DISCUSSION PAPER SERIES

IZA DP No. 239

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January 2001

Forschungsinstitut
zur Zukunft der Arbeit
Institute for the Study
of Labor

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Discussion Paper No. 239
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IZA Discussion Paper No. 239
January 2001

ABSTRACT

Human Capital Investment and Globalization in Extortionary States*

This paper considers education investment and public education subsidies in closed and open economies with an extortionary government. The extortionary government in a closed economy has incentives to subsidize education in order to overcome a hold-up problem of time consistent taxation, similar to benevolent governments. The two types of government differ in their education policies if highly productive labor is fully mobile. Extortionary governments' incentives for education subsidies vanish and they even have an incentive to prevent individuals from mobility increasing education investment. Tax competition therefore reduces hold-up problems of time consistent extortionary taxation, but also introduces incentives that reduce workers' utility.

JEL Classification: H21, H23

Keywords: Globalization, commitment, time consistent income taxation, migration, education

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* This paper is part of the SNS (Center for Business and Policy Studies) project on *Controlling the Scope, Size and Efficiency of the Public Sector.*

1 Introduction

The transaction costs of migration are declining in Europe. Migration obstacles within the EU, for instance, have been abolished in several steps, with the biggest step made in 1992 when the common market that granted free mobility for factors was introduced. The resulting increase in mobility is discussed and documented in, for example, Wildasin (2000). In addition, the further EU enlargement that opens up the labor markets between the current members of the EU and the countries currently applying for membership, as well as other global trends, will further increase labor mobility in the first decade of the new century. In this paper we consider the impact of increased mobility for education policy and the taxation of returns from human capital investment.

The starting point of this paper is the well established insight that optimal education policy and taxation of human capital income are closely related. Human capital investment suffers from a severe hold-up problem. The optimal time consistent tax on the returns from human capital investment is high at the time when education investment decisions are already made. This high tax is anticipated by individuals at the stage when they make their investment choices, and this reduces their incentives to invest[1]. Boadway, Marceau and Marchand (1996) analyze this problem and show that mandatory education or, similarly, subsidized provision of public education is a natural solution to this problem.[2] Hence, public provision of education is a second-best policy. It is chosen as a remedy for the detrimental welfare effects of time consistent human capital income taxation in a closed economy.[3] While Boadway, Marceau and Marchand (1996) consider benevolent

[1]Kydland and Prescott (1980) were among the first to analyse time consistent taxation of investment returns and the hold-up problem it generates in the context of capital income taxation.

[2]Indeed, this instrument is widely used in many OECD countries. Public investment in schooling and higher education is considerable. The mean of public expenditure on educational institutions among OECD countries has been 4.9 percent of GDP in 1996 (OECD Figures, 1999, p.67) and this amount exceeds private expenditure on educational institutions by several hundred percent. Given the fact that human capital is, for most parts, a private good, this may be surprising. Human capital returns are highly taxed. Maximum personal income tax rates of central government within the OECD averaged 54.2 percent in 1986, and ranged from 33 percent (New Zealand) to 65 percent (Japan), with an OECD average of 47.8 percent in 1996 (OECD Figures, 1989, 1999).

[3]Gradstein (1998) has made a similar point regarding the role of public provision of

governments, it is clear that benevolent governments as well as kleptocrat or Leviathan governments face the same hold-up problem when it comes to the taxation of human capital returns; hence, their analysis carries over qualitatively to the Leviathan case.

Increased international mobility of skilled labor changes the set of constraints under which national policies are chosen. Taking the private investment problem and time consistent taxation as an isolated problem, it has been emphasized in the tax competition literature more generally that the increased mobility of a tax base—such as highly skilled workers and their income—constrains the national governments in their ability to tax, because the individuals can avoid paying one country's taxes by moving to another country. Hence, international mobility of skilled labor changes the taxation problem and may therefore solve the hold-up problem of time consistent taxation. This was pointed out for capital income taxation more generally by Kehoe (1989) for the case of benevolent redistributive taxation. Other contributions have addressed the issue of education policy as an isolated problem and disregard the time consistency issue. For instance, Justman and Thisse (2000) start with the assumption that education policy must be provided publicly for exogenous reasons, and conclude that mobility of the highly skilled may necessitate harmonization or coordination between the countries' policies. In principle, this coordination could take place on the expenditure side (coordinated spending on public education), or on the revenue side (coordination of human capital taxes). These contributions disregard the important fact that public education provision and high income taxes are symptoms for a more fundamental time consistency problem, and that education policy is already a second-best policy that addresses an existing distortion: the hold-up problem due to time consistent taxation of human capital returns.

