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Gerontocracy revisited: unilateral transfer to the young may benefit the middle-aged

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Abstract

According to conventional wisdom, intergenerational transfers can survive, in the absence of altruism, only if the old are net recipients. I prove that this need not hold in an overlapping generations model with a fixed factor. For example, the middle-aged owning land may gain by providing public education even when they cannot tax the young and when the young face no credit market constraints. This requires that labor is not mobile. Furthermore, establishing public education may benefit only the generation which pays for education twice, first for itself and then for the next generation.

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1. Introduction

Conventional wisdom argues that in the absence of altruism, an older generation would pay for the education of the following generation only if it can reap gains through social security benefits or other forms of public expenditure. Konrad (1995) formalizes this argument by showing that even a gerontocracy controlled by the old may find it optimal to finance education for the young in order to boost social security tax revenue. Rangel (2000) develops a theory of voluntary intergenerational exchange for selfish generations. He distinguishes between intergenerational goods which are provided by the middle-aged

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to the young and those which are provided by the middle-aged to the old. He shows that a pay-as-you-go system may be self-sustainable if it generates a positive surplus for each participating generation. However, providing education for the younger generation is not sustainable without linking it to sufficiently big transfers to the old. If the surplus generated by the pay-as-you-go system and other goods provided by the middle-aged to the old do not exceed the costs of providing the education and other intergenerational goods that benefit the young, then the middle-aged would prefer to repudiate such an intergenerational contract.

If a pay-as-you-go social security system were the only mechanism allowing for public provision of education to survive, then privatizing social security would eliminate public provision of education. In a world of credit constraints or non-insurable risks, this could have dire consequences for future growth and welfare. In a world with full certainty and no credit market constraints, we would expect an efficient level of private investment in human capital. However, there are market mechanisms which may encourage the middle-aged to finance education for the young even in the absence of social security taxes or any other public expenditures benefiting the old. If the middle-aged have a stake in the future and the value of that stake depends on future human capital, the middle-aged may voluntarily invest in the younger generation.

Boldrin (1994) presents a closed economy model in which the working generation accumulates physical capital, where physical capital and human capital are technologically complementary. He poses the question whether the middle-aged might be willing to support public education for the young even if they cannot tax the young and there is no altruism. He shows that when the young cannot borrow from the older generations to invest in education, the middle-aged may collectively find it rational to vote in favor of providing public education in order to increase the value of their physical capital. Education provided for the young is essentially a public good benefiting all the middle-aged. Public provision of education is used to avoid free riding. **Boldrin and Montes (2000)** generalize this insight by arguing that a pay-as-you-go social security system may encourage efficient human capital investment by increasing the stake that the current middle-aged generation has in future production.

Cremer et al. (1992) analyze intergenerational transfers within the family without altruism. In their model, each generation lives for three periods. In the first period, individuals receive education as children. In the second period, they divide their time as adults between work, leisure and attention to their retired parents. In the third period, they derive utility from consumption and attention provided by their children. Cremer et al. show that adults may invest in the education of their children in order to extract more surplus from attention for a bequest game. Public education may still be motivated to improve welfare of steady-state generations, as strategic attention for bequest game may result in parents buying too little education for their children. The inefficiencies arise from missing markets. If there would be credit markets to finance the education of children and a market for filial attention by children, then the market equilibrium would be optimal for the steady-state generations.

My paper argues that there exists a market mechanism which may render investment in human capital of the following generation profitable even without any market failure, and with internationally mobile financial capital. This mechanism consists of market trans-

actions of land.¹ Here land should be interpreted generally to incorporate all fixed factors used in production. The middle-aged may want to invest in the young in order to receive a higher price for their land when they sell it to the following generation. While Konrad (1995) recognizes this mechanism in the discussion, it is not included in his model. Furthermore, in Konrad's model, public provision of social capital is financed with taxes collected from the young later in the same period. In contrast, in this paper the middle-aged generation deciding on publicly provided education also finances it. Unlike contributions by Boldrin (1994) and Boldrin and Montes (2000), my results do not rely on assuming credit market constraints facing the young. Such constraints, as well as including a pay-as-you-go social security system, would only strengthen my result. Furthermore, Boldrin (1994) assumes that the middle-aged impose an income tax also on the income of the old in order to finance education, whereas in my model the middle-aged bear the full burden of financing public education.

