postulated results.

Originality/value: The authors explained theoretically why inheritance taxation sometimes hampers and sometimes stimulates human capital accumulation without referring to different capital accumulation models, but only to the complementarity or substitutability of various types of capital.

Keywords: human capital, capital accumulation, bequest taxation, economic growth, inheritance

1. Introduction

The authors addressed the problem of inheritance taxation impacting human capital accumulation. The issue raises a lot of controversy as the theoretical predictions (cf. Section 2) are contradictory. Inheritance taxation can hamper or stimulate the accumulation of human capital. To test this, the study considered two models. In the first one, human capital is inherent in labour, approximated by wages, whilst in the second one human capital is a distinct production factor, accumulated together with physical capital. In both settings it was assumed that the representative agent lived only for one period *t*, and in the next period, was replaced by a new one. This process goes on indefinitely (dynastic model). The utility of the consumer depends on the current consumption and the consumption of future generations, hence some level of altruism towards descendants was assumed. The paper indicates conditions when an increase in the inheritance tax supports or harms economic growth (cf. discussion in Eftimoski, 2022, and the positive human and physical capital impact on growth in (Dias, & Tebaldi, 2012)).

The results of the models are twofold. If human capital is inherent in labour, the inheritance tax on physical capital damages wages, adversely affecting human capital accumulation. If, however, human capital is a distinct production factor, then the inheritance tax does not affect the investment rate in human capital accumulation, yet the ratio of human to physical capital in equilibrium is higher than in the no-tax case. The diversity in the results proceeds directly from the assumed relation between human and physical capital. In the first case, physical and human capital are complementary, while in the second, they are independent. Specifically, in the latter case, inheritance taxation should not affect the accumulation of human capital in the steady-state equilibrium.

Inheritance tax is detrimental to the accumulation of human capital only when output is produced primarily by physical capital, in which case any factor adversely affecting physical capital also has a negative effect on human capital. The impact is non-negative if capital is a separate risk factor, which refers to the substitutability of production factors. According to the meta-analysis of studies on elasticity of substitution (Knoblach et al., 2020), elasticity of substitution between labour (including human capital) and physical capital is lower than 1, also consistent with the studies for developed economies (Mućk, 2017), with an average elasticity of 0.7. However, some research suggested it is close to, (Claro, 2003) or even more than 1 (Karabarbounis, & Neiman, 2014). Formally, as elasticity greater than 1 indicates substitutability, while lower than 1 – complementarity, one cannot exclude any of these possibilities. In this study, the authors considered elasticity of substitution lower than 1 (the first case) and equal to 1 (the second case), as elasticity greater than 1 does not seem likely in contemporary economies. Nevertheless, the conclusions from the second case remain valid for elasticity greater than 1 and support the claim that inheritance taxation policy does not disturb long-term growth.

The analysis sheds some light on the contradictory effects postulated in the literature since it relies on the same modelling approach but with different assumptions about the planning horizon and possible substitutability or complementarity between physical and human capital.

The paper is organized as follows. First, a brief literature review is presented (Section 2). The following two sections refer to the proposed model settings. In Section 3, wages approximate human capital, which cannot be substituted for physical capital. In Section 4, human capital is a distinct production factor, evolving according to the standard specification. Human and physical capital can be substituted for each other. Section 5 considers an economy with two types of agents adjusting their consumption and capital to present the equilibrium features. Finally, Section 6 discusses the conclusions and implications of the obtained results for policy-making.

2. Literature review

The problem of how bequest taxation affects human capital has not yet been considered comprehensively in the literature. Grüner and Heer (1994) were probably the first to conceptualise the impact of the bequest taxation on human capital accumulation. In their endogenous growth model, an altruistic individual spends his/her lifetime on leisure, education, ρ_t, and work, leaving the physical capital accumulated during lifetime to his/her heirs. Inheritance tax creates a disincentive to accumulate physical capital, however, as the parent derives utility from the well-being of the children, he/she strives to invest in their human capital H_{t+1}, by putting more effort (time) into education, according to the standard Lucas specification $H_{t+1} = A\rho_t H_t + H_t$ with *A* being a constant.

Grüner and Heer (1994) numerically showed that the second effect prevails, i.e. the net effect of inheritance tax on human capital is positive.

Ihori (1997, 2001) adopted the idea of the trade-off between the two channels the parent may use to increase the children's welfare. In the three-period overlapping generations model, the altruistic parent can choose to spend his/her resources (other than time) on the human capital formation of the child (as bequests to human capital) or on bequests to the child in the form of physical capital. In the earlier version of the model (Ihori, 1997), human capital was assumed to be accumulated through natural processes (genetically, i.e. inherited from previous generations) and education expenditure. The model considered that externalities generated by all other economic agents might affect an individual's human capital. The parent, however, did not consider the externality effect on the children. In such a setting, a tax on bequests to physical capital reduces the marginal benefits to the child from the physical gift, inducing the parent to invest more in human capital. Later, Ihori (2001) modified the model specification so that the individual's human capital was a function of two inputs: time spent by the child on education, and the parents' investment in education. Individuals differ in the productivity of educational input. The marginal productivity of the parent's transfer to the human capital of the child depends on the level of the child's educational input, and the human capital of the child on the parent's bequest instead of the average level of human capital existing in the economy. Hence, children growing up in wealthier families can access better education services, enhancing their human capital formation. If the after-tax marginal return on human capital is higher than the after-tax marginal return on physical capital, the intergenerational transfer takes the form of human capital investment – otherwise physical capital is accumulated. With heterogeneous agents, the tax would only reduce the marginal return of individuals with lower educational input productivity.

