On the political economy of social security and public education*

Panu Poutvaara
Centre for Economic and Business Research†

March 3, 2003

Abstract

I analyze simultaneous voting on the wage tax rate and investment in public education using a model with three overlapping generations and ability differences inside each cohort. Wage tax revenue finances public education and social security benefits. I derive the results both for a once-and-for-all voting system with commitment and for repeated voting. My model allows demographic change and productivity growth. Even when cohorts are of the same size, the median voter may be a young uneducated citizen.

Keywords: Social security; Public education; Voting; Implicit intergenerational contract; Structure-induced equilibrium
JEL classification: H52; H55; D72

*The first draft of this model appeared as part of my doctoral dissertation at the University of Helsinki. An earlier version was written while I was a Marie Curie Fellow at CES at the University of Munich, whose hospitality I gratefully acknowledge. Earlier versions of this paper were presented at the ENTER Jamboree in Mannheim, February 14-17, 2001, the European Public Choice Society Annual Meeting in Paris, April 18-21, 2001, the 57^{th} International Institute of Public Finance Congress in Linz, August 27-30, 2001, the CEPR/EPRU Workshop "Dynamic Aspects of Public Expenditure" in Copenhagen, September 28-30, 2001, and at the EEA Annual Meeting in Venice, August 22-24, 2002. I am indebted to Vesa Kanniainen, Tapio Palokangas, Jukka Pirttilä, Steinar Strøm, Andreas Wagener, and conference participants for useful comments. Financial support from the Yrjö Jahnsson Foundation and from the Danish Ministry of Economic and Business Affairs is gratefully acknowledged, without implicating either for the views expressed.

†Postal address: Centre for Economic and Business Research (CEBR), Langelinie Alle 17, DK-2100 Copenhagen, Denmark. *E-mail address*: panu.poutvaara@cebr.dk.

1 Introduction

Education and social security are amongst the most important public expenditures in most developed countries. The education system to a large extent determines future human capital and is therefore crucial to productive capacity. Social security benefits are a major form of redistribution in most countries. These systems interact in individual and political decision-making, as redistribution through social security gives lower-ability individuals a claim on the future productivity of high-ability individuals. Rangel (forthcoming) and Boldrin and Montes (2002) formalize public education and pay-as-you-go social security as two parts of an intergenerational contract. In their models, all voters inside each cohort are identical. To the best of my knowledge, there are no studies analyzing the political economy of majority voting on public education and social security in the presence of ex ante visible ability differences inside each cohort.[1] As policy space is multidimensional and voters may have preferences which are not single-peaked, Condorcet winners need not exist. The aim of this paper is to analyze under what conditions they do exist. Building on earlier work by Shepsle (1979), Cooley and Soares (1999) and Conde Ruiz and Galasso (2003), I identify conditions under which public education and social security can be maintained, with

[1] Browning (1975), Boadway and Wildasin (1989), Cooley and Soares (1999), Boldrin and Rustichini (2000), Casamatta et al. (2000), Nataraj (2002) and Conde-Ruiz and Galasso (2003) present majority voting models of social security. Meltzer and Richard (1981) suggest that the share of income redistributed depends on the voting rule and on the distribution of productivity in the economy. All these contributions treat individual productivity as exogenous. Creedy and Francois (1990), Glomm and Ravikumar (1992, 2001), Fernandez and Rogerson (1995), Benabou (1996), De Fraja (2001) and Hassler et al. (2002) analyze public expenditures on education in the absence of social security.

repeated voting, by an implicit intergenerational contract relying on subgame perfect voting strategies without commitment. I also identify who form the coalitions in favor of public education and social security, respectively.