The introduction of land into an OLG framework generates the following new and surprising results. First of all, the middle-aged may want to provide public education even if the young would not face any credit market constraints, and could finance their education themselves. The old may voluntarily overinvest in the young even when they cannot tax any of the productivity increase. Secondly, it is possible that all welfare gains from establishing public education accrue to the generation which pays for education *twice*, once for itself and then for the subsequent generation. A numerical analysis suggests that all of the following generations lose. Therefore, an intergenerational contract relying on a voluntary provision of a good for the next generation *may under certain conditions* be an undesirable equilibrium for the steady-state generations. This result is in distinct contrast with the intuitive expectation that the generation establishing public education without being able to tax any of the benefits through a social security system would be made worse off.

The eventual overprovision equilibrium relies on a combination of decentralized individual actions and a possibility to provide public education for the next generation. It is essential that the middle-aged may provide public education for the young also after they have themselves bought land from the previous generation. If there is an overprovision of public education, then this leads to higher land rents, which are capitalized in the value of the land. Even if public education were overprovided, it may be that the capital loss in the value of the land resulting from a permanent switch to a lower human capital formation and land rent is larger than the potential saving in tax payments by abolishing publicly provided education. Thus, it would be in the interest of the middle-aged to continue to provide public education once they have purchased the land. This is reflected in the market price for land. At the same time, the members of the young generation suffer from free-riding in eliminating public education. Even if they would be collectively better off by abolishing publicly provided education, all young individuals have a private incentive to receive public education as they view their own individual action as non-pivotal. Equivalently, the intergenerational trade in land taking place when

¹ Homburg (1991) demonstrates the importance of including land in the production function in a growth model. Intergenerational trade in land rules out dynamic inefficiency as well as Golden Rule growth.

the old want to sell their land is a Nash equilibrium as individuals are non-pivotal in the voting decision.²

Rangel's (2000) results suggest that voluntary intergenerational transfers may survive only if they produce a surplus for all participating generations. He also argues that the middle-aged would always repudiate even an efficient social contract under which they invest in the following generation without receiving any transfers back. According to Konrad (1995), there may be an overinvestment in social capital by the older generation. The older generation chooses social capital investment in order to maximize tax revenue from the young net of investment costs. Both Boldrin and Rustichini (2000) and Cooley and Soares (1999) construct a model in which a pay-as-you-go system can be adopted as a voting equilibrium among generations in a closed economy. The middle-aged and old generations consider the contributions they have made as sunk costs. My paper differs from these earlier contributions in that resources are voluntarily transferred from an older to a younger generation without any transfers back from the younger to the older generations.

The paper is organized as follows. Section 2 presents the laissez-faire solution. There are no efficiency or welfare motivations for public investment, implying that the laissez-faire outcome is Pareto efficient. Section 3 analyzes the conditions under which the middle-aged prefer to finance public education. Game theoretically, the economy is depicted as a repeated game with overlapping generations of players in the spirit of Kandori (1991), Salant (1992), Smith (1992), Boldrin and Montes (2000) and Rangel (2000). As in Rangel (2000), the provision of education is assumed to rely on a trigger strategy. Each middle-aged generation assumes that if it would repudiate from providing public education, then all the following middle-aged generations would also repudiate, and the economy would end up in a laissez-faire equilibrium. Section 4 concludes.

2. Laissez-faire outcome

2.1. The model

There are three generations: the young, the middle-aged and the old. The young invest in education, the middle-aged work, and the old derive income from land ownership. There is perfect certainty and all individuals of each generation are identical. All individuals make their decisions in a decentralized manner. The mass of each generation (cohort) is normalized to unity and consists of a continuum of individuals, so that each individual behaves atomistically taking the marginal productivity of human capital in the economy as given.

