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Mobility and the Role of Education as a Commitment Device

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Abstract

In closed economies, human capital investment faces a hold-up problem of excessive redistributive taxation. Increased international labor mobility, however, changes the constraints which affect optimal education and tax policy. We show that in a non-altruistic, gerontocratic world, investments in human capital which increase the mobility of the young generation can be interpreted as a commitment device overcoming the hold-up problem. This is in line with Kehoe (1989) who derives a similar result with respect to capital mobility.

Keywords: education, intergenerational transfers, commitment

JEL Code: H52, H55

1. Introduction

In a closed economy, investment in human capital faces a hold-up problem with respect to taxation. Once the investment is made, human capital is a fixed factor. Consequently, the optimal tax on human capital is high. Boadway, Marceau and Marchand (1996) analyze the time consistency problem for a benevolent government and discuss its consequences for the incentives to invest in human capital. Increased international labor mobility, however, changes the constraints which affect optimal education and tax policy.

As Sinn (1997) shows, the only stable equilibrium with fiscal competition in an economy with wage taxation and labor mobility is one without taxation and consequently without redistribution. However, there are some arguments in favor of a less pessimistic view. Mobility costs allow a tax up to these costs without inducing emigration. As these costs are not necessarily exogenous, the government might have an interest in increasing these mobility costs by offering an educational program with a clear focus on domestically valuable skills. This would increase the scope for redistributive taxation if, and only if, the mobile generation was not able to react.

In our model, however, there are possibilities for the mobile (young) generation to react to the strategies of the immobile (old) generation by choosing the amount of human capital investment. Consequently, a necessary condition for the survival of a moderate redistributive system in favor of the old generation is that there is a credible commitment that prevents excessive redistribution. We analyze the strategies of the young and the old generation and

show that in a non-altruistic, gerontocratic world, providing education which increases the mobility of the young generation can be interpreted as a commitment device.[1] Transfers to the young and to the old are thus linked in a strategic way.[2] Each generation has an incentive to invest in the human capital of the subsequent generation in order to increase its mobility as this solves the problem of time-inconsistency concerning redistributive taxation. This result is similar to Kehoe (1989) who shows that capital mobility—by acting as a commitment device—can solve the hold-up problem of time-consistent taxation for a benevolent government. Factor mobility—in the form of mobile capital or mobile labor—reduces the incentive of the government to tax the returns of this factor ex-post in an excessive way.[3]

The idea is modeled in the following way. Suppose that the population can be divided into two generations: one young generation and one old generation. The young generation is first educated and then starts to work. The old generation has the power to levy a tax on the young generation. The tax rate is set to equalize the domestic net wage and the foreign net wage, which is the outside option for the young generation. To avoid the possibility that the young individuals do not invest in human capital—given the high tax burden they anticipate once they have acquired country-specific human capital—the old generation would like to commit itself credibly to a low level of taxation in the future. One commitment device is to reduce mobility costs by providing the young individuals with language skills and information about foreign customs, laws, and regulations. The wage abroad thus increases making the outside option more attractive. A necessary condition for the feasibility of this strategy, however, is the power to control the skill composition.

Our model relies on the productivity effect of human capital investment as a link between the young and the old generation allowing for migration of the young. It is thus related to Konrad (1995a, 1995b) who addresses the provision of education and infrastructure. Konrad (1995a) focuses on how the investment incentives are affected by increased mobility with fiscal federalism; Konrad (1995b) discusses how these incentives change with population growth. The model is also related to the literature on investment in general versus specific human capital. Contrary to the conclusion by Becker (1964) that firms do not invest in the general skills of their employees in competitive markets where they cannot collect the returns from these investments, some firms do in fact provide their workers with general human capital. Kessler and Lülfesmann (2000) show that there is an incentive complementarity between employer-sponsored general and specific training.[4] This means that in their model the possibility to provide specific training induces the employer to invest in general training. General investment thereby reduces the hold-up problem concerning the provision of firm-specific investment. Our model is, however, different in one respect: "general" human capital, i.e. human capital that increases mobility, does not raise productivity equally in all countries but is only productive abroad. The decision for more "general" human capital is therefore always a decision against less (country-) "specific" human capital—something which is not present in the training decision.

The paper is organized as follows. The next section presents the model for two and for n countries and compares the results with the first best. In section three, monetary costs of education are added to the analysis. The fourth section extends the basic setting and

discusses two variants of the basic model and their consequences for the welfare and the income of the young and the old generation. In the first variant, the old generation has the possibility to restrict the amount of education which the young generation can choose to some discrete levels and in the second variant, the old generation can subsidize the human capital investment by the young generation. The last section draws some conclusions for the future of the welfare state in Europe.

2. Education as a Commitment Device

How is public education affected by increased mobility? To answer this question, we analyze in a first step the interaction between two countries each of which takes the behavior of the other country as given. In a second step, we apply this framework to a federation of n countries assuming that no country is big enough to exert some market power. In both cases, we assume that there are no informational problems.