Staffolani and Valentini (2007) showed that when 'inborn' talents are unevenly distributed among individuals, and individual educational attainment can be financially constrained, proportional bequest taxation may augment human capital in an economy, provided that revenues from the tax were used to redistribute intergenerationally among all individuals (from wealthier parents of less skilled individuals to better-skilled children of poorer parents). This conclusion adds to the so-called Carnegie conjecture, the essence of which is that inheritance makes the recipient work less and be less willing

to acquire skills (cf. Holtz-Eakin et al., 1993; Kulp et al., 2023). The Carnegie's proposition was tested by Hedlund (2020), who demonstrated that when companies cannot perfectly observe employee skills, they tend to 'free-ride' on others' human capital attainment, resulting in lower average skill levels. As this increases with inherited wealth, by reducing it the tax induces workers to acquire skills (i.e., stimulates human capital formation) (cf. also Kudła, 2004). However, it does not preclude the labour supply increase to compensate for the lower expected inheritance (Kindermann et al., 2020; Hamaaki, & Ibuka, 2024).

On the other hand, Alonso-Carrera et al. (2012) claimed that by reducing the amount of bequest that the parents leave to their offspring, the inheritance tax increases the amount that an individual must receive from his/her parents to invest in the education of the children. Therefore, the tax negatively impacts human capital in the steady state, hence Farhi and Werning (2010) proposed a subsidy to human capital with a higher marginal subsidy on lower human capital investments.

Thus, the results of theoretical research on the impact of bequest taxation on human capital have been contradictory opposite. Hendricks (2003) claimed that this contradiction may result from different assumptions on how human capital is transferred intergenerationally. In the infinite-horizon growth models such as those of King and Rebelo (1990) and Caballé and Santos (1993), intergenerational persistence was unreasonably assumed to be high. Therefore, the implications of those models are actually only of slight importance, whereas life cycle models underestimate the effects of taxation as, in the life-long horizon, the decision is limited.

3. Human capital approximated by wages

First, consider a simple case in which homogenous agents live only for one period t; in period $t+1$, a new cohort is born, and so on. Assuming that there was a natural link between any two consecutive cohorts, i.e. a representative individual born in t derives utility from his/her consumption and the consumption of his/her descendants

$$U_t = u(c_t) + \beta U_{t+1}, \tag{1}$$

where $\beta < 1$ reflects how much the individual values the well-being of the descendants. Although human capital is intangible as it is marketed, it can be approximated by wages. Physical capital is therefore the only state variable. In the case of no taxes at all, the agent faces the budget constraint:

$$k_{t+1} = (1-\delta)k_t + r_t k_t + w_t - c_t, \tag{2}$$

where the total time endowment is normalised to 1.

The equilibrium wage and rental price are determined by the supply side of the economy:

$$r_t = \alpha(k_t)^{\alpha-1},$$

$$w_t = (1-\alpha)(k_t)^{\alpha},$$

assuming that the output takes the form $Y_t = (K_t)^{\alpha}(L_t)^{1-\alpha}$.

In principle, the agent may be willing to leave a bequest to his/her heirs in the form of physical capital. If any inheritance is taxed at rate τ, then the individual eventually leaves only $(1-\tau)k_{t+1}$ units of capital while the government captures the remainder at time t.

The government can use the revenue collected, τk_{t+1}, to finance benefits that the public may or may not enjoy or to rebate in the form of lump-sum transfers. The study assumed the latter option and denoted the transfers with Γ_t, if any, received by a household at time t. The authors wanted to emphasise that all individuals treat such rebates as given. Furthermore, these transfers occur at the end of period $t-1$, i.e. when capital stock k_t is formed. Note that any part of the capital captured by the government that is not used in the production process is transformed into a consumption good consumed by the government. With inheritance tax and the transfers, the budget constraint takes the form:

$$k_{t+1} = (1 - \delta + r_t)[(1 - \tau)k_t + \Gamma_t] + w_t - c_t. \quad (3)$$

The bequest taxation has two effects on welfare. First, it diminishes the capital individuals receive from their ancestors, and second, it decreases the amount left to the descendants, i.e. if the previous cohort leaves k_t, only $(1 - \tau)k_t$ is received by the next cohort, and the subsequent cohort inherits only $(1 - \tau)k_{t+1}$. The well-being of the individual born in *t* is therefore:

$$U_t = u(c_t) + \beta U[(1 - \tau)k_{t+1} + \Gamma_{t+1}]. \quad (4)$$

For the record, if the rebate was at 100% and the individual was to internalise it in full, equations (3) and (4) would be the same as (2) and (1), respectively. The rebate is, however, treated here as a lump-sum and exogenous, thus (4) is distinct from (1).