Production uses a combination of land and human capital supplied by the middle-aged. All individuals can borrow and lend internationally at a constant world interest rate. As

² It is crucial that individuals view their individual actions in the land market, in receiving public education and in voting as non-pivotal. This is the case with a large number of individuals. The result would not hold if there were only one individual in each generation. A single pivotal middle-aged agent could refuse buying land in order to commit to abolishing inefficient provision of public education.

there are no credit market constraints or uncertainty, individuals maximize their utility when they maximize the net present value of resources available for consumption. The budget constraint requires that for each generation, the net present value of consumption cannot exceed the net present value of income. Furthermore, the financial position of the country vis-a-vis the rest of the world must satisfy the transversality condition. When the net foreign assets of the economy in period t are denoted by B_t , the transversality condition requires that $\lim_{T \rightarrow \infty} (1/(1+r))^T B_{t+T+1} = 0$ (Obstfeld and Rogoff, 1996). At the end of Appendix A, I show that the transversality condition is satisfied.

The time structure inside a period is as follows:

- (1) Production takes place. The middle-aged supply their labor inelastically.
- (2) The middle-aged receive their marginal product as their wage income and the old receive the income accruing to land. The middle-aged pay back the loan that they have taken as young. The young take a loan.
- (3) The old sell land to the middle-aged. They pay back the loan taken (receive back the savings made) when they were the middle-aged. The middle-aged decide on their net saving for the old age.
- (4) The young complete their education and pay for it using the loan they have taken.

It is not essential to define at which point the young start their investment in education. Furthermore, production may also continue during later parts of the period. The results are also insensitive to a change in which the old would sell their land to the middle-aged before the land receives its factor income. The timing of individual actions, except for consumption and saving decisions, is depicted in Fig. 1. The timeline is divided into three periods corresponding to youth, middle age and old age.

The production in period t , Y_t , is determined by a Cobb–Douglas function, which combines the human capital in the economy in the respective period, H_t , and land. The amount of land is normalized to unity. Formally,

$$Y_t = H_t^\alpha,$$

in which α , where $0 < \alpha < 1$, is the elasticity of production with respect to human capital and also the share of production accruing to human capital.

The human capital of a representative individual, h_t , is equal to H_t , as the size of the cohort is normalized to unity. The human capital of an individual in period t depends on that individual’s investment in education in period $t - 1$. Investment in education, denoted

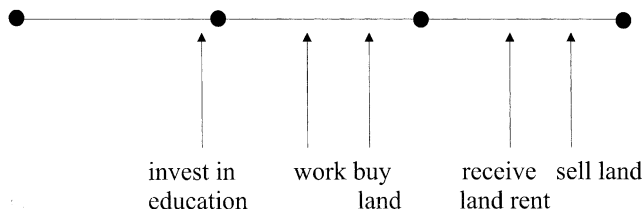


Fig. 1. Timing with private education.

by e , consists of inputs whose price is normalized to unity. The production function of human capital, dropping individual-specific subscript, is:

$$h_t = e_{t-1}^\beta,$$

in which $0 < \beta < 1$ captures the assumption that the marginal productivity of the inputs into education is diminishing.

The middle-aged have to wait for one period before they receive income from the ownership of land and the income from selling it to the following generation. The arbitrage requires that the return from the ownership of land equals the world interest rate, denoted by r . Therefore, the value of the land in period t , V_t , is determined by:

$$(1 + r)V_t = (1 - \alpha)H_{t+1}^\alpha + V_{t+1}. \quad (1)$$

What remains is to show that there are no multiple equilibria as the land price at $t = 0$ is endogenous.³ Tirole (1985) shows that if there is an asset bubble in the economy, then it must grow at the interest rate. As there is no economic growth in my model and the interest rate is positive, the bubble would grow infinitely and is ruled out by the wealth constraint. Therefore, the land price is driven by the market fundamental. This market fundamental is the discounted value of all future land rents, and therefore there is a unique land price with given expected land rents and an internationally determined interest rate.