2.1. The Model

In each country, there is an old generation and a mobile young generation.[5] Members of each generation are homogeneous. Both countries compete for the young individuals by setting a proportional wage tax rate. These tax rates can be different for the domestic individuals a country wants to keep and the foreign individuals a country wants to attract. Separating the competition for the mobile individuals from country i and country j reflects the fact that domestic individuals and immigrants are very often treated differently with respect to fiscal matters. In reality, one does not find different wage tax rates for domestic and foreign workers, but when everything—including transfers and taxes and taking into account partially incompatible or incompletely harmonized social security systems—is taken into account the total net tax charge is very likely to be different for locals and foreigners.

The old generation raises these taxes that have to be paid by the young generation. It is thus assumed that the old generation has the power to tax the young generation, i.e. there is a gerontocracy.[6] Additionally, it is assumed that production Y_i in country i is determined by a function F_i

$$Y_i = F_i(L_i) \tag{1}$$

which depends on domestically productive labor provided by domestic and immigrated individuals expressed in efficiency units L_i. Let I_i denote the domestically valuable human capital of the N_i domestic workers and I_i^j the human capital of the N_i^j immigrated workers from country j which is productive in country i. We then have for the total amount of efficiency units available for production in country i

$$L_i = I_i N_i + I_i^j N_i^j. \tag{2}$$

The function $F_i(L_i)$ is assumed to display constant marginal productivity with respect to labor ($\partial F_i / \partial L_i = m_i > 0$).

The model has the following decision structure from the point of view of country i (cf. Figure 1). In the first stage, the old generation decides about the composition of the

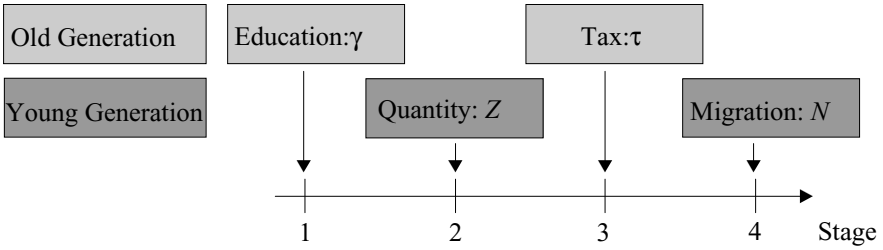

Figure 1. Decision structure of the model.

educational program. This means that the old generation determines which skills are taught in school. This can be justified by considering secondary education where the curriculum is normally fixed by the government or some school board. It is assumed that education can be divided into one part that increases the domestic productivity (e.g. law of the domestic country) and one part that increases the productivity in the foreign country (e.g. foreign languages). In reality, this separation can hardly be made, since foreign languages, for example, increase both the domestic productivity and the foreign productivity—though to relatively different extents. To know some French is certainly useful in Italy; for working in France, however, a very good knowledge of this language is indispensable. The strict separation of human capital into skills that are exclusively productive either at home or abroad is motivated by putting the emphasis on these relative increases. For simplicity, the part of education that increases productivity equally in the home and in the foreign country (e.g. mathematical skills) is neglected in the analysis. Let us define γ_i as the fraction of education that increases only the domestic productivity in country i.

In the second stage, each member of the young generation chooses the amount of education Z_i. In many countries, the young individuals have some choice concerning the years they want to spend in school and the diploma they want to acquire. The amount of education Z_i multiplied by the part of the skills that increases domestic productivity γ_i can be interpreted as an investment in domestically valuable human capital I_i

$$I_i = \gamma_i Z_i. \tag{3}$$

In the third stage, the old generation of country i and the old generation of country j set the proportional wage tax t_i and t_i^j which applies to the young individuals of country i. Given these tax rates, the members of the young generation decide in the last stage whether to emigrate or to stay in the home country.

In the one-shot game here, the old generation chooses thus the structure of education before the tax rate. This corresponds to the observation that the educational structure normally changes less frequently than the tax policy, although in reality, the educational structure γ and the tax rate t are revised on a regular basis so that reputation building plays an important role. The solution of the model is then obtained as a sub-game perfect equilibrium by solving the decision structure backwards.[7]

2.1.1. Stage 4: Migration Decision Each member of the young generation compares the wage in the home country i to the wage in the foreign country $j, i \neq j$. The domestic net

wage in country i for a young individual from country i is given by the marginal product of labor after taxes

$$w_i = m_i \gamma_i Z_i (1 - t_i) \tag{4}$$

with m_i as the domestic wage per efficiency unit of domestically valuable human capital, $I_i = \gamma_i Z_i$, and t_i as the wage tax of country i. The foreign net wage in country j for a young individual from country i is given by

$$w_i^j = m_j (1 - \gamma_i) Z_i \left(1 - t_i^j\right) \tag{5}$$

where $(1 - \gamma_i)Z_i$ is the human capital of an individual of country i valuable in country j, and t_i^j denotes the wage tax of country j which applies to an immigrant from country i. In equilibrium, the net return to human capital has to be equal. In order to keep the young or to attract the young from the other country respectively, the old generations in both countries engage in tax competition.