The tax policy directly affects the intertemporal trade-off (see Appendix A). In addition, there may arise indirect effects operating through the interest rate r_{t+1}. In order to determine them, the study took into consideration the steady state, where $c_t = c_{t+1}$. Hence, $u'(c_t) = u'(c_{t+1})$, and the Euler equation entails:

$$r^* = \frac{1}{\beta(1 - \tau)} + \delta - 1$$

which is higher than in the no-tax case. As $r = \alpha k^{\alpha-1}$, where *k* denotes the amount of capital *per capita* in the economy, then

$$r^* = \alpha[(1 - \tau)k^* + \Gamma^*]^{\alpha-1}.$$

As the steady state value of the interest rate r^* increases with the tax rate, the total amount of capital available for production

$$(1 - \tau)k^* + \Gamma^*$$

declines with τ. Now assume that fraction λ of government revenue τk^* is returned to the public, while the residual is used to finance government expenditure. The overall amount of capital in the economy in the steady state is then equal to

$$K^* = (1 - \tau)k^* + \lambda\tau k^*.$$

As $r^* = \alpha(K^*)^{\alpha-1}$, hence

$$K^* = \left[\frac{\alpha}{r^*}\right]^{\frac{1}{1-\alpha}} = \left[\frac{\alpha}{\frac{1}{\beta(1-\tau)} + \delta - 1}\right]^{\frac{1}{1-\alpha}}.$$

It follows that the available capital stock in the economy in a steady state falls with the inheritance tax rate. As long as the rebates are incomplete ($\lambda < 1$), private gross bequests rise with the tax rate for a given value of K^*. Summing up, *the steady state levels of capital and output of the economy decline with an increase in the tax rate.*

To examine the effects of the taxation of bequests on human capital, the authors chose to proxy human capital with wages earned by individuals. In this case, the wage rate was $w_t = (1 - \alpha)(k_t)^{\alpha}$, and given that the authors argued that the overall amount of capital in the steady state is negatively affected by the presence of taxation, one can conclude that wages earned by individuals are also negatively affected. Hence, *tax inheritance negatively impacts human capital.*

4. Human capital as a distinct production factor

Consider human capital as an independent state variable, i.e. formed as a result of purposeful economic activity. The formation of human capital entails benefits and costs, which rational economic agents balance. On the one hand, the higher the stock of human capital, the more productive the

individuals are and the higher their wages, and on the other, human capital accumulation incurs costs in terms of forgone income. Hence, the utility function takes the form:

$$U(k_t, h_t) = \max_{c_t, \rho_t}\{u(c_t) + \beta U(k_{t+1}, h_{t+1})\} \tag{5}$$

and the capital motion equation is given by

$$k_{t+1} = (1 - \delta + r_t)k_t + w_t(1 - \rho_t)h_t - c_t, \tag{6}$$

where ρ_t denotes the fraction of human capital devoted towards human capital formation, while $1 - \rho_t$ is the fraction of human capital used to produce physical capital. Human capital evolves according to

$$h_{t+1} = (1 - \delta_H)h_t + A\rho_t h_t, \tag{7}$$

where *A* is a constant. Thus the endowment of time (which is normalised to 1) is allocated between human capital and physical capital formation. In equilibrium $\frac{h}{k}$, ρ, and the rate of human capital growth should be constant. Therefore

$$\frac{h}{k} = \frac{1}{1-\rho}\left(\frac{A+\delta-\delta_H}{\alpha}\right)^{\frac{1}{1-\alpha}} \tag{8}$$

and

$$\frac{h_{t+1}}{h_t} = 1 - \delta_H + A\rho. \tag{9}$$

Let us now examine how the taxation of bequests affects the process of formation of human capital. As before, let us assume that physical capital left to the next generation is taxed at rate τ, and government revenue τk_{t+1} can be at least partially transferred in a lump-sum to the public. In such a setting, physical capital evolves according to

$$k_{t+1} = (1 - \delta + r_t)[(1 - \tau)k_t + \Gamma_t] + (1 - \rho_t)h_t w_t - c_t \tag{10}$$

and human capital formation is unaffected. However, since economic agents are taxed, they enjoy only $(1 - \tau)k_{t+1} + \Gamma_{t+1}$ units of capital. Therefore, the utility function takes the form:

$$U\big((1 - \tau)k_t + \Gamma_t, h_t\big) = \max_{c_t, \rho_t}\big\{u(c_t) + \beta U\big((1 - \tau)k_{t+1} + \Gamma_{t+1}, h_{t+1}\big)\big\}. \tag{11}$$

The inheritance tax directly affects the above conditions and the equilibrium (see Appendix B), and also has indirect effect.

As before, search for an equilibrium where $\frac{K}{h}$ and ρ are constants, using *K* instead of *k* in the latter ratio to denote the part of capital used for production. It consists in private physical capital and the part of the government tax receipts that are neither 'consumed' nor rebated to the public. In equilibrium, the net rate of return on physical capital equals the rate of return on human capital

$$(1 - \tau)(1 - \delta + r_{t+1}) = (A + 1 - \delta_H)\frac{w_{t+1}}{w_t}.$$

This condition can be rewritten (see details in Appendix B for equations (3b) and (4b))

$$(1 - \tau)\left(1 - \delta + \alpha(1 - \rho)^{1-\alpha}\left(\frac{K}{h}\right)^{\alpha-1}\right) = A + 1 - \delta_H \tag{12}$$

providing

$$\frac{h}{K} = \frac{1}{1-\rho}\left[\left(\frac{A+1-\delta_H}{1-\tau} - 1 + \delta\right)\frac{1}{\alpha}\right]^{\frac{1}{1-\alpha}} \tag{13}$$

which sets the interest rate in equilibrium at $r^* = \frac{A+1-\delta_H}{1-\tau} - 1 + \delta$. This indicates that the higher the tax rate, the higher the interest rate. In order to find out how bequest taxation affects human capital, one needs to employ a more specific form of the utility function, considering the two commonly used types.