I propose a model of an economy with three overlapping generations of heterogeneous citizens. The young choose between studying and working. The middle-aged work either as educated or uneducated labor. Part of potential tax revenue is lost due to a dead-weight loss from taxation, limiting taxation below a confiscatory level. The old are retirees. The wage tax revenue is used to finance both public education for the young and social security benefits to the retirees. I restrict my analysis to a linear taxation.[2] For simplicity, I assume uniform benefits, a simplification which allows me to capture the redistributive effects of social security.[3] The citizens vote simultaneously for the wage tax rate and for the quality of public education. While modeling a simultaneous vote on both dimensions guarantees Sheple's (1979) structure-induced equilibrium in a once-and-for-all voting, the issue of whether such voting outcome could be maintained with repeating voting still persists. With repeated voting, I use the concept of stationary subgame perfect structure-induced equilibrium, developed by Conde Ruiz and Galasso (2003). This concept combines structure-induced equilibrium in a voting system with commitment to an implicit intergenerational contract.[4]

[2] Voting equilibrium may not be established by general non-linear taxation because of the possibility of Condorcet cycles.

[3] Miles and Timmermann (1999) report that the gross replacement rate was more than 10 percentage points higher for low-income workers in Belgium, Denmark, France, Greece, Ireland, Luxembourg, the Netherlands, Spain, Sweden and the United Kingdom in 1997.

[4] A related concept developed to study repeated majority voting is the notion of a Dynamic Con-

My model differs from the previous literature by analyzing the voting game on social security and public education when citizens differ in both ability and age. When citizens differ in both age and ability, a prospect of voting coalitions across cohorts arises. Furthermore, social security and public education may derive support from different constituencies. Pogue and Sgontz (1977) have already argued that the pay-as-you-go social security system provides a more powerful incentive for the current working age generations to invest in the human capital of younger generations compared to a fully-funded social security system. Konrad (1995) presents an overlapping generations model in which the old generation controls the political process. He argues that the old have an incentive to provide education and public infrastructure in order to increase social security tax revenue used to finance their benefits. Pogue and Sgontz (1977) and Konrad (1995) do not incorporate ability differences. Kaganovich and Zilcha (1999) analyze how the allocation of tax revenues between public investment in education and social security benefits affects growth and welfare. Instead of analyzing voting, they solve the optimal government policy of dividing tax revenues between funding education and social security, such that steady-state growth is maximized. Kemnitz (2000) also assumes that the government chooses the social security tax rate that will finance old-age benefits and the tax rate that will finance public education for children.

The interaction between voting on income redistribution without commitment and

dorcet Winner, developed by Bernheim and Nataraj (2002). They assume infinitely-lived agents. Using the same framework, Nataraj (2002) considers dividing a fixed surplus with overlapping generations. In my paper, however, the surplus is endogenous as it depends on investments in education.

human capital formation has been recently analyzed also by Hassler et al. (forthcoming) and Hassler (2003). Hassler et al. (forthcoming) provide an analytical characterization of Markov perfect equilibria with repeated voting on one issue, namely distortionary income redistribution. In their model, individuals invest privately in education. They find out that future constituency for redistributive policies depends positively on current redistribution. Hassler et al. (2003) argue that redistribution tends to be too persistent relative to what would have been chosen by a social planner. Hassler et al. (forthcoming) and Hassler et al. (2003) analyze voting without reputation mechanisms, while my analysis follows Cooley and Soares (1999), Boldrin and Rustichini (2000), and Conde Ruiz and Galasso (2003) by assuming that an implicit intergenerational contract is supported by a trigger strategy.

The structure of this paper is as follows. Section 2 presents the model. Section 3 examines the voting equilibrium on the wage tax rate and the investment in public education with a once-and-for all voting system and with repeated voting. Section 4 concludes the paper.

2 The Model

The structure of my model is as follows. At the first stage, individual-specific random variables related to ability are revealed. At the second stage, citizens vote separately and simultaneously on the wage tax rate and the public resources devoted to education. All cohorts participate in voting. At the third stage, citizens make their individual

decisions on a career as an educated or uneducated worker. As usual, the game is resolved backwards. Individual life-cycle, except for consumption and saving decisions, is depicted in Fig. 1.

[Fig. 1]

2.1 The Citizens

With a given proportional wage tax rate and a given quality of education, young citizens have two discrete choices: (i) investing in their human capital or (ii) entering the labor market. Those who choose investment in human capital face an opportunity cost of a lost wage income in the first period. In the second period, they enter the labor market as educated workers. Those who enter the labor market in the first period of their lives also remain uneducated in the second period.[5] The length of each period is one. I analyze a small open economy, where the citizens can buy or sell assets in international financial markets at a given world interest rate r. There is no migration. Production technology is linear in both types of labor, so that issues of complementarity and substitutability do not arise.