Concerning the young generation of country i, the old generation has an advantage by disposing of two instruments—the tax rate t_i and the structure of the human capital γ_i. The foreign old generation, in contrast, can only try to attract the young individuals of country i by setting a low tax rate t_i^j. Given a sufficiently high γ_i, the domestic old generation can always force the foreign tax rate to zero and keep the young generation in the home country.[8] In equilibrium, we have $t_i^j = 0$ for the foreign wage tax rate and $t_i > 0$ for the domestic one with all young individuals from country i staying in their home country. This leads to

$$m_i \gamma_i Z_i (1 - t_i) = m_j (1 - \gamma_i) Z_i \tag{6}$$

2.1.2. Stage 3: Tax Decision The old generation maximizes its income by raising a proportional wage tax t_i in such a way that the young individuals of country i stay in the home country.

From equation (6) we get for the optimal wage tax rate t_i^*

$$t_i^* = 1 - \frac{m_j (1 - \gamma_i)}{m_i \gamma_i} \tag{7}$$

2.1.3. Stage 2: Education Quantity Decision At the second stage, each member of the young generation in country i decides on the amount of education by maximizing the wage net of tax w_i in country i taking into account the disutility from education. For tractability, the disutility is assumed to be a quadratic function of the amount of education Z_i.[9] The maximization problem thus is given by

$$\max_{Z_i} \; m_i \gamma_i Z_i (1 - t_i) - Z_i^2. \tag{8}$$

This yields with t_i^* for the optimal amount of education Z_i^*

$$Z_i^* = \frac{1}{2} m_j (1 - \gamma_i). \tag{9}$$

Equation (9) shows that there is a negative relationship between the educational level Z_i and the skill composition parameter γ_i. A higher value for γ_i, i.e. a more domestically oriented

educational structure, decreases the outside option of the young generation. This allows the old generation to extract a larger part of the productivity gain without having to fear emigration. The prospect of higher future taxes, however, decreases the incentives for the young generation to invest in education Z_i. The old generation cannot influence the chosen amount of education Z_i directly; all it can do is to choose a certain structure γ_i.

2.1.4. Stage 1: Education Structure Decision In the first stage, the old generation maximizes its income from the tax revenue by choosing the educational structure γ_i[10]

$$\max_{\gamma_i} m_i \gamma_i Z_i^* t_i^*. \tag{10}$$

The first order condition is given by

$$m_i m_j \left(\frac{1}{2} - \gamma_i\right) = -m_j^2(1 - \gamma_i). \tag{11}$$

The left-hand side shows two opposing effects on the income of the old generation from a marginal increase in γ_i, which can be seen by rewriting this expression as

$$m_i\, Z_i^* + m_i\, \gamma_i\, \frac{\partial Z_i^*}{\partial \gamma_i} = m_i m_j \left(\frac{1}{2} - \gamma_i\right). \tag{12}$$

First, for a given amount of education Z_i^* the output increases with the educational structure γ_i. This effect is equal to $m_i Z_i^*$. Second, the young generation decreases the chosen quantity of education Z_i. This effect is equal to $m_i \gamma_i\, \partial Z_i^*/\partial \gamma_i$. The sum of both effects is the left-hand side of equation (11). The right-hand side of equation (11) shows how a marginal increase of γ_i, i.e. a more domestically oriented educational structure, influences the income of the young generation in the form of the foreign wage rate, which is the outside option of the young generation. Differentiation of the foreign income of the young generation w_i^j with respect to γ_i yields $-m_j^2(1 - \gamma_i)$. Increasing γ_i implies that the migration option becomes less attractive which increases the taxation possibility for the old generation. The optimum is reached when an increase in γ_i equalizes the effects on the income of the old and of the young generation.

For the optimal educational structure we get

$$\gamma_i^* = \frac{1}{2}\frac{m_i + 2m_j}{m_i + m_j}. \tag{13}$$

2.1.5. Results For m_i, m_j positive and finite, we thus have $\frac{1}{2} < \gamma_i^* < 1$ which leads to

Proposition 1. *The old generation has an incentive to set up an educational system that increases foreign skills ($\gamma_i^* < 1$) in order to restrict future taxation. Education is used as a commitment device by the old generation.*

The lower γ_i, the more attractive it is for the young individuals to migrate. Consequently, the old generation cannot set a high tax rate without inducing emigration. This solves the hold-up problem of time-consistent taxation.