For a benevolent government that uses tax revenue to redistribute according to a welfarist objective, this connection is taken into account in the analysis of increased mobility by Andersson and Konrad (2000). As is shown there, full mobility of the skilled does not necessarily eliminate the incentives for public provision of education or education subsidies and does not necessarily generate an allocation problem. On the contrary, full mobility may restore efficiency.

In this paper we consider tax policy and public provision of education

education; Kanniainen and Poutvaara (2000) have explored how complementarities in production make subsidization of education desirable.

for a Leviathan government, also concentrating on the close link between taxation and education policy. We start with a closed economy that resembles the Leviathan models of government in Olson (1993) and McGuire and Olson (1996) but introduce the problem of time consistent taxation in this framework. We find that a Leviathan would like to overcome the hold-up problem of time consistent taxation by education subsidies. We show here that this policy benefits both the Leviathan and the people.

Our main results are on the impact of mobility of skilled labor. Having solved for the case with zero international mobility by considering the closed economy, we compare this outcome to the case with full mobility, and to the intermediate case with finite but positive mobility cost. With full mobility, we show first that the Leviathan fully abstains from any public provision of education or education subsidies. In fact, the Leviathan would like to tax or fully eliminate private investment in education in this case if this were possible. It is important to note that this outcome—i.e. full elimination of private investment—is inferior to the closed economy outcome both for the Leviathan and for the individuals. Depending on how the Leviathan can adjust the education policy to a switch from a closed economy to a globalized economy in which the highly skilled workers are mobile, the individuals' expected utility can be higher or lower in the globalized world compared to the closed economy case. In a static context with taxes being the only decision variables, the view that increased international tax-base mobility benefits the population if the Leviathan does not spend the tax revenue on activities that benefit the population is well established. Our result shows that the outcome can be different in a dynamic context. If Leviathans can distort an investment decision that affects mobility, they still dislike tax competition, but tax competition between Leviathans need no longer be beneficial for the people; this is true even if the Leviathan fully appropriates all tax revenues for personal use.[4]

We also solve for the tax competition equilibria if the highly skilled workers have finite but strictly positive migration cost. We find that the expected tax revenues in the (mixed strategy) equilibria exceed the sum of migration cost that would occur if every highly skilled worker moves to another country.

[4]Edwards and Keen (1996), for instance, show that tax competition in a static framework is less likely to be in the interest of the population the smaller the share of the tax revenue that is spent on goods which are valued by the population. Of course, there is no contradiction between our results and Edwards and Keen (1996) as we simply highlight an additional dimension of the problem.

From this result we draw conclusions for public education investment and for welfare.

The paper is organized as follows. In the next section we set out the model, and in section 3 we consider the closed economy case. In section 4, we consider a globalized world, and in section 5 we conclude.

2 The model

Consider the following two-period model that adopts Olson's (1993) investment problem of a Leviathan but accounts for the hold-up problem in taxation considered in the context of benevolent governments as in Boadway, Marceau and Marchand (1996), Konrad (2000) and Andersson and Konrad (2000).[5] There are two identical countries A and B, each with a continuum $[0, 1]$ of individuals. Individuals live for two periods. In period 1 all individuals are identical. Each makes a private investment in education. The amount of effort invested by individual i is e_i. Individuals earn labor income in period 2. They differ in their productivity. The productivity of each individual is determined (by nature) at the beginning of period 2. Individual i's probability of becoming highly productive is $p(e_i)$. Earnings are m_H or $m_L < m_H$, if the individual ends up with High or Low productivity respectively. Individual i's investment e_i in period 1 increases the probability for the individual to become highly productive. If no educational investment is made, the individual will have low productivity with probability one in period 2. The probability $p(e_i)$ is assumed to be a monotonically increasing function in educational investment. In addition, we assume that $p(0) = 0$, $\lim_{e_i \to 0} p'(e_i) = \infty$, $p'(e_i) > 0$, $p''(e_i) < 0$, and $\lim_{e_i \to \infty} p(e_i) < 1$.[6] We further assume that the individual productivity outcomes for all individuals are mutually stochastically independent.

The government can reduce the individual cost of investment in education by subsidizing or publicly providing goods that are complementary with education effort. Let s be the governmental expenditure on subsidizing education, per capita. We assume that this expenditure reduces the cost of

[5] It is straightforward to endogenize labor supply in this model, or to extend this model and its equilibrium results to an overlapping generations model with an infinite horizon.

[6] The two-type assumption is for simplicity only and has been made in the optimal tax literature, e.g., by Stern (1982), Stiglitz (1982) and, in a related context, by Boadway and Marchand (1995).

education from e by a factor $\psi(s)$, with $\psi(0) = 1$, $\psi'(s) < 0$ and $\psi''(s) > 0$, and $\lim_{s\to\infty} \psi(s) = a > 0$.