2.2. Equilibrium under *laissez-faire*

Time indices are dropped in the steady-state equilibrium, so that $e_t = e_{t+1} = e$ and therefore $H_t = H_{t+1} = H$ and $V_t = V_{t+1} = V$. The young individually choose their own educational investment. Each young individual takes the expected net return on human capital, denoted by ρ , as given. Educational investment e is chosen in order to maximize:

$$\max_e \left[\frac{e^\beta \rho}{1 + r} - e \right],$$

with the first-order condition being:

$$\frac{\rho \beta e^{\beta-1}}{1 + r} = 1. \quad (2)$$

The left-hand side gives the net present value of the return on the marginal educational investment, whereas the right-hand side is the marginal cost. As there are no borrowing constraints, investment is made in order to maximize the net present value of wage income net of investment costs. Next, substitute

$$\rho = \alpha H^{\alpha-1} = \alpha h^{\alpha-1},$$

³ I am indebted to an anonymous referee for raising this point.

where $h = e^\beta$, into the first-order condition (2). This allows us to solve the individually optimal educational investment:

$$\hat{e} = \left(\frac{\alpha\beta}{1+r} \right)^{\frac{1}{1-\alpha\beta}}. \quad (3)$$

Note that the ownership of land has no effect on educational choices. By Fisher's Separation Theorem, investments in education and land market are made in order to maximize the net present value of lifetime income, and a perfect international loan market allows to separate these decisions from the intertemporal allocation of consumption. In the steady-state equilibrium, the price of land is

$$V(\hat{e}) = \frac{(1-\alpha)\hat{e}^{\alpha\beta}}{r}. \quad (4)$$

3. Public provision of education

3.1. The setting of the intergenerational game

Under public provision of education, individuals have a dual role as consumer/producers and voters. As consumer/producers, they decide in a decentralized manner on participating in public education, buying land as middle-aged and selling it as old, as well as on saving and loaning in each period. As voters, they decide on a coordinated action to finance public education through compulsory taxation. Steps 1, 2 and 3 inside a period are the same as in the laissez-faire solution. The fourth step, however, now reads as:

(4') The middle-aged vote on a lump-sum tax collected from themselves to purchase education for the young. The young voluntarily receive the education.

As all the middle-aged are identical, they agree on the lump-sum tax. The time structure is such that the middle-aged cannot commit to a given provision of human capital for the next generation before they purchase land from the old.⁴ As there is a continuum of young individuals, each of them views his or her action as non-pivotal. Accepting publicly provided education is always individually better action than refusing it.⁵ Other parts of the time structure could be changed without affecting the results as described in Section 2.1. The timing of individual actions except for saving and consumption is depicted in Fig. 2.

My result would not hold if voting would take place before the middle-aged would buy land. In that case, the middle-aged would first vote against the provision of public education,

⁴ It is enough to assume that the middle-aged cannot commit to not purchasing more education for the young than they have declared beforehand. As the price that the middle-aged pay for the land turns out to be increasing in expected future human capital, it would never be in the interest of the middle-aged to claim, before buying the land, that they would invest more in human capital than they would actually do.

⁵ If public provision of education is expected to be maintained in the next period, it is individually optimal to receive it as young instead of paying for education twice, first for oneself and then through taxes for the next generation. And even if a young individual would expect that public provision of education would be eliminated, it would still be optimal to receive it. Such an individual would never pay for education, receiving public education as young and avoiding paying taxes as middle-aged if public education were abolished. As there is a large number of individuals, everyone takes the marginal productivity of human capital as given.