Reinserting γ_i^* into Z_i^* and t_i^*, we get as equilibrial values for the amount of education and the tax rate

$$Z_i^* = \frac{1}{4}\frac{m_i m_j}{m_i + m_j} \tag{14}$$

and

$$t_i^* = \frac{m_i + m_j}{m_i + 2m_j}. \tag{15}$$

It is worth noting that the tax rate t_i^* is smaller than 1 as long as m_i, m_j are positive and finite, i.e. it is never optimal for the old generation of country i to levy a wage tax of 100%. If the tax rate was set above t_i^*, emigration would lead to zero income for the old generation. Hence, it is optimal for the old generation to choose a t_i, γ_i combination that does not induce emigration: all members of the young generation stay in the home country generating a positive tax income for the old generation. For country j, we get analogous results. The qualitative results also persist for the special case where the countries are identical. In this case, we get $\gamma_i^* = \frac{3}{4}$ and $t_i^* = \frac{2}{3}$.

2.1.6. n Countries Extending the two-country setting to n countries is straightforward as the basic arguments do not change. So far, we had two countries i and j competing on two separate markets for the mobile young of each country. Now, we have n separate markets with competition over the mobile young of these n countries. This does not imply, however, that on each of these markets all n countries are involved. Who competes with the respective home country can be influenced by the home country by the choice of the educational structure. Concerning the skills that are only productive abroad $(1 - \gamma_i)$, we have to distinguish two cases.

First, we can think of these skills as being equally productive in all foreign countries $j \neq i$. Thus, we have again γ_i denoting the domestically productive part of human capital and $1 - \gamma_i$ denoting the part which is productive abroad, i.e. in the $n - 1$ foreign countries. Then, country i has to set the tax rate sufficiently low to win the competition against the foreign country or countries which present the best outside option for the young generation—having the highest marginal productivity. This will always be possible given the fact that the domestic country i has two instruments, γ_i and t_i, with which to compete whereas the foreign countries can only vary the tax rate t_i^j.

Second, it is also possible that the old generation can determine the skills for every foreign country separately so that $1 - \gamma_i = \sum_{j \neq i} \gamma_j^i$. However, as the only purpose of an outside option for the young generation ($\gamma_i < 1$) is to serve as a commitment device for the old generation, it is not efficient for the old generation to spread the foreign skills over several countries. It is enough that $\gamma_j^i > 0$ for one country $j \neq i$ which brings us back to the two-country model.

In fact, a home country always faces only one competitor—or several, but identical competitors with respect to the marginal productivity of labor—on its home market even in a setting with n countries. The results for the asymmetric and symmetric case which we have derived for two countries therefore carry over to the n country case.

2.2. Social Planner

The social planner, who wants to obtain the social optimum for the domestic individuals, chooses the γ, Z combination that maximizes the domestic tax and labor income for the old and the young generation minus the disutility from education. As she does not need to commit herself to a certain policy, the social planner, who only takes the domestic country into account, invests exclusively in domestically valuable skills ($\gamma = 1$). Therefore, equation (3) simplifies to $I_i = Z_i$. Assuming a linear utility function with respect to consumption—so far this assumption was not necessary, the maximization problem can be written as

$$\max_I \; N_i m_i I_i - N_i I_i^2. \tag{16}$$

Rewriting the first order condition determines the socially optimal investment in human capital I_i^{**}

$$I_i^{**} = \frac{1}{2} m_i. \tag{17}$$

Without the feasibility of an intergenerational contract, however, there is a negative relationship between γ and Z (see equation (9)). The higher the value for γ, i.e. the closer γ gets to the socially optimal level, the less attractive the investment in human capital becomes for the young generation. Hence, the old generation has to choose a skill composition which can at least partly increase productivity in the foreign country (i.e. $\gamma < 1$) in order to induce the young generation to invest in human capital.

From a social planner's point of view, the members of the young generation learn too many skills which only increase foreign productivity. The socially optimal value for the human capital investment I_i^{**} cannot be reached. This can easily be seen by comparing the amount of domestically valuable human capital $Z_i^* \gamma_i^*$ with the socially optimal level I_i^{**}.[11] In the first best, all education is used to increase domestic productivity ($\gamma = 1$), whereas in the second best, γ is below 1. Due to the distorted skill composition and the distorted education decision of the young generation, there is too little investment in human capital. These results can be summarized in the following proposition.

Proposition 2. *Without the feasibility of intergenerational contracts, human capital investment is below the social optimum. There are two sources of inefficiencies.* (1) *The structure γ of education is distorted towards too many skills that increase only the foreign productivity.* (2) *The level of education Z is below the social optimum.*