If the utility function is of the constant relative risk aversion (CRRA) type

$$u(c) = \frac{c^{1-\theta} - 1}{1 - \theta}$$

then (12) becomes

$$(1 - \delta_H + A\rho)^{\theta} = \beta(A + 1 - \delta_H) \tag{14}$$

which leads to the equilibrium value of ρ[1]

$$\rho^* = \frac{1}{A}\left\{[\beta(A + 1 - \delta_H)]^{\frac{1}{\theta}} - 1 + \delta_H\right\}. \tag{15}$$

Therefore, one can derive the growth rate of h using (9), given that the ratio of $\frac{h}{K}$ is constant, as is the growth rate of physical capital. The same growth rates for human and physical capital imply that the output also grows at the same rate.

To sum up, the authors found an equilibrium in which *h* and *K* grow at the same rate determined by ρ^*, which is constant and given by (15) – note that the value of ρ^* is not affected by the tax policy.

Thus, it is established that inheritance tax does not impact the fraction of human capital devoted to producing human capital. Earlier, it was shown that $\frac{h}{K}$ are functions of ρ and τ.

If the utility function is of the logarithmic type

$$u(c) = v(c) = log(c)$$

and taking into consideration that $\frac{u'(c_t)}{u'(c_{t+1})}$ is equal to $\frac{c_{t+1}}{c_t}$ (for $\theta = 1$), one can rewrite (14) as

$$\rho = \beta + \left[\frac{\beta}{A} - 1\right](1 - \delta_H).$$

Thus, it was concluded that the bequest tax does not distort human capital formation, whilst all the other conclusions made in the previous case remain valid.

To sum up, *taxing bequests does not influence human capital accumulation*, although it affects the human-to-physical capital ratio, while leaving all the variables' growth rates unaffected in the steady state.

5. The steady state with heterogeneous agents

In order to investigate the effect of inheritance taxation on human capital when taxes and rebates differ for various persons, the model from Section 4 was enriched by introducing two types of agents and a diversified tax policy. This augmentation allowed for the simulation of a redistribution policy.

According to (13), the relation between human and physical capital is constant in equilibrium. Thus, by finding the value of physical capital, one can determine the relation of physical to human capital and potential paths of adjustment. The latter is determined by the value of physical capital and parameters affecting human capital accumulation, i.e. $\alpha, \beta, \delta, \delta_H, \theta, A$ and τ.

Suppose that there are two types of agents, and both are observable: one with a higher capital endowment, and one endowed with lower capital. The maximisation problem of the agent of type *i* can be stated as

$$V_i\left((1 - \tau_i)k_{i,t} + \Gamma_{i,t}\right) = \max_{c_t}\left\{u\left(c_{i,t}\right) + \beta V_i\left((1 - \tau_i)k_{i,t+1} + \Gamma_{i,t+1}\right)\right\},$$

[1] Naturally, only values between 0 and 1 are admissible.

where

$$k_{i,t+1} = (1 - \delta + r_t)\left[(1 - \tau_i)k_{i,t} + \Gamma_{i,t}\right] + w_t - c_{i,t}\,. \tag{16}$$

The solution to this problem is given by

$$u'(c_{i,t}) = \beta(1 - \tau_i)V_i'\left((1 - \tau_i)k_{i,t+1} + \Gamma_{i,t+1}\right)$$

and

$$V_i'\left((1 - \tau_i)k_{i,t+1} + \Gamma_{i,t+1}\right) = \beta(1 - \tau_i)(1 - \delta + r_t)V_i'\left((1 - \tau_i)k_{i,t+1} + \Gamma_{i,t+1}\right).$$

The above conditions, in particular, imply that

$$\frac{u'(c_{i,t+1})}{u'(c_{i,t})} = \frac{1}{\beta(1-\tau_i)(1-\delta+r_t)}\,.$$

When the utility function is of the CRRA type, e.g. $u(c) = \frac{c^{1-\theta}-1}{1-\theta}$, then

$$\left(\frac{c_{i,t+1}}{c_{i,t}}\right)^{\theta} = \frac{1}{\beta(1-\tau_i)(1-\delta+r_t)}\,. \tag{17}$$

Assume that the mass of type *i* is equal to μ_i, thus $\mu_1 + \mu_2 = 1$. The government does not save and consume any capital, which is not given as rebate to the taxpayers, therefore the total amount of capital k_t available in the economy for production at time *t* is given by

$$k_t = \mu_1\left[(1 - \tau_1)k_{1,t} + \Gamma_{1,t}\right] + \mu_2\left[(1 - \tau_2)k_{2,t} + \Gamma_{2,t}\right]. \tag{18}$$