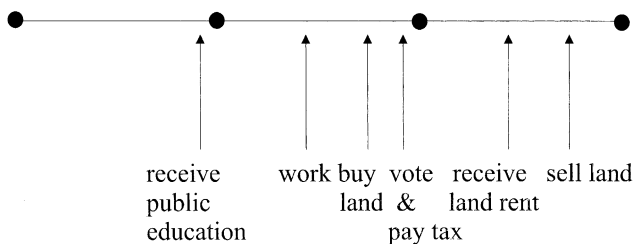


Fig. 2. Timing with public education.

and then buy land at a lower price than would be the case with public education. On the other hand, my results could be expected to hold also if the old would be allowed to vote. When voting would take place after the old have sold their land, the old are indifferent to the provision of public education, financed by taxes on the middle-aged. The young, on the other hand, could actually be expected to vote against public provision of education, if that would be an inefficient equilibrium and the young would already have voting rights.

Denote the first period in which public education can be provided by 0, and the lump-sum tax collected in period t by τ_t .⁶ The lump-sum tax τ_t is equal to the investment in education as there is no population growth. It is assumed that if public provision of education can be sustained in equilibrium, then there is an equilibrium tax rate $\hat{\tau}$.⁷ Starting from period $t = 0$, each middle-aged generation either deviates or adopts the following trigger strategy:

$$\tau_t = \left\{ \begin{array}{ll} \hat{\tau} & \text{if } t = 0 \\ \hat{\tau} & \text{if } \tau_0 = \tau_1 = \dots = \tau_{t-1} = \hat{\tau} \text{ and } t \geq 1 \\ 0 & \text{otherwise} \end{array} \right\}. \tag{5}$$

If $\tau_t \neq \hat{\tau}$ and $\tau_t > 0$, then the economy reverts in the following period to the laissez-faire equilibrium in which each generation purchases its own education in a non-coordinated manner. The lump-sum tax is restricted to be non-negative. If the middle-aged choose $\tau_t = 0$, then the economy immediately reverts to private investment in education by the young.

3.2. Equilibrium with public education

The political economy model is solved relying on a trigger strategy. Such models almost always lead to multiple subgame-perfect equilibria. One such equilibrium is that there is no public provision of education in any period. I will, however, concentrate on whether there may exist a steady-state subgame-perfect equilibrium with publicly provided education. Let us first assume that there exists a steady-state subgame-perfect equilibrium with publicly

⁶ I have assumed that the possibility of publicly provided education becomes known only in the first period when it can be established after the middle-aged have bought the land. In that sense, the introduction of taxation technology is an unpredicted shock to the model.

⁷ As there is no population growth or technological change, there is no reason to expect that the tax rate would change over time. In a growing economy, we would analyze an equilibrium path of tax rates over time. While this would make the analysis more cumbersome, it would not provide any additional insight.

provided education. The existence is confirmed below by explicitly specifying the steady-state and stating the conditions under which it exists.⁸ As the size of the cohort is normalized to unity, human capital in the steady-state equilibrium with lump-sum tax $\hat{\tau}$ is given by $\hat{\tau}^\beta$. This allows for the solving of the steady-state market price of land

$$V(\hat{\tau}) = \frac{(1 - \alpha)\hat{\tau}^{\alpha\beta}}{r}.$$

When the initial middle-aged generation decides on whether to switch to public education, it has already purchased land. Therefore, the price that it has paid for the land is irrelevant for the choice of educational policy. Public investment in education is chosen in order to maximize the discounted sum of rental income and sale revenue from the land in the next period, net of investment cost. As $\hat{\tau}$ can be sustained in equilibrium, the middle-aged generation of period 0 knows that future generations will choose the same level of taxation as they choose. Rental income in the following period is simply $(1 - \alpha)\tau^{\alpha\beta}$. Therefore, τ is chosen in order to maximize

$$\max_{\tau} \left(\frac{(1 - \alpha)\tau^{\alpha\beta}}{1 + r} + \frac{(1 - \alpha)\tau^{\alpha\beta}}{(1 + r)r} - \tau \right), \tag{6}$$

giving as the optimal choice:

$$\hat{\tau} = \left(\frac{(1 - \alpha)\alpha\beta}{r} \right)^{\frac{1}{1 - \alpha\beta}}. \tag{7}$$