3. Costs of Education

To single out the effects of the intergenerational setting, we have so far neglected any monetary costs of education. This section analyzes the case where monetary costs C per unit of education Z are completely borne by the old generation.[12] Only stage 1 of the

analysis above is affected. The optimal skill composition γ_i^{C*} is given by[13]

$$\gamma_i^{C*} = 1 - \frac{1}{2}\frac{(m_i - C)}{(m_i + m_j)}. \tag{18}$$

Taking the costs into account does not change the qualitative results of the analysis. Quantitatively, however, the costs lead to a higher optimal value for γ_i^{C*}

$$\gamma_i^{C*} > \gamma_i^*. \tag{19}$$

This is intuitively clear when thinking about the following mechanism: a higher γ induces the young generation to choose less education Z because the outside option is less attractive. This reduces the costs of providing for Z for the old generation. The disadvantage of a higher γ in the form of a lower Z is therefore partially compensated by the advantage of lower costs. It can be shown that the total investment in human capital $\gamma_i^{C*} Z_i^{C*}$ is again below the socially optimal level I_i^{C**} from the point of view of a social planner who is only interested in the domestic country

$$I_i^{C**} = \frac{1}{2}(m_i - C). \tag{20}$$

Proposition 3. *Each generation has an incentive to invest in the human capital of the subsequent generation, even if the monetary costs are fully borne by the old generation. The human capital investment, however, is again below the social optimum.*

4. Extensions

We have seen that with and without monetary costs of education, the old generation allows for a positive degree of mobility of the young generation which serves as a commitment device overcoming the hold-up problem. Redistributive taxation is thus feasible. The domestically valuable human capital investment is positive but lower than socially optimal. It is therefore worthwhile to analyze two variants of the model and to compare these results to the results of the basic model with respect to the allocative and distributive implications.

So far, we have allowed for continuous choices of the educational quantity $Z_i \geq 0$ by the young generation and have abstracted from introducing other possible instruments of the old generation to influence this choice. In the first variant, we now analyze the possibility of restricting the values Z_i can take. In the second variant, we examine whether it might be advantageous to consider a subsidy to compensate the young generation for (part of) the disutility. Whether these two variants bring us closer to the social optimum than the basic model will then be analyzed.

4.1. Discrete Choice of Z

From the point of view of the old generation, education that is only productive in the home country is preferred. But setting $\gamma_i = 1$ induces the young generation to choose no education

at all (cf. equation (9)) resulting in no income for the old generation. Very often, however, the possible choices of the amount of education are directly or indirectly restricted, e.g. via regulations which introduce some minimum amount of education required for obtaining a degree. Suppose that this minimum amount of education $\bar{Z}_i > 0$ is chosen such that the income of the young generation is zero making the young generation indifferent between $Z_i = 0$ and $\bar{Z}_i > 0$ but leading to a positive output.[14] This output is then completely redistributed to the old generation.

The income of the young generation

$$m_i \gamma_i Z_i (1 - t_i^*) - Z_i^2 = m_j (1 - \gamma_i) Z_i - Z_i^2 \tag{21}$$

is zero for $Z_i = 0$ and $\bar{Z}_i = m_j(1 - \gamma_i)$. Thus the old generation might wish to require $\bar{Z}_i$ for a degree thus indirectly restricting the choice of the young generation to 0 and $\bar{Z}_i$. If we assume that in this case the young individuals choose $\bar{Z}_i$, we can derive the optimal choice of the educational structure from an optimization problem analogous to equation (10)

$$\max_{\gamma_i} m_i \gamma_i \bar{Z}_i t_i^* = m_i \gamma_i (m_j (1 - \gamma_i)) \left(\frac{(1 - \gamma_i) m_j}{\gamma_i m_i} \right) \tag{22}$$

yielding for the optimal structure

$$\gamma_i^{D*} = \frac{1}{2} \frac{m_i + 2m_j}{m_i + m_j}. \tag{23}$$

With $\gamma_i^{D*} = \gamma_i^*$ and $\bar{Z}_i = 2Z_i^*$ and no change in the wage tax rate it can easily be seen that the tax base will be larger leading to a higher income for the old generation when the choice of the amount of education is (indirectly) restricted. The old generation increases its income at the expense of the young generation whose income reduces to zero.

4.2. Direct Subsidies

If the members of the old generation are able to influence the costs of the young generation to acquire education, i.e. the disutility, via some kind of subsidy, they can also use this instrument to increase their income.

The income of the young generation is then

$$m_i \gamma_i Z_i (1 - t_i^*) - Z_i^2 \phi(S_i) \tag{24}$$

where $\phi(S_i)$ is a function that is decreasing in subsidies S_i at an increasing rate and $\phi(0) = 1$ and $\lim_{S \to \infty} \phi(S_i) = a \geq 0$.[15]

The young generation chooses $Z_i^{S*} = \frac{m_j(1-\gamma_i)}{2\phi(S_i)}$ which exceeds Z_i^* for $S_i > 0$ in order to maximize the income when educational subsidies are available. The structure of education which maximizes the income of the old generation

$$\max_{\gamma} N_i m_i \gamma_i Z_i^{S*} t_i^* - N_i S_i \tag{25}$$

is $\gamma_i^{S*} = \frac{m_i + 2m_j}{2m_i + 2m_j}$ which equals γ_i^*. Given γ_i^{S*} and Z_i^{S*}, the value for S_i that maximizes the income of the old generation has to fulfill $A(-\phi(S_i^*)) = \phi(S_i^*)^2$ where $A = m_i \gamma_i Z_i t_i$.