Moreover, let $\Gamma_{i,t} = \lambda_i\left(\tau_1\mu_1k_{1,t} + \tau_2\mu_2k_{2,t}\right)$, where λ_i define the rebate obtained by the agent of type *i* from the government. Assume that $\lambda_1 + \lambda_2 = 1$ which means that all tax revenues are redistributed between agents, hence

$$k_t = \mu_1\left[(1 - \tau_1)k_{1,t} + \lambda_1\left(\tau_1\mu_1k_{1,t} + \tau_2\mu_2k_{2,t}\right)\right] + \mu_2\left[(1 - \tau_2)k_{2,t} + \lambda_2\left(\tau_1\mu_1k_{1,t} + \tau_2\mu_2k_{2,t}\right)\right]. \tag{19}$$

The value of r_t at time *t* is given by the Cobb-Douglas function as

$$r_t = \alpha k_t^{\alpha-1} \tag{20}$$

and the value of w_t at time *t* is given by

$$w_t = (1 - \alpha)k_t^{\alpha}. \tag{21}$$

The evolution of $k_{i,t+1}$ takes the form

$$k_{i,t+1} = (1 - \delta + r_t)\left[(1 - \tau_i)k_{i,t} + \lambda_i\left(\tau_1\mu_1k_{1,t} + \tau_2\mu_2k_{2,t}\right)\right] + w_t - c_{i,t}. \tag{22}$$

Equations (17) and (22) are symmetric for the agents of the types 1 and 2. Therefore, if the relation of consumption is the same in equilibrium (according to equation 17) then both tax rates have to be $\tau_1 = \tau_2 = \tau$ to equalise consumption of both agents $c_{1,t} = c_{1,t+1}$ and $c_{2,t} = c_{2,t+1}$.

In the steady state, from (17) one can calculate r^*, which is the rate of return in equilibrium, together with physical capital in equilibrium k^* given by (20)

$$k^* = \left(\frac{\alpha\beta(1-\tau)}{1-\beta(1+\delta)(1-\tau)}\right)^{\frac{1}{1-\alpha}}. \tag{23}$$

The total value of physical capital used for production in the steady state can be calculated from (18) for the agents of types 1 and 2

$$\mu_1k_1^* + \mu_2k_2^* = \frac{1}{(1-\tau)+\tau(\lambda_1k_1^*+\lambda_2k_2^*)}\,k^*. \tag{24}$$

Finally, using (24) together with (22), one can calculate the value of total consumption in the steady state

$$\mu_1c_1^* + \mu_2c_2^* = w^* - \frac{1-(1-\delta+r^*)(1-\tau)+\tau(\lambda_1k_1^*+\lambda_2k_2^*)}{(1-\tau)+\tau(\lambda_1k_1^*+\lambda_2k_2^*)}\,k^*. \tag{25}$$

The actual values of $c_1^*,\ c_2^*,\ k_1^*,\ k_2^*$ can be determined when one specifies the initial values of $k_{1,t}$ and $k_{2,t}$. The equilibrium is a saddle point in a four-dimensional state space. There is a one-dimensional stable manifold for this equilibrium – the linear approximation matrix has only one eigenvalue with modulus less than 1. The initial condition that converges to the equilibrium must be chosen on this manifold.

Therefore, more interesting than the path of convergence is the analysis of changes in physical capital and consumption for both types of agents in the steady state in response to inheritance tax and rebate changes. These changes resemble the redistribution policy and indicate the expectations about the direction of capital and consumption adjustments. As human capital is linked with physical capital by formula (13), it is also possible to show the changes in the human-to-physical capital ratios. Consider the simulation setting which assumes that agents of type 1 have a higher capital endowment and agents of type 2 have a lower one. Therefore, as the type of an agent is observable, the government rebates more to agent 2 than to agent 1 (e.g. $\lambda_1 = 1/3$ and $\lambda_2 = 2/3$) to decrease the inequalities. The share of poorer agents in the economy is higher $\mu_2 = 0.9$, and the share of affluent agents is lower and equal to $\mu_1 = 0.1$. Tax τ is equal to 0.08, $\alpha = 0.6$, $\beta = 0.995$, $\delta = 0.07$. For this list of parameters, the set of equations (19)-(22) for the agents of types 1 and 2, together with (17), for constant consumption between periods equal to 1 $\left(\frac{c_{1,t+1}}{c_{1,t}} = \frac{c_{2,t+1}}{c_{2,t}} = 1\right)$, can be solved numerically to obtain values of $c_1,\ c_2, k_1,\ k_2$.

Figure 1 shows consumption and capital for τ increasing from 0.08 to 0.18. It can be observed that they are decreasing with rising inheritance taxes. The redistribution increases consumption of the poorer agents for each tax rate (in this simulation, even above the consumption of type 1 agents). At the same time, capital endowment remains higher for agents of type 1.