Citizens differ in their ability as educated workers. Ability of citizen i is denoted by a_i. The gross wage income of an educated citizen depends on his or her ability, the quality of education he or she received as young, as well as the state of the technology.

[5] I analyze a model with one educational institution called university, instead of modeling a discrete choice between several educational levels. The model could be generalized so that the "uneducated" would obtain a lower-level education.

The gross wage for a middle-aged educated citizen with ability a_i in period t, $A_t a_i q_{t-1}$, is the product of his or her ability, the quality of education provided in the previous period, q_{t-1}, and the economy-wide technology parameter, with value A_t in period t. In the rest of the paper, I omit the individual-specific subscript whenever it is not necessary. The wage for an uneducated individual is A_t in the first period of life, and $A_t u$ in the second. The productivity grows at a constant rate g, so that $A_t = (1+g)^t A_0$. The wage tax rate in period t is denoted by τ_t and social security benefits are given by b_t. The net lifetime income prospects for the two careers are summarized in Table 1.

	educated	uneducated
period 1	-	$(1-\tau_t)A_t$
period 2	$(1-\tau_{t+1})A_{t+1}aq_t$	$(1-\tau_{t+1})A_{t+1}u$
period 3	b_{t+2}	b_{t+2}

Table 1. Net income prospects in alternative careers.

Utility depends positively on consumption. Education has no non-monetary costs or benefits. As there are no borrowing constraints, utility maximization implies maximizing the net present value of resources available for consumption.[6] Income maximization yields:

Lemma 1 *In period t with an expected wage tax rate τ^e_{t+1} in the following period, the*

[6]The utility function would have to be specified without access to international capital market. With international borrowing, total consumption and investment in the economy need not equal the total production in each period.

lowest ability $\widetilde{a}_t$ *with which the citizens become educated in period* t *is given by*

$$\widetilde{a}_t(\frac{1-\tau_t}{1-\tau_{t+1}^e}, q_t) = \frac{(1+r)}{(1+g)}\frac{(1-\tau_t)}{(1-\tau_{t+1}^e)q_t} + \frac{u}{q_t}. \tag{1}$$

Proof. The expected net present value of net wage income as educated is $(1-\tau_{t+1}^e)A_{t+1}aq_t/(1+r)$ and as an uneducated $(1-\tau_t)A_t + (1-\tau_{t+1}^e)A_{t+1}u/(1+r)$. By $A_{t+1} = (1+g)A_t$, the equality of these expressions results in Lemma 1. ■

In (1), $\widetilde{a}_t$ is increasing in $\frac{1-\tau_t}{1-\tau_{t+1}^e}$ and decreasing in q_t. Therefore, expectations of a decrease in the wage tax rate, that is, a decrease in τ_{t+1}^e, would decrease the cutoff level of ability, as would increases in the quality of education provided.

In each period, there are three overlapping generations. The measure of a cohort being young in period t is denoted by N_t. Cohort size may grow at a constant rate n, $n \geq 0$, so that $N_t = (1+n)^t N_0$. Citizens are heterogeneous in their ability. The individual-specific ability variable follows in each period the same continuous distribution in an interval, $a \in [0, \overline{a}]$. This distributional assumption guarantees that at any level of educational investment, there are always some individuals who do not attend university. While the model could be analyzed with arbitrary values of r, g and n, it is reasonable to assume that $r \geq g + n + ng \geq 0$. This ensures that the economy is dynamically efficient. I also assume that $n < \frac{\sqrt{5}-1}{2} = 0.6$. This guarantees that the young do not form a majority of population.