As the old generation can always choose $S_i = 0$, the income of the old generation with an educational subsidy is at least equal to the income without subsidy $m_i \gamma_i Z_i t_i (\frac{1}{\phi(S_i^*)} - 1) - S_i^* \geq 0$. The income of the young generation is at least as high as the disutility is not larger, the amount of education not smaller, but the tax rate and the educational structure remain unchanged.

4.3. Welfare Comparison

So far, we have analyzed to what extent these two additional instruments affect the income of the young and the old generation. Now, we turn to the welfare analysis.[16] Allowing for a restriction of the quantity of education to two discrete values does not change the socially optimal amount of human capital investment from the point of view of one country—taking only those individuals into account who have not emigrated. As we have seen (cf. Section 2.2.), the social optimum is $I^{**} = \frac{1}{2} m_i$ which exceeds the domestically productive human capital investment of the basic model $I^* = \frac{1}{2}\gamma_i(1 - \gamma_i)m_j$.

Restricting the quantity of education to two discrete values leads to investment in human capital of the amount

$$I^D = \gamma_i^{D*} Z_i^{D*} = 2\,\gamma_i^* Z_i^* > I^* = \gamma_i^* Z_i^* \quad \text{but } I^D < I^{**}. \tag{26}$$

Thus, the social optimum will not be reached although the human capital with a restricted choice of education exceeds the human capital with an unrestricted choice.

Next, we have to look at the domestically productive human capital when subsidizing is possible. In this case, the social optimum can be derived from

$$\max_I \; N_i m_i I_i - N_i S_i - N_i \phi(S_i) I_i^2 \tag{27}$$

leading to $I^{S**} = \frac{m_i}{2\phi(S_i)}$. It turns out that human capital investment with the possibility to subsidize I^S is never smaller than in the basic model I^*

$$I^S = \gamma_i^{S*} Z_i^{S*} = \frac{\gamma_i^* Z_i^*}{\phi(S_i)} \geq I^* = \gamma_i^* Z_i^* \text{ as } \phi(S_i) \leq 1 \tag{28}$$

but does not reach the social optimum

$$I^S = \gamma_i^{S*} Z_i^{S*} = \frac{\gamma_i^* Z_i^*}{\phi(S_i)} < I^{S**} = \frac{m_i}{2\phi(S_i)}. \tag{29}$$

What is worth noting if we allow for these variants of the basic model: the human capital investment gets closer to the social optimum, but the fundamental structure of the model does not change. In particular, the structure of education is unaffected and still serves as a commitment device ($\gamma^* < 1$) in order to counterbalance the gerontocratic power of the old generation.

5. Consequences for the Welfare State

We have seen that in a mobile, non-altruistic world, increasing the mobility of the young generation enables the old generation to commit itself credibly to a lower tax level in the

future. To say it differently, a more attractive outside option of the young generation which serves as the commitment device prevents emigration and preserves a redistributive tax system. Although there is an efficiency loss due to human capital investments that increase the foreign productivity but not the domestic one, the welfare state will not erode.

This result is interesting as it allows drawing some conclusions about the possible development of the welfare state on the European level. For deriving this result we have taken two stylized facts into account which are or will be relevant for Europe: higher (potential) mobility of the young and higher life expectancy of the old. Let us briefly comment on both of them.

Focusing first on mobility, we can observe that a higher degree of integration within the European Union over the last decade has not increased the number of immigrants to Germany from other EU countries (see Figure 2). With the exception of Italy, the levels have never been very high and have been even decreasing over the last decades. The accession of new members to the EU has not influenced the number of immigrants to Germany. The number of Germans who have left Germany for another EU country has not changed significantly either, remaining at a very low level.[17] This is in line with our model. Making it easier for the young to emigrate will not necessarily mean that migration is happening. On the contrary, it is exactly this better outside option that may make migration (partially) redundant.

But do we already live in a gerontocratic system or will we in the near future? The fact that the median voter is still clearly younger than the retirement age does not have to be a fundamental criticism of the assumed gerontocracy, as the following two arguments