The middle-aged of period 0 want to establish public provision of education instead of the laissez-faire solution only if this increases their lifetime net income. A sufficient and necessary condition for this is derived in Appendix A. Appendix A also proves that this is a sufficient and necessary condition for the public provision to be sustainable in equilibrium. The results can be summarized as

Proposition 1. *The presence of land may alone motivate public provision of education, even when private investments are efficient and there is no altruism. There exists a steady-state subgame-perfect equilibrium in which education is provided publicly if, and only if, the interest rate satisfies*

$$r < \frac{(1 - \alpha)(1 - \alpha\beta)^{\frac{1 - \alpha\beta}{\alpha\beta}}}{1 - (1 - \alpha)(1 - \alpha\beta)^{\frac{1 - \alpha\beta}{\alpha\beta}}}.$$

⁸ As the individuals can save and borrow from the international markets, decisions on providing public education depend only on the comparison between its expected returns and costs. Therefore, the only adjustment process for the land price consistent with perfect foresight is an immediate jump to the steady state. In a closed economy, as in models analyzed by Boldrin (1994) and Boldrin and Montes (2000), solving the transition dynamics explicitly would require specifying the utility function. The interest rate would then become endogenous, and the sum of consumption and investment would have to equal production in each period.

Proof. See Appendix A.

It also holds that

Proposition 2. *If there is a public provision of education, then it leads to a larger investment in education than in a decentralized solution.*

Proof. By (3) and (7), public provision results in a higher investment in education than private investment, if $r < (1 - \alpha)/\alpha$. However, this is already implied by the condition for a public provision of education,

$$r < \frac{(1 - \alpha)(1 - \alpha\beta)^{\frac{1-\alpha\beta}{\alpha\beta}}}{1 - (1 - \alpha)(1 - \alpha\beta)^{\frac{1-\alpha\beta}{\alpha\beta}}},$$

stated in Proposition 1. \square

The intuition for Proposition 2 is as follows. The value of the land is increasing in human capital, and as the laissez-faire solution is always available, a necessary condition for the middle-aged to provide public education is that it increases human capital sufficiently to increase the present value of lifetime income of the middle-aged net of taxes.

The value of the land plays an equivalent role to that of the trigger strategy in Rangel (2000). In Rangel's model, the trigger strategy relies on transfers from the younger to the older generations. In my model, there is no need for transfers from the young to the old. Instead, the trigger strategy relies on decentralized and voluntary market transactions. If a middle-aged generation deviates from the public provision of education to the following generation, then it would suffer a capital loss in the value of the land.⁹

Numerical examples suggest that the internationally determined interest rate has to be very low to justify public provision of education from the viewpoint of the middle-aged.¹⁰ This is not surprising as my results are derived using the extreme assumption that a public provision of education does not offer any efficiency gains, and that the middle-aged generation finances education entirely without being able to tax any of its benefits. Furthermore, assuming the Cobb–Douglas production function excluded the possibility that the share of production going to the land owners could be increased by increasing the stock of human capital, and there was no growth. Including a social security tax would increase the range of interest rates in which the middle-aged generation would find it optimal

⁹ The strategy used in equilibrium is weakly dominated, as the middle-aged strictly prefer not to buy land if they anticipate any other tax rate than $\hat{\tau}$. If the middle-aged would, however, not buy land otherwise, then the market price of land could be decreased by an infinitesimal amount, and then all the middle-aged would strictly prefer to buy land. Domestic land ownership could be guaranteed by foreigners facing a small transaction cost if they would buy domestic land, whereas there would be no transaction cost in loan market.

¹⁰ For example, for $\alpha = \beta = 1/2$ the condition is $r < 27/101$. If this would be accrued over 20 years, yearly interest rate should be less than 1.2%. With only a 10 year delay between investment cost and the trade in land, a yearly interest rate would still have to be less than 2.4%.

to finance public education. Furthermore, even without social security taxes, the middle-aged generation may resort to the less expensive strategy of only partially subsidizing investment in education. However, these modifications are not needed to prove that it *may* be in the interest of the older generations to engage in unilateral transfers to the younger generations even when the younger generations face no credit market constraints.