An individual's utility will be described by

$$U_i = -\psi(s)e_i + \nu(e_i) + (1 - p(e_i))u(x_L) + p(e_i)u(x_H), \tag{1}$$

where x_L and x_H are the individual's incomes if the educational investment is not/is successful. Education cost $\psi(s)e_i$ enters utility as a cost in period 1. Education e_i enters in this cost term in (1) linearly by normalization. The function $\nu(e)$ is assumed to be increasing and strictly concave and measures the consumption benefit from education in period 2, with $\nu(0) = 0$. Net income x_i enters utility positively: the utility of income function u is monotonically increasing and concave.

3 The closed economy

Consider first a situation in which migration is ruled out, for instance because the cost of migration is extremely high. We will characterize the laissez-faire outcome as a benchmark case, and then study a Leviathan government.

3.1 The laissez-faire equilibrium

Suppose there is no government that could impose taxes and subsidize education. Individuals choose education e_i. Also, much in line with the literature (see, e.g., Eaton and Rosen 1980, Varian 1980, and Sinn 1996), we assume that private insurance markets do not exist.[7] The private human capital investment problem is straightforward. Individuals maximize their expected utility, which leads to the first-order condition

$$1 - \nu'(e_i) = p'(e_i)[u(m_H) - u(m_L)] \tag{2}$$

characterizing the equilibrium human capital investment. The effort that solves this equation is e^*, the * denoting laissez-faire equilibrium values throughout.

[7] The most compelling justification for this assumption has been given by Sinn (1996): when individuals make major human capital investment decisions, they are often too young to be allowed to participate in business life and write insurance contracts. The assumption about availability of private insurance is crucial for the results, as has been seen in Andersson and Konrad (2000).

3.2 The Leviathan equilibrium

Consider now a (kleptocrat) Leviathan government that maximizes tax revenue net of its expenditure on education subsidies. This revenue is not refunded to the population in terms of public goods or transfers, but is used on purposes that benefit only the Leviathan. Assuming for simplicity that the interest rate is zero, the Leviathan's payoff is the sum of taxes in period 2 minus the sum of education subsidies in period 1. The Leviathan and the individuals are players in a simple 4-stage game. In stage 1 the Leviathan chooses per-capita education subsidies $s \geq 0$. In stage 2 individuals choose their human capital investments e. Then, in stage 3, nature determines whether an individual will have high or low productivity, as described in section 2. Finally, in stage 4, the Leviathan chooses taxes.

For simplicity we assume that the Leviathan can observe individual incomes (that is, productivity types) and is constrained to appropriate only the share of income that exceeds some minimum income $m_{\min}$, with $m_{\min} < m_L$.[8] Time consistent behavior implies that the dictator confiscates all income that exceeds $m_{\min}$. This solves stage 4 of the game.

Individuals anticipate this time consistent behavior of a Leviathan when they determine their optimal human capital investment in stage 2.[9] They maximize

$$-\psi(s)e_i + \nu(e_i) + p(e_i)u(x_H) + (1 - p(e_i))u(x_L)$$

and anticipate that $x_H = x_L = m_{\min}$. The first-order condition that determines their equilibrium choice of education investment for given subsidies is

$$-\psi(s) + \nu'(e) = 0 \qquad (3)$$

[8] In a full information context, it would not be natural to restrict the Leviathan to use a proportional tax, and type-dependent flat taxes are the Leviathan's most efficient instruments. Of course, incomplete information may require that different productivity types earn different information rents. But this is a different aspect that is tangential to the issues we are focussing on here.

[9] Note that it is not difficult to anticipate the future level of taxes in reality. When making an education investment decision at year t, an individual may simply use the current tax rate on to human capital returns that accrue in period t as an approximate estimate, because the government that chooses this tax rate in year t does this by solving a time consistent optimal taxation problem that is very similar to the one it will solve 20 or 30 years later, when the current investment in year t pays off.

and this implicitly determines private education investment as a function of public subsidies, $e(s)$, and also the equilibrium shares of productivity types as $p(e(s))$.

In stage 1 the Leviathan chooses education subsidies in order to maximize

$$p(e(s))(m_H - m_{\min}) + (1 - p(e(s)))(m_L - m_{\min}) - s. \tag{4}$$

The dictator has an incentive to increase individual investment in education and to subsidize such investment. The marginal condition for such public educational investment is

$$p'(e)\frac{\partial e}{\partial s}(m_H - m_L) = 1, \tag{5}$$

where $\partial e/\partial s$ can be obtained from (3). The Leviathan's incentives for governmental provision of public education subsidies are similar to the incentives for such subsidies that have been derived in Andersson and Konrad (2000) for fully benevolent governments that face a time consistency problem and try to use public education subsidies as a second best remedy.