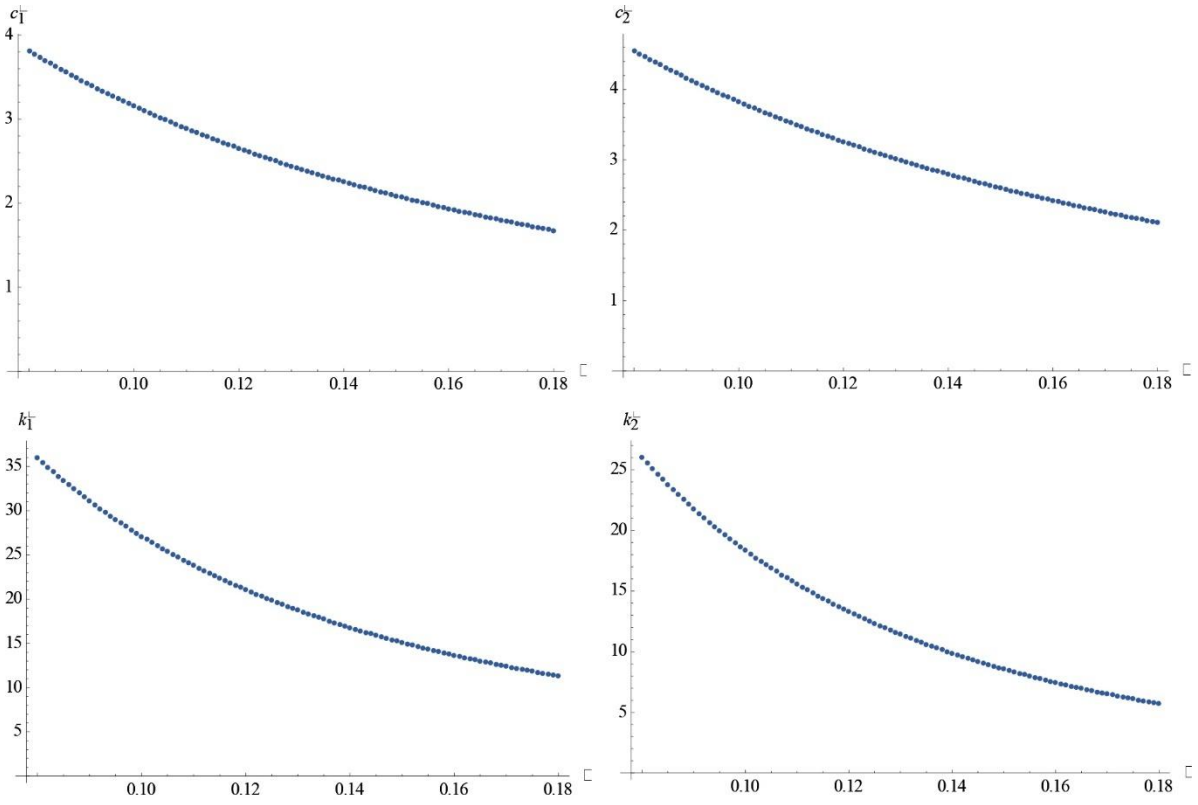

Fig. 1. Consumption and physical capital in the steady state with two agents for different levels of inheritance tax τ and redistribution policy $\lambda_1 < \lambda_2$

Source: own calculation.

Consumption of the agents of type 1 increases with received rebates λ_1, which automatically means a drop in transfers λ_2 to agents of type 2 (as $\lambda_1 + \lambda_2 = 1$) (see Figure 2). The change in rebates affects not only the consumption of the agents, but also the level of physical capital available to all the agents since the rebates return capital to the economy (which is now not consumed by the government). Therefore, the rebates increase the physical capital of both types of agents.