The welfare effects of providing public education on future generations are not clear *ex ante*. As a consumption good can be saved and borrowed internationally with a given interest rate, welfare of any cohort is increasing in the net present value of its lifetime consumption. On the one hand, future generations are able to postpone the financing of education from youth to middle-age, thereby saving the interest payment on investment. On the other hand, the resulting level of educational investments is not efficient. Numerical simulations suggest that the establishment of public education lowers the utility of the current young and all future generations.¹¹ Therefore, there would be no potential of intergenerational Pareto improvement through the establishment of public education. This result is consistent with the First Fundamental Theorem of Welfare Economics. As there are no externalities or missing markets, the *laissez-faire* outcome is Pareto optimal. What is remarkable is that none of the steady-state generations has an incentive to abolish the system of public education once established as proved in Appendix A.

4. Conclusion

In this paper, I have demonstrated that the intergenerational trade in land may have surprising effects on the provision of intergenerational goods. In a model without land, Rangel (2000) proved that voluntary intergenerational transfers can survive only if they generate a positive surplus in transfers for the old. I show that if there is intergenerational trade in land, the middle-aged may voluntarily provide education for the young even when they do not receive any transfers. The provision of public education may be established solely in order to increase the market value of land. Furthermore, the provision of public education may lead to excessive investment in human capital even when it does not change the actual share of production going toward human capital. Even though I have presented my analysis focusing only on education, the mechanism is much more general. The presence of intergenerational trade in land may motivate excessive public investment in any factor enhancing the productivity of land, and therefore increasing its market price. For example, there may be excessive investment in infrastructure.

¹¹ Numerical simulation was carried out for all values of $\alpha \in [0.1, 0.9]$, $\beta \in [0.1, 0.9]$, $r \geq 0.05$ at the interval of 0.01. I first calculated the parameter combinations with which the middle-aged of period 0 would prefer to establish public provision of education. Then I compared the net present value of lifetime income for a steady-state generation under the *laissez-faire* solution and under the public provision of education. Under very low interest rates, lump-sum taxes may exceed wages for the steady-state generations. Even though it were interpreted that the model is not applicable with those values, there is still a range of interest rates in which it is profitable for the middle-aged to provide education for the young even though they cannot tax the young, and the steady-state generations have a lower positive net lifetime income under public provision of education than under a *laissez-faire* equilibrium.

Globalization may undermine public support for education in two different ways. First of all, labor mobility restricts redistribution between different groups, as demonstrated by Wildasin (1991) and many other authors. Labor mobility may eliminate the incentives for a middle-aged generation to provide education in order to increase the value of the land, as an increase in human capital would be diluted internationally. Secondly, international dispersion of the land ownership decreases national incentives to provide education for the following generation even when labor is immobile. The smaller the share of land owned domestically, the less the middle-aged are prepared to pay in taxes in order to increase its market value.

While public provision of education turned out to be excessive in my simple model, it may play a beneficial role for younger generations in a more complex model. If there are externalities associated with education or if there are imperfect credit markets for the young or missing insurance markets for income risks associated with education, then public intervention may provide a Pareto improvement. Under those circumstances, the deterioration of public education may counterweigh potential benefits of globalized labor markets. Furthermore, my model suggests that the ownership of land may play an important role in the political decision-making on intergenerational goods even when land is untaxed. The more widely the land ownership is distributed inside an economy, the wider the support for investment in the following generation. In a globalized economy, investing social security wealth in the domestic market may be justified in order to provide incentives for the older generation to invest in the younger generation. Therefore, even a funded social security system might be able to provide incentives for public investment in the human capital of the following generation, provided that such social security funds are invested in the domestic market, and labor mobility is sufficiently low.