An interesting aspect of this policy is that, although it does not increase individuals' net of tax income in the equilibrium, the Leviathan's education policy benefits the individuals because it increases their rent from education consumption.

4 A globalized world

Language barriers, asymmetric information as regards local customs, laws and regulation, and partially incompatible, or at least incompletely harmonized, social security provisions still generate considerable migration cost for those wo consider moving from one country to another. However, there is a clear trend by which migration cost is being reduced, due to economic and political integration. Education can be expected to make individuals more mobile. For instance, language skills help overcoming language barriers. To emphasize this general trend, we assume in this section that skilled workers are mobile, whereas unskilled workers are perfectly immobile. The situation in which individuals with high productivity have uniform migration cost equal to zero will be a particularly interesting benchmark case[10] that can

[10] This assumption is, for instance, also pursued in Poutvaara (1999) who considers labor tax competition when taxes are used for redistribution. He assumes, however, that the government can fully commit itself to an ex-ante optimal tax policy.

be compared with the equilibrium in a closed economy. After exploring this case, we will solve for the equilibria with strictly positive but finite migration cost.

Note first that, given the assumed symmetry, the laissez-faire outcome does not change if migration is feasible. Individuals' income in the laissez-faire depends only on their productivity and it is the same in both countries, whether they migrate or not.

Consider now the situation with two Leviathan governments in two countries, A and B, in a globalized world. The game structure is as follows. In period 1, in stage 1, the governments in both countries choose their education subsidies, $s^A \geq 0$ and $s^B \geq 0$. Leviathans maximize revenue. We assume that the Leviathans are not constrained with respect to their expenditure by future revenues and can make losses; that is, their desired subsidies can always be financed. In stage 2 individuals choose their education effort.

In stage 3, nature reveals each individual's productivity type; that is, individual earnings in period 2. In stage 4, at the end of period 1, Leviathans choose taxes. In stage 5 (period 2), immobile, low-skilled individuals have no choice and stay in the country of their origin, but high-skilled individuals choose their country of residence. This last stage is the major difference between closed economies and economies in which the highly productive individuals can freely migrate between countries. Mobile individuals who are born in country A can stay in this country and earn $m_H - t_H^A$, or they move to country B and receive net income $m_H - t_H^B - C$, where C is the cost of migrating from one country to the other.

In order to concentrate on the education investment incentives, we assume constant returns technologies, with m_H and m_L the physical products of the two productivity types.[11]

We can easily characterize the migration equilibrium in stage 5 of the game. If individuals receive the same net income regardless of whether they migrate or not, we assume that they stay in their country of origin. Accord-

[11] This is a simplification, because migration changes the relative scarcity of skilled and unskilled labor, and, depending on the production functions, mobility of other factors, trade restrictions etc. migration may have a number of, partially offsetting, effects. However, for each of these effects a straighforward analysis could be carried out showing how this effect counteracts or reinforces the mechanisms that are under consideration in this paper.

ingly, the number of highly skilled individuals in country A is

$$\gamma_H^A = \begin{cases} p(e^A) + p(e^B) & \text{if } \ t_H^A < t_H^B - C \\ p(e^A) & \text{if } \ t_H^A + C \geq t_H^B \text{ and } t_H^A \leq t_H^B + C \\ 0 & \text{if } \ t_H^A > t_H^B + C \end{cases} ; \tag{6}$$

γ_H^B is obtained by replacing all superscripts A by B and vice versa.

Moving to stage 4, the Leviathan in country A maximizes

$$t_H^A \gamma_H^A + t_L^A (1 - p(e^A)) \tag{7}$$

subject to $t_H^A \in [0, m_H - m_{\min}]$ and $t_L^A \in [0, m_L - m_{\min}]$, and (6) for given tax rates t_H^B and t_L^B. By (7), Leviathan A's tax revenue is the sum of revenues from taxing the number (γ_H^A) of high-productivity individuals that choose their residence in country A plus the revenues from taxing the immobile low-productivity individuals. The optimization problem for the Leviathan in country B is obtained by replacing all superscripts A by B and vice versa.

For the explicit solution of the tax competition game and of stages 2 and 1 of the game, we distinguish two cases. We consider first the case with zero migration cost and then move to the more general case.