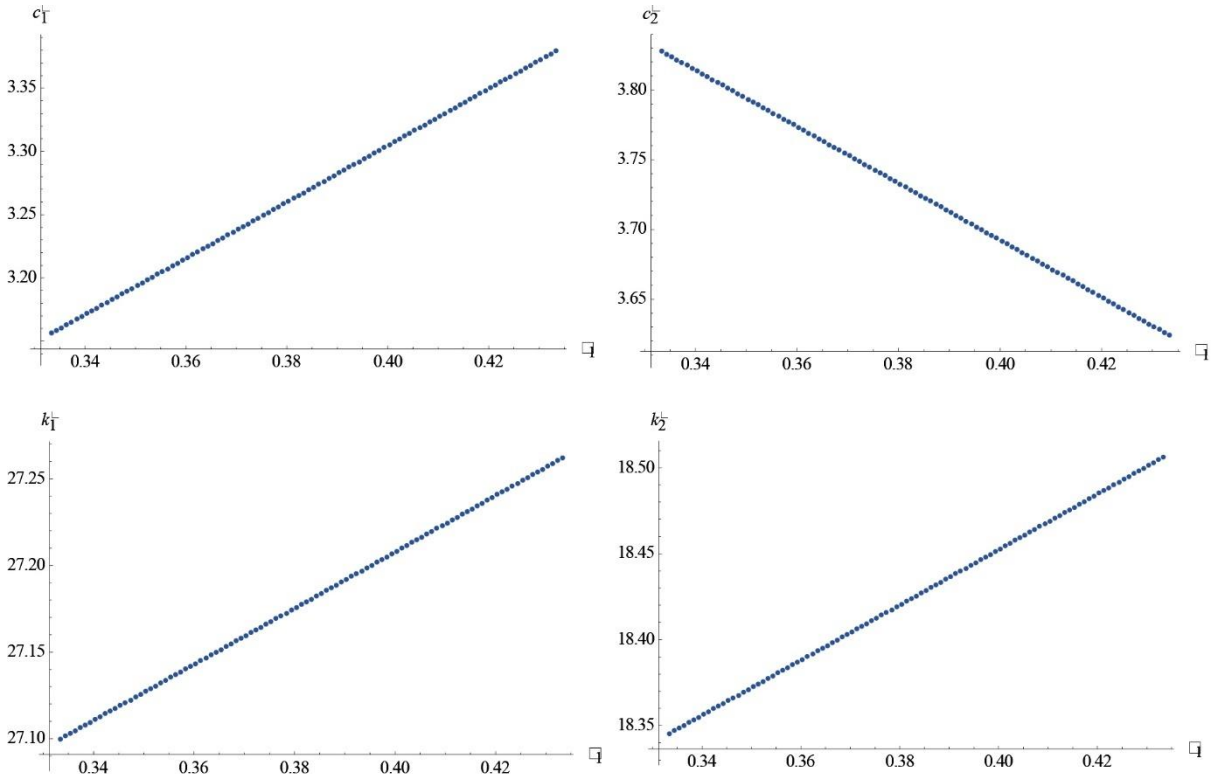

Fig. 2. Consumption and physical capital in the steady state with two agents for different levels of transfers λ

Source: own calculation.

One can also describe the situation when the steady state is disturbed by the exogenous change in total available physical capital. For example, when physical capital rises, the return on capital decreases according to (20), which implies higher consumption in the next period, which is in line with (17). In other words, additional capital has to be consumed to restore the equilibrium. The opposite situation (negative change of physical capital) is more interesting, as an exogenous drop in this capital can be triggered by increased inheritance taxation (assuming that physical capital confiscated by the government through inheritance taxation is not returned to the economy). In this situation, *r* becomes higher and consumption in the next period will be lower. Suppose that collected taxes are returned to the taxpayers, and in this case, physical capital goes up according to (19), and rate *r* is less affected, allowing for a smaller consumption drop.

In the case of a full rebate (all tax revenues are returned to consumers), there is no drop in capital at all, as *r* is not affected. However, the distribution of consumption can be different than before the change if transfers λ_1, λ_2 are not equal. In particular, consumption can be higher for an individual receiving a higher λ and lower for an individual receiving a lower λ. Such a redistribution favours an individual with a lower initial capital endowment if transfers are higher for him/her, and lower for an individual with a greater initial capital.

In fact one can show the ratio between human and physical capital using (13). Denoting human capital used in production as $H_t^P = H_t(1-\rho)$, ratio $\frac{H_t^P}{K_t}$ is shown in Figure 3.

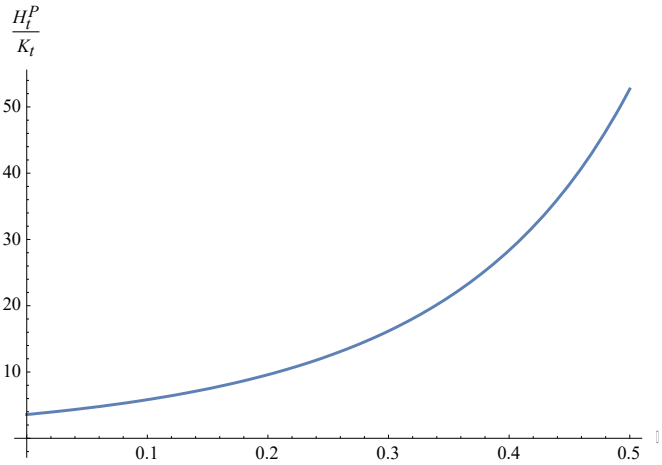

Fig. 3. The ratio of human capital used in production *h(1-ρ)* to physical capital in the steady state for increasing τ

Source: own calculation.

The ratio of human to physical capital increases with the tax, and this increase is not linear but exponential. Therefore, high inheritance taxation can substantially diminish physical capital, and high rebates should be introduced to mitigate this effect.

The conclusions remain the same for the logarithmic utility function, as the equilibrium is not altered. The difference is the value of θ, which is equal to 1 in the logarithmic case, but as consumption in the steady state is not changing, then the left side of (17) is still 1.

6. Discussion and conclusions

The study investigated the impact of bequest taxation on formation of human capital. The analysis was conducted in two settings, examining subsequent generations of individuals who live for one or two periods, with a certain level of altruism exhibited by the ancestral generation towards their descendants.

In the first framework, the authors examined a one-sector model with intangible human capital, approximated by wage income, and concluded that in a steady state the bequest tax negatively impacts on human capital accumulation. This situation is more likely for developed countries, where physical capital can hardly be substituted (i.e. physical and human capital are complementary). In this situation, inheritance taxation should not be implemented, or taxes should remain low .

In the second setting, human capital is an outcome of purposeful activity which requires resources, so that in each period economic agents must balance its costs and benefits. In such a case, inheritance taxation does not affect the growth rate of human capital, no matter what type of utility function (i.e. the CRRA type or the logarithmic one). The accumulation of human capital is not disturbed, but the composition of the two types of capital is altered. The model can be extended to an economy of two types of agents, thus the general conclusions remain the same, but due to redistribution effects, the consumption of agents with a lower initial capital endowment can even be higher than the consumption of agents with a higher initial physical capital endowment. The tax rebates (tax revenues returned to taxpayers) positively stimulate the accumulation of physical capital.