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Appendix A

Proof of Proposition 1

I calculate first the payoff for a middle-aged generation from playing the equilibrium strategy. Then I calculate the payoff from deviation and show the condition under which

no deviation from the equilibrium strategy is profitable. When the consumption good can be saved and borrowed internationally with a given world interest rate, it is enough to maximize the net present value of resources available for consumption.¹² When the decision on public education is made, the price paid for land before that as well as the price paid for the own education for the initial middle-aged generation having a choice on whether to establish public education as well as wage income received are all sunk, and therefore they do not enter the decision problem when voting. When deciding whether to establish (as the initial middle-aged generation) or maintain (as any following middle-aged generation) publicly provided education, the middle-aged compare only the net present value of the difference in land rent and land price to the tax payment. The payoff from the assumed equilibrium strategy defined by (5) and (7) for the middle-aged generation is the same for all middle-aged generations as long as there has been no deviation, including the first generation which may provide education publicly.¹³ Substituting (7) into (6) yields

$$\left(\frac{(1-\alpha)\alpha\beta}{r}\right)^{\frac{\alpha\beta}{1-\alpha\beta}} \frac{(1-\alpha)(1-\alpha\beta)}{r}. \quad (\text{A.1})$$

I first analyze a deviation to $\tau = 0$. This leads to the laissez-faire equilibrium. In the laissez-faire equilibrium, the middle-aged receive by (3) and (4)¹⁴

$$\frac{(1-\alpha)\hat{e}^{\alpha\beta}}{1+r} + \frac{V(\hat{e})}{1+r} = \frac{(1-\alpha)}{r} \left(\frac{\alpha\beta}{1+r}\right)^{\frac{\alpha\beta}{1-\alpha\beta}}. \quad (\text{A.2})$$

Next, I analyze a deviation to any positive lump-sum tax which differs from the equilibrium strategy. Formally, I solve for an optimal τ_d when $\tau_d > 0$, $\tau_d \neq \hat{\tau}$. By the trigger

¹² In a closed economy, the utility function would have to be specified without access to international capital market. In that case, total consumption and investment in education would equal the total production in each period. With an international capital market, this need no longer be the case.

¹³ While the first generation turns out to be better off when public education is adopted, this difference follows from it having paid a lower price for land when publicly provided education was not yet available. All the following generations have to pay a higher price for land, if public education is established and maintained. As these trades take place in each period before the decision of lump-sum taxes is made, they do not enter the decision on taxes. Therefore, the first generation and all the following generations play the equilibrium strategy under the same conditions.

¹⁴ This is the net present value of those income streams which are affected by the analyzed choice. Borrowing e for the young generation in the current period and receiving $(1+r)e$ back in the next period are not written explicitly, as they cancel each other out in the present value.

strategy, a deviation would imply that from the following period onwards, the economy would stay in a laissez-faire equilibrium. A deviation $\tau_d > 0$ is chosen in order to maximize:

$$\max_{\tau_d} \left[\frac{(1-\alpha)\tau_d^{\alpha\beta}}{1+r} - \tau_d + \frac{V(\hat{e})}{1+r} \right]. \quad (\text{A.3})$$

As the solution to (A.3) leads to a smaller net present value of income received as middle-aged and old than (A.2), the most profitable deviation is $\tau = 0$. Thus, public provision is preferred if the net present value of income given by (A.1) exceeds the laissez-faire outcome given by (A.2). This condition yields:

$$r < \frac{(1-\alpha)(1-\alpha\beta)^{\frac{1-\alpha\beta}{\alpha\beta}}}{1 - (1-\alpha)(1-\alpha\beta)^{\frac{1-\alpha\beta}{\alpha\beta}}}. \quad (\text{A.4})$$

Therefore, public education is established and sustained in equilibrium if, and only if, condition (A.4) is met. The economy satisfies the transversality condition $\lim_{T \rightarrow \infty} (1/(1+r))^T B_{t+T+1} = 0$ both with and without public education, as B_{t+T+1} is a constant $\forall T \in \{0, 1, \dots\}$ in the steady-state (Obstfeld and Rogoff, 1996).

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