4.1 Zero migration cost

Suppose that the cost of migrating from one country to another is zero; i.e., $C = 0$ in equation (6). In this case the tax-competition game is a simple Bertrand game and the unique Nash equilibrium is $t_H^A = t_H^B = 0$, and $t_L^A = t_L^B = m_L - m_{\min}$. Moving to stage 2, individuals anticipate that they pay a tax equal to $t_L^A = t_L^B = m_L - m_{\min}$, if they find out that they have low productivity and are immobile, and that they will not pay any taxes if they become productive in stage 3. Accordingly, their incentives to invest in education for given education subsidies are described by the first-order condition

$$-\psi(s)e + \nu'(e) + p'(e)(u(m_H) - u(m_{\min})) = 0.$$

This condition reveals that, for any given $s \geq 0$, individuals' incentives for human capital investment in a state that is ruled by a Leviathan strictly exceed their investment incentives in the laissez faire if high productivity goes along with high mobility. Intuitively, individuals can escape from confiscatory taxation if they become highly skilled, whereas low-skilled workers are taxed. Hence, the benefit of becoming highly skilled is larger in a global world with Leviathan governments than in the laissez-faire.

Consider finally stage 1. The Leviathan who calculates this game through knows that highly productive and mobile individuals will not pay taxes, this being in contrast to immobile individuals with low productivity. Hence, even the first unit of education subsidy strictly lowers the Leviathan's payoff, and the equilibrium has zero subsidies. Indeed, the Leviathan would like to tax education effort—or even spend resources to prevent individuals from acquiring education—since education also makes them mobile. If he could do this at no cost, he would prohibit education.

We summarize these results as

Proposition 1 *Consider two countries with (kleptocratic) Leviathan governments. Suppose highly productive individuals are perfectly mobile and individuals with low productivity are perfectly immobile. In the equilibrium the governments will not subsidize education investment. The Leviathan has an incentive to tax or to prohibit education. Further, private investment in education is higher than in the laissez-faire equilibrium.*

The fact that the government would like to spend resources in order to prevent individuals from obtaining education is of particular interest. If taxation or prohibition of education is possible, the efficiency properties of the resulting equilibrium are very poor. Suppose, for instance, that the Leviathan can prohibit education at no cost. Hence, education $e = 0$ in the equilibrium, all individuals have low incomes and remain immobile and end up with utility $U_i = u(m_{\min})$ which is less than their expected utility in the closed economy. Also the Leviathan is worse-off than in the closed economy in this case. Moreover, if education prohibition is not costless or not feasible, but taxation of education effort is feasible, the government will divert its efforts to extract revenue from individuals from tax policy to education policy. However simple, this observation is an important caveat against the conclusion—put forward, for instance, by Brennan and Buchanan (1980)—that tax competition between Leviathan governments is unambiguously a good thing since it prevents governments from over-taxing individuals. Tax competition may divert the attention of the Leviathan to more costly means of extortion.

4.2 Tax competition with finite moving costs

We will now consider tax competition in a setting which constitutes an intermediate case between the closed economy and the globalized world, *viz.* a setting where people face finite, positive moving costs. In more precise terms, we will assume that each individual faces a cost, $C > 0$, if he or she moves from one country to the other. Apart from the arguably obvious appeal as realistic, this assumption turns out to have the implication that no pure-strategy tax equilibrium exists as long as the moving cost is not too large.

We will confine our analysis to symmetric equilibria of the whole game. We will first solve for the equilibrium of the symmetric tax-competition game for a given $p(e^A) = p(e^B) \equiv p$; the associated (symmetric) equilibrium of the whole game then follows immediately. In constructing the equilibrium of the tax-competition game, only the choice of the tax of high-productivity individuals is relevant, and the government in country A thus solves

$$\max_{t_H^A} \tau = t_H^A \gamma_H^A$$

subject to $t_H^A \in [0, m_H - m_{\min}] \equiv [0, \bar{t}_H]$ and (6); the upper bound on the tax, $\bar{t}_H$, will be key in what follows. It will turn out to be useful to first consider large moving costs and then go on to small moving costs, pasting the two parts together in the end.

Thus, consider first $C \geq \bar{t}_H/2$. This is the condition on moving costs that ensures that we are in effect dealing with closed economies. The reason is that all taxes $t_H^i < C$, $i = A, B$, are strictly dominated by $t_H^i = C$. Therefore, $t_H^i < C$ can be eliminated, and this in turn ensures that a country choosing $t_H^i \leq 2C$ will never face out-migration since this requires $t_H^j < C$, $j \neq i$, (the strict inequality being due to the tie-breaking assumption). This proves

Proposition 2 *Consider symmetric equilibria of the tax-competition game with moving cost C, and $\bar{t}_H = m_H - m_{\min}$ being the upper bound on the tax of high-productivity workers. If $C \geq \bar{t}_H/2$, both countries will set $t_H^i = \bar{t}_H$.*

Consider now the case where C is small (relative to $\bar{t}_H$). The first thing to note is that whenever the condition of the proposition is not met—i.e. when $C < \bar{t}_H/2$—there does not exist a pure-strategy equilibrium. To see this consider country A's best responses to a fixed t_H^B. If $t_H^B \leq 2C$ country

A has an incentive to set $t_H^A > t_H^B$ and obviously t_H^B cannot be optimal. If $2C < t_H^B \leq 3C$, the same incentive remains as long as it is possible to set $t_H^A > t_H^B$; if not, country A has an incentive to *undercut* by setting t_H^A slightly below $t_H^B - C$; finally, if $t_H^B > 3C$, it is always optimal to undercut. Since, obviously, it is never optimal for a country to *allow undercutting*, it is clear that no pure-strategy equilibrium exists.