Inheritance tax decreases the utilisation of physical capital, making human capital more important in an economy. In other words, taxing bequests can modify the composition of production factors. Therefore, if policymakers opt for higher utilisation of the existing workforce (curbing unemployment) or strive to decrease the environmental cost of economic growth (through lower use of physical capital), they should consider using the inheritance tax. These effects stem from increasing the ratio between the two types of capital in favour of human capital, and the observation that human capital

is more intensively using labour, and it is probably also less harmful to the environment. It should also be emphasised that even high taxation of bequests does not harm economic growth, and tt is essential if policymakers use high inheritance taxation to reduce wealth inequalities (Piketty, 2011; Piketty, & Saez, 2013; García-Miralles, 2020).

Since inheritance tax reduces accumulated wealth with possibly no compensatory effect in the form of induced human capital, such a tax might not be recommended according to the model from Section 3, in order to avoid side effects for human capital if these two production factors are complementary. However, this depends on the elasticity between these two types of capital, which is determined by the structure of an economy (more service or manufacturing-oriented).

Future research should focus on adjustment in the longer planning horizon of agents and different production functions. For example, one can apply the constant elasticity of substitution (CES) production function, as it represents various levels of complementarity and substitutability of production factors. Moreover, one can analyse a simple two-period model when the optimization of economic agents' behaviour is affected by different bequest motives, for example, paternalistic or exchange for services from descendants, and the equilibrium does not require a long-term adjustment path. Finally, these models do not use physical capital to produce human capital, but one can expect that not only time is needed for the accumulation of human capital, and high capital endowment supports the formation of both types of capital.

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Appendix A. Wages as a proxy for human capital

The case of no taxation

There is only a single state variable, and one can summarise the problem of a person born in t as maximising (1) subject to (2). The solution to the above problem is trivial and leads to a familiar Euler-type equation, which can be stated as

$$\frac{u'(c_t)}{u'(c_{t+1})} = \beta(1 - \delta + r_{t+1}) \tag{1A}$$

which, together with the budget constraints and the initial value of k, allows to determine the value of consumption in all periods for a given path of wages and the rental price of capital.

The case of inheritance taxation

The solution to the optimisation problem is

$$\frac{u'(c_t)}{u'(c_{t+1})} = \beta(1 - \tau)(1 - \delta + r_{t+1}). \tag{2A}$$

Note that taxation impacts the form of the Euler equation as condition (2A) is different from (1A).

Appendix B. Human capital as a separate state variable

The case of no taxation

The first-order conditions imply that in equilibrium, the net rate of return of physical capital is equal to the rate of return of human capital

$$1 - \delta + r_{t+1} = (A + 1 - \delta_H)\frac{w_{t+1}}{w_t}. \tag{1B}$$

If one assumes the Cobb-Douglas production function (function with elasticity of substitution equal to 1), then $y_t = (k_t)^{\alpha}[(1 - \rho_t)h_t]^{1-\alpha}$, then the wage paid to a unit of human capital takes the form $w_t = (1 - \alpha)(1 - \rho_t)^{-\alpha}(k_t)^{\alpha}(h_t)^{-\alpha}$, and similarly $r_t = \alpha(1 - \rho_t)^{1-\alpha}(k_t)^{\alpha-1}(h_t)^{1-\alpha}$. Substituting these relationships to equation (1B) one obtains

$$1 - \delta + \alpha(1 - \rho_t)^{1-\alpha}\left(\frac{k_t}{h_t}\right)^{\alpha-1} = (A + 1 - \delta_H)\left(\frac{1-\rho_t}{1-\rho_{t+1}}\frac{k_{t+1}}{h_{t+1}}\frac{h_t}{k_t}\right)^{\alpha}. \tag{2B}$$

The case of inheritance taxation

As before, in equilibrium, the net rate of return of physical capital is equal to the rate of return of human capital

$$(1-\tau)(1-\delta+r_{t+1}) = (A+1-\delta_H)\frac{w_{t+1}}{w_t}. \tag{3B}$$

Denote the overall amount of physical capital available to economic agents at time t as K_t, then $K_t = (1-\tau)k_t + \Gamma_t$, assuming that any capital that remains in the possession of the government is not used for production purposes and serves to finance government consumption. Recall that $r_{t+1} = \alpha(K_{t+1})^{\alpha-1}[(1-\rho_{t+1})h_{t+1}]^{1-\alpha}$ and $w_{t+1} = (1-\alpha)(1-\rho_{t+1})^{-\alpha}(K_{t+1})^{\alpha}(h_{t+1})^{-\alpha}$, hence one can rewrite the above condition as

$$(1-\tau)\left(1-\delta+\alpha(1-\rho_{t+1})^{1-\alpha}\left(\frac{K_{t+1}}{h_{t+1}}\right)^{\alpha-1}\right) = (A+1-\delta_H)\left(\frac{1-\rho_{t+1}}{1-\rho_t}\right)^{-\alpha}\left(\frac{K_{t+1}}{h_{t+1}}\frac{h_t}{K_t}\right)^{\alpha}. \tag{4B}$$