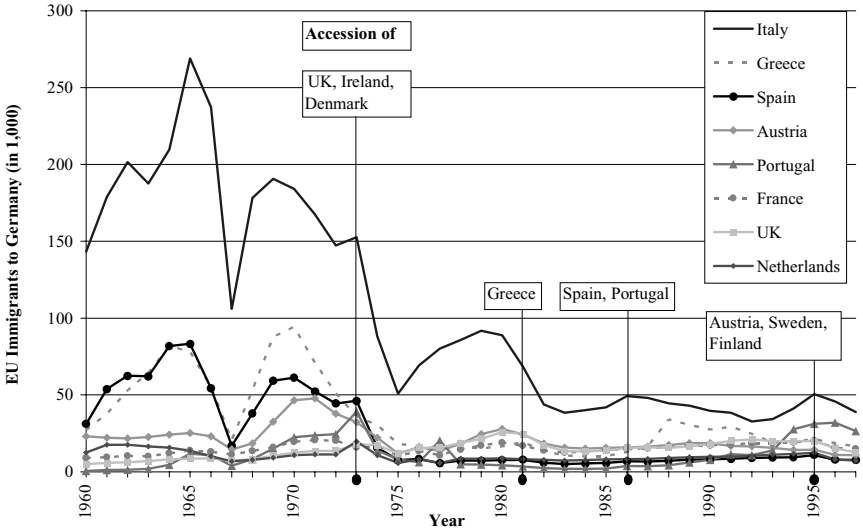

Figure 2. Immigrants to Germany from other EU countries for countries with migration flows to Germany of more than 5,000 per year (OECD, 1999b). Including information as to the year of accession to the EU (Belgium, France, Germany, Italy, Luxemburg, and the Netherlands as members since the beginning).

show. First, the forecasts for the demographic development show that the median voter will get older and older in the years to come. In Germany, for example, the median voter is today 45 years old. Within the next decades, the age of the median voter will increase significantly—reaching 55 years in 2030 and 59 in 2050.[18] The demographic developments in other EU countries are similar. Second, it is not necessary that the age of the median voter is equal to or higher than the retirement age in order to speak of a gerontocracy. Individuals close to the retirement age have similar interests to the retired. A gerontocratic system, however, can to a certain extent be counterbalanced by higher (potential) mobility of the young. Thus, a welfare state in the form of an intergenerationally redistributive tax system need neither explode nor erode.

Appendix 1

The socially optimal education level is given by (cf. equation (17))

$$I^{**} = \frac{1}{2} m_i. \tag{A1}$$

Comparing the socially optimal amount of human capital to the amount realized without a social planner, we get for $0.5 < \gamma^* \leq 1$

$$\gamma_i^* Z_i^* < I^{**} \Leftrightarrow \gamma_i^* \frac{(1-\gamma_i^*)m_j}{2} < \frac{m_i}{2} \tag{A2}$$

By using equation (13), this can be easily verified

$$\begin{aligned} &(m_i + 2m_j)[(2m_i + 2m_j) - (m_i + 2m_j)]m_j < m_i(2m_i + 2m_j)^2 \\ &m_i(m_i + 2m_j)m_j < m_i(2m_i + 2m_j)^2 \\ &0 < 4m_i^2 + 7m_i m_j + 2m_j^2 \end{aligned} \tag{A3}$$

The human capital investment with (indirectly) restricted choice of the educational quantity is also smaller than the relevant social optimum

$$\gamma_i^{D*} Z_i^{D*} < I^{**} \Leftrightarrow \gamma_i^*(1-\gamma_i^*)m_j < \frac{m_i}{2}. \tag{A4}$$

This can be shown by

$$\begin{aligned} &(m_i + 2m_j)m_j < \frac{(2m_i + 2m_j)^2}{2} \\ &0 < 2m_i^2 + 3m_i m_j \end{aligned}. \tag{A5}$$

Appendix 2

If the monetary costs C per unit of education Z are completely borne by the old generation, only stage 1 of the analysis above is affected. Equation (10) thus becomes

$$\max_{\gamma} \; N_i m_i \gamma_i Z_i t_i - N_i Z_i C, \tag{A6}$$

with the first order condition

$$m_i m_j \left(\frac{1}{2} - \gamma_i\right) = -(m_j)^2(1-\gamma_i) - m_j \frac{C}{2}. \tag{A7}$$

The interpretation of this equation is identical to the interpretation in Section 2.1.4 with the exception that there is an additional disadvantageous term on the right-hand side caused by the costs of education. Rearranging this equation yields the optimal educational structure γ_i^{C*}

$$\gamma_i^{C*} = 1 - \frac{1}{2}\frac{(m_i - C)}{(m_i + m_j)}. \tag{A8}$$

It can again be seen that $0.5 < \gamma_i^{C*} < 1$ (for $m_i - C > 0$). Thus, taking the costs into account does not change the qualitative results of the analysis. Quantitatively, however, the monetary costs C lead to a higher optimal value for γ.

In order to obtain the social optimum for this case, a social planner has to take the production and the costs of education, i.e. the disutility of education as well as the monetary costs, into account:

$$\max_I \; N_i m_i I_i - C N_i I_i - N_i I_i^2. \tag{A9}$$

Rewriting the first order condition yields the socially optimal investment in human capital

$$I_i^{C**} = \frac{1}{2} m_i - \frac{1}{2} C. \tag{A10}$$

In order to show that $Z_i^{C*}\gamma_i^{C*} < I_i^{C**}$, one has to take into account that $C \in [0; m_i]$ as $\gamma^* \in (\frac{1}{2}; 1)$ and that

$$Z_i^{C*} = \frac{1}{4} m_j \frac{(m_i - C)}{(m_i + m_j)}. \tag{A11}$$

For $C = 0$, it has already been shown that $Z_i^{C*}\gamma_i^{C*} \leq I_i^{C**}$.[19] And for $C = m_i$, it is easy to show that $Z_i^{C*}\gamma_i^{C*} = I_i^{C**} = 0$.