Thus, we will look for mixed-strategy equilibria. It is rather straightforward to verify that a mixed-strategy equilibrium exists; all of the conditions for the existence of a mixed-strategy equilibrium clarified by Dasgupta and Maskin (1986) are met.[12] In addition, the conditions are met for a symmetric equilibrium to exist that is atomless at all points of discontinuity of the payoff function.

It is clear from Proposition 2 that each of the two countries can ensure a payoff of $2 \cdot C \cdot p$ in any equilibrium by setting $t_H^i = 2C$ (recall that p is the proportion of high-productivity workers in each country). It turns out, however, that governments in fact do a little bit better.

Proposition 3 *Consider symmetric equilibria of the tax-competition game with moving cost C, and $\bar{t}_H = m_H - m_{\min}$ being the upper bound on the tax of high-productivity workers. If $C \leq \bar{t}_H/(2+\sqrt{2})$, it is a mixed-strategy equilibrium for both countries to choose $t_H^i = C \cdot x$ where x is distributed as*

$$F(x) = \begin{cases} 1 - (D+1)/(x+1) & \text{if } x \in [D, D+1] \\ 2 - (D+1)/(x-1) & \text{if } x \in [D+1, D+2] \end{cases} \quad \text{where } D = \sqrt{2};$$

the resulting expected payoff is $\tau = (\sqrt{2}+1) \cdot C \cdot p$.

Proof: See the Appendix.

Some points are worth noting. First, the countries do better than the minimum indicated by Proposition 2; while it is obvious from that statement that $\tau \geq 2 \cdot C \cdot p$, the actual payoff is $\tau = (\sqrt{2}+1) \cdot C \cdot p$. Secondly, the strategies are atomless but the density is not continuous.

Let us now consider intermediate values of C.

[12] The conditions are that the sum of payoffs be upper semi-continuous in the choice variables and that individual payoffs be weakly lower semi-continuous in each player's choice variable. In addition, the set of points of discontinuity of the payoff function must be small and well behaved.

Proposition 4 *Consider symmetric equilibria of the tax-competition game with moving cost* C*, and* $\bar{t}_H = m_H - m_{\min}$ *being the upper bound on the tax of high-productivity workers. If* $\bar{t}_H/(2+\sqrt{2}) < C < \bar{t}_H/2$*, it is a mixed-strategy equilibrium for both countries to choose* $t_H^i = C \cdot x$ *where* x *is distributed as*

$$F(x) = \begin{cases} 1-(D+1)/(x+1) & \text{if } x \in [D,E) \\ 1-1/D & \text{if } x \in [E,D+1) \\ 2-(D+1)/(x-1) & \text{if } x \in [D+1,E+1) \\ 1 & \text{if } x = \bar{t}_H/C \end{cases}$$

where

$$D = \sqrt{\bar{t}_H/C + \frac{1}{4}} - \frac{1}{2} \text{ and } E = D^2 + D - 1;$$

the resulting expected payoff is $\tau = (D+1) \cdot C \cdot p$.

Proof: See the Appendix.

It is straightforward to verify that $D > 1$ whenever $C < \bar{t}_H/2$, and that $D < \sqrt{2}$ whenever $C > \bar{t}_H/(2+\sqrt{2})$; this combined with the fact that $E - D = D^2 - 1$ shows that the set of equilibria derived is continuous in C in the precise sense that the limits of the expressions in Proposition 4 when $C \to \bar{t}_H/2$ and when $C \to \bar{t}_H/(2+\sqrt{2})$ converge to the expressions of Propositions 2 and 3. There is a gap in the distribution in the sense that there is no probability mass in the interval $[E, D+1]$; the length of this interval is $D+1-E = 2-D^2$ which is strictly positive when $D < \sqrt{2}$. Note further that $E+1 = \bar{t}_H/C$ (corresponding to the maximum tax); i.e., there is no gap in the upper part of the distribution. Finally, there is an atom in the distribution at $x = \bar{t}/C$ if and only if this gap is present: $\lim_{x \to E+1^-} F(x) = 1-(2-D^2)/(D^2+D-1) < 1$ when $D < \sqrt{2}$.

The most interesting aspects of these tax competition equilibria are as follows. For given education effort, the Leviathans' expected tax revenue is strictly increasing in migration cost, and the average tax revenue which is to be paid by highly skilled mobile individuals in the equilibrium exceeds what the Leviathan could obtain from charging a tax that simply equals the migration cost.

From here it is straightforward to calculate individuals' incentives for investing in education. Note, however, that the random tax strategies make highly productive individuals' net incomes a random variable as well. Given their concave utility-of-income function, they exhibit risk aversion, which makes education investment less attractive for them. At the same time this risk aversion effect makes the comparative statics of the solution ambiguous and welfare may become non-monotonic in the size of the migration cost. This is why we do not present the detailed analysis of the education choice here. As is clear from continuity, sufficiently low migration cost can lead to an equilibrium outcome which has lower utility than the equilibrium outcome for sufficiently high migration cost for both the Leviathan and the individuals.

5 Summary

We have analyzed the equilibrium outcome both in a closed economy and in a globalized economy where the government is a Leviathan. As a starting point, the paper has acknowledged the close relationship between education subsidies and time consistent tax policy. In closed economies, the two types of government lead to very similar behavior both with respect to education subsidies and private education effort. However, in the open economy context with free mobility of highly productive labor, the two types of government can lead to very different behavior. As has been shown in Andersson and Konrad (2000), benevolent governments may still spend money on education subsidies. Leviathans do not. Leviathans would even like to spend money on making it more likely that individuals do not become highly skilled (and mobile); if costlessly possible, they would prohibit education. As a result, mobility of the highly skilled and the induced tax competition reduces the Leviathan's utility. The individuals' utility may increase or decrease. Utility clearly increases if the Leviathan's education policy remains unchanged. However, in particular if the Leviathan can discourage education, tax competition may reduce the equilibrium utility for Leviathans *and* for individuals.

Appendix

Proof of Proposition 3.

Let us work with $C = 1$. Let $F(x)$ be the cumulative distribution function for the equilibrium strategy and let D denote the lower bound of the support of the equilibrium strategy (i.e. $D = \inf\{\text{ supp } (F)\}$). Let τ_0 denote equilibrium tax revenue.

Now, for $x \in [D, D+1]$, the payoff is simple since there cannot be out-migration

$$\tau_0 = p \cdot x \cdot F(x+1) + 2p \cdot x \cdot (1 - F(x+1)), \tag{8}$$

which can be written

$$\frac{\pi_0}{x} = F(x+1) + 2 \cdot (1 - F(x+1)) = 2 - F(x+1), \tag{9}$$

where $\pi_0 = \tau_0/p$. This implies

$$F(x+1) = 2 - \frac{\pi_0}{x}, \quad x \in [D, D+1], \tag{10}$$

or

$$F(x) = 2 - \frac{\pi_0}{x-1}, \quad x \in [D+1, D+2]. \tag{11}$$

Now

$$F(D+1) = 2 - \frac{\pi_0}{D} > 0 \quad \Rightarrow \quad \pi_0 < 2D, \tag{12}$$

and

$$F(D+2) = 2 - \frac{\pi_0}{D+1} \leq 1 \quad \Rightarrow \quad \pi_0 \geq D+1. \tag{13}$$

The latter (in-)equality can be seen intuitively as well: each player can guarantee himself $D+1$. The implication is that $2D > D+1$; i.e. $D > 1$.

The density is

$$f(x) = \frac{\pi_0}{(x-1)^2}, \quad x \in [D+1, D+2], \tag{14}$$

which is decreasing.

Now, consider the possibility that supp $(F) = [D, D+2]$; i.e., that $F(D+2) = 1$ and therefore $\pi_0 = D+1$ because of (13). The payoff from choosing $x \in [D+1, D+2]$ (which must equal π_0) is

$$\pi_0 = 0 \cdot F(x-1) + x \cdot (1 - F(x-1)), \quad x \in [D+1, D+2], \tag{15}$$

since there cannot be in-migration; or

$$F(x-1) = 1 - \frac{\pi_0}{x} = 1 - \frac{\pi_0}{x-1+1}, \quad x \in [D+1, D+2], \tag{16}$$

or

$$F(x) = 1 - \frac{\pi_0}{x+1}, \quad x \in [D, D+1]. \tag{17}$$

The corresponding density is

$$f(x) = \frac{\pi_0}{(x+1)^2}, \quad x \in [D, D+1]. \tag{18}$$

Clearly

$$F(D) = 1 - \frac{\pi_0}{D+1} = 0, \tag{19}$$

whereas

$$F(D+1) = 1 - \frac{\pi_0}{D+2} = \frac{D+2-\pi_0}{D+2} = \frac{D+2-(D+1)}{D+2} = \frac{1}{D+2}, \tag{20}$$

this is true from the left. From the right we have

$$F(D+1) = 2 - \frac{\pi_0}{D} = \frac{2D-\pi_0}{D} = \frac{2D-(D+1)}{D} = \frac{D-1}{D}. \tag{21}$$

The equation

$$\frac{1}{D+2} = \frac{D-1}{D} \tag{22}$$

has the solution $D = \sqrt{2}$.