Therefore, it remains to check

$$Z_i^{C*}\gamma_i^{C*} \left\{ \begin{matrix} > \\ = \\ < \end{matrix} \right\} I_i^{C**} \Leftrightarrow m_j\left(1 - \gamma_i^{C*}\right)\gamma_i^{C*} \left\{ \begin{matrix} > \\ = \\ < \end{matrix} \right\} m_i - C. \tag{A12}$$

We define $Q \equiv m_j(1 - \gamma_i^{C*})\,\gamma_i^{C*}$ and differentiate Q with respect to C

$$\frac{\partial Q}{\partial C} = m_j \frac{\partial \gamma_i^{C*}}{\partial C}\left(1 - 2\gamma_i^{C*}\right) \tag{A13}$$

where

$$\frac{\partial \gamma_i^{C*}}{\partial C} = \frac{1}{2(m_j + m_i)}. \tag{A14}$$

With (A13) and (A14), one gets

$$\frac{\partial Q}{\partial C} = \frac{m_j}{2(m_i + m_j)}\left(1 - 2\gamma_i^{C*}\right). \tag{A15}$$

In order to sign the derivative $\partial Q/\partial C$, we use the following two relationships:

$$\frac{m_j}{m_i + m_j} < 1 \tag{A16}$$

$$-1 < \left(1 - 2\gamma_i^{C*}\right) < 0. \tag{A17}$$

The latter follows from the fact that $\gamma_i^C \in (\frac{1}{2}; 1)$. Hence, the derivative $\partial Q/\partial C$ lies within the following interval:

$$-\frac{1}{2} < \frac{\partial Q}{\partial C} < 0. \tag{A18}$$

This has to be compared with the derivative of the socially optimal solution

$$\frac{\partial I_i^{C**}}{\partial C} = -\frac{1}{2}. \tag{A19}$$

As a comparison of equations (A18) and (A19) shows, a marginal increase in the costs C means that the marginal decrease of the socially optimal education level I_i^{C**} is higher in absolute terms than the marginal decrease of the education level $\gamma_i^{C*} Z_i^{C*}$ within the interval $C \in [0; m_i]$. We know that at the right border of the interval (i.e. $C = m_i$) $I_i^{C**} = \gamma_i^{C*} Z_i^{C*} = 0$, and so the socially optimal value I_i^{C**} exceeds $\gamma_i^{C*} Z_i^{C*}$ for all C within the interval.

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Notes

1. For public education as commitment device in an altruistic model see Gradstein (2000).
2. Intergenerational transfers are quite significant in the developed countries: roughly 5 percent of GDP are transferred to the young in the form of public education and about 8 percent of GDP are received by the old via public pension schemes (OECD, 1996, 1999a; Thum, 2000).
3. See Andersson and Konrad (2003) who analyze how labor mobility affects the government's incentive to subsidize human capital and the individuals' incentives to invest in human capital.
4. For a more general discussion of training of workers see Lazear (1995).
5. We abstract from a possible second group of individuals in each country with sufficiently high mobility costs to render them immobile.
6. See for example Konrad (1995a, 1995b) and the discussion in Section 5.
7. For a similar set-up in a related analysis see Andersson and Konrad (2003).
8. This equilibrium condition abstracts from the possibility that the young generation might have the opportunity to tax the subsequent generation in the future. This setting can be justified by assuming a singular demographic shock, i.e. that the gerontocratic system is temporary.
9. The increasing marginal disutility of education can also be interpreted in a broader sense. Let's take $\underline{w}$ per year as the forgone wage income during the educational period, i.e. the opportunity costs of education per year. If we interpret Z as the level of education (and not as the years of education) with $Z = f(Years)$ and $Z_{Years} > 0$, $Z_{Years\ Years} < 0$, then the marginal costs of a higher educational level are increasing in the years of education.

10. Note that Z_i^* and t_i^* are functions of γ_i.
11. See Appendix 1.
12. The young generation is assumed to bear costs of education only in the form of disutility.
13. See Appendix 2 for all derivations of this section.
14. This can be motivated by assuming that the signaling function of a degree is essential for the wage determination. Years of school $Z_i, 0 < Z_i < \bar{Z}_i$, will not be chosen although this would be possible.
15. See Andersson and Konrad (2003) for an identical formulation of educational subsidies.
16. See Appendix 1 for all derivations of this section.
17. Between 1970 and 1999 less than 0.05% of the population (based on West Germany before 1990) left Germany per year for one of the other (later) EU 15 countries (Statistisches Bundesamt, various volumes).
18. The calculation is based on the population predictions of the U.S. Bureau of the Census (2000).
19. See the argumentation in Section 2.2.

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