We thus have an equilibrium:

$$F(x) = \begin{cases} 1 - \pi_0/(x+1) & \text{if} \quad x \in [D, D+1] \\ 2 - \pi_0/(x-1) & \text{if} \quad x \in [D+1, D+2] \end{cases} \tag{23}$$

and

$$f(x) = \begin{cases} \pi_0/(x+1)^2 & \text{if} \quad x \in [D, D+1] \\ \pi_0/(x-1)^2 & \text{if} \quad x \in [D+1, D+2] \end{cases} \tag{24}$$

Proof of Proposition 4.

Let us work with $C = 1$ and continue to use the notation of the proof of Proposition 3.

Let $E \leq D+1$. For $x \in [D, E]$, the payoff is simple

$$\pi_0 = x \cdot F(x+1) + 2 \cdot x \cdot (1 - F(x+1)); \tag{25}$$

which can be written

$$\frac{\pi_0}{x} = F(x+1) + 2 \cdot (1 - F(x+1)) = 2 - F(x+1), \tag{26}$$

implying

$$F(x+1) = 2 - \frac{\pi_0}{x}, \quad x \in [D, E], \tag{27}$$

or

$$F(x) = 2 - \frac{\pi_0}{x-1}, \quad x \in [D+1, E+1]; \tag{28}$$

now

$$F(D+1) = 2 - \frac{\pi_0}{D} > 0 \quad \Rightarrow \quad \pi_0 < 2D, \tag{29}$$

and

$$F(E+1) = 2 - \frac{\pi_0}{E} \leq 1 \quad \Rightarrow \quad \pi_0 \geq E. \tag{30}$$

The implication is that $2D > E$. The density is

$$f(x) = \frac{\pi_0}{(x-1)^2}, \quad x \in [D+1, E+1], \tag{31}$$

which is decreasing.

The payoff from choosing $x \in [D+1, E+1]$ (which must equal π_0) is

$$\pi_0 = 0 \cdot F(x-1) + x \cdot (1 - F(x-1)), \quad x \in [D+1, E+1], \tag{32}$$

or

$$F(x-1) = 1 - \frac{\pi_0}{x} = 1 - \frac{\pi_0}{x-1+1}, \quad x \in [D+1, E+1], \tag{33}$$

or

$$F(x) = 1 - \frac{\pi_0}{x+1}, \quad x \in [D, E]. \tag{34}$$

The corresponding density is

$$f(x) = \frac{\pi_0}{(x+1)^2}, \quad x \in [D, E]. \tag{35}$$

Clearly

$$F(D) = 1 - \frac{\pi_0}{D+1} \geq 0 \implies D + 1 \geq \pi_0 \tag{36}$$

whereas

$$F(E) = 1 - \frac{\pi_0}{E+1}. \tag{37}$$

Now assume that $\pi_0 = D + 1$, and note that $F(E) = F(D+1)$,

$$F(E) = 1 - \frac{\pi_0}{E+1} = F(D+1) = 2 - \frac{\pi_0}{D} = 1 - \frac{1}{D}, \tag{38}$$

or,

$$1 - \frac{D+1}{E+1} = 2 - \frac{D+1}{D} = 1 - \frac{1}{D}, \tag{39}$$

or,

$$E = D^2 + D - 1. \tag{40}$$

Note that

$$E - D = D^2 - 1. \tag{41}$$

Finally,

$$\begin{gathered} F(E+1) = 2 - \frac{\pi_0}{E} = 2 - \frac{D+1}{D^2+D-1} = \frac{2D^2+2D-2-(D+1)}{D^2+D-1} = \\ \frac{2D^2+D-3}{D^2+D-1} = 1 + \frac{D^2-2}{D^2+D-1} = 1 - \frac{2-D^2}{D^2+D-1} = 1 - \alpha, \end{gathered} \tag{42}$$

where α is the size of the atom at $\bar{t}_H$. In addition,

$$\pi_0 = D + 1 = \bar{t}_H \cdot (1 - F(E)) = \bar{t}_H \cdot \frac{1}{D}, \tag{43}$$

$$(D + \frac{1}{2})^2 = \bar{t}_H + \frac{1}{4}, \tag{44}$$

$$D = \sqrt{\bar{t}_H + \frac{1}{4}} - \frac{1}{2}. \tag{45}$$

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