2.2 The Government's Budget Constraint

With an expectation that the wage tax rate chosen in the current period will be maintained in future, educational decisions depend only on the quality of education provided and individual ability. I assume that providing education requires only human capital of teachers and professors, the cost of which grows at the same rate as general productivity.[7] The resource cost of human capital for providing education per cohort size of one, C, is increasing in its quality, q_t. The resource cost function satisfies the following conditions:

$$C(0) = 0, C'(q_t) > 0, C''(q_t) \geq 0. \tag{2}$$

The cost of providing public education of quality q_t is then $A_t N_t C(q_t)$.[8] The government budget constraint with a pay-as-you-go system must allow tax rates for the young to differ from the tax rates faced by the middle-aged in their youth, otherwise the voting game could not be analyzed. Therefore, it is necessary to include time subscripts. I also assume that q_t is restricted to a given interval $0 \leq q_t \leq \overline{q}$. Here $\overline{q}$ is assumed to be so costly to produce that the marginal cost of providing the quality of education at that level would exceed the gain from increased productivity of those to be educated.

I restrict my analysis to equilibria in which citizens expect the wage tax rate that

[7] As the costs of university tuition have risen often even faster than the general price level, this seems a reasonable first approximation.

[8] The term $N_t C(q_t)$ is the resource cost, in terms of human capital of professors, of providing education of quality q_t to a cohort of size N_t, while A_t reflects the productivity of human capital outside education sector, and is therefore equal to its wage rate.

they vote for to be in place permanently, or to revert to zero in case of a deviation from the equilibrium to be specified. This corresponds to the trigger strategy specified in the following section. This implies that in the steady-state, the previous generation made their educational choices in period $t-1$ assuming that the wage tax rate in period t would be the same as in period $t-1$. From equation (1), this implies that $\widetilde{a}_{t-1} = \frac{(1+r)}{(1+g)q_{t-1}} + \frac{u}{q_{t-1}}$. In order to analyze out-of-equilibrium behavior of the economy, one must take into account that $\widetilde{a}_t$ depends on the expectations concerning the future wage tax rate. The current wage tax revenue is given by

$$\begin{aligned} R_t(\tau_t, \tau^e_{t+1}, q_t, q_{t-1}) &= \tau_t \left[1 - L(\tau_t)\right] A_t N_t F(\widetilde{a}_t) \\ &\quad + \tau_t \left[1 - L(\tau_t)\right] A_t N_{t-1} F\left(\frac{(1+r)}{(1+g)q_{t-1}} + \frac{u}{q_{t-1}}\right) u \\ &\quad + \tau_t \left[1 - L(\tau_t)\right] A_t N_{t-1} q_{t-1} \int_{a=\frac{(1+r)}{(1+g)q_{t-1}}+\frac{u}{q_{t-1}}}^{\overline{a}} a f(a) da. \end{aligned}$$

where $f(a)$ is the density function of a and $F(a)$ its cumulative distribution function. Both are measured with respect to a cohort size of unity, so that the expressions for tax revenue include the measures of cohort size. $L(\tau)$ denotes the share of tax revenue lost due to the dead-weight loss associated with taxation where the tax rate is τ.[9] For simplicity, I assume that the share of income lost is the same for each cohort in the first and the second period. The first term gives the tax revenue received from the young uneducated, the second term gives the tax revenue from the middle-aged uneducated

[9] Those indifferent to education become educated. As the mass associated with any single point is zero, this assumption is inconsequential.

and the third term gives the tax revenue from the middle-aged educated. I assume that wage tax revenue is a concave function of the wage tax rate and has a Laffer curve shape. Realized wage tax revenue is zero both with a wage tax rate of 0 and a wage tax rate of 1, and there is a wage tax rate of $\widetilde{\tau}$, where $0 < \widetilde{\tau} < 1$, which maximizes the wage tax revenue. Formally,

$$\begin{aligned} 0 &\leq L'(\tau) \leq 1, \text{and } \exists \widetilde{\tau}, 0 < \widetilde{\tau} < 1 : \\ \frac{d}{d\tau}\{\tau[1 - L(\tau)]\} &\geq 0 \text{ when } \tau \leq \widetilde{\tau} \text{ and} \\ \frac{d}{d\tau}\{\tau[1 - L(\tau)]\} &\leq 0 \text{ when } \tau \geq \widetilde{\tau}. \end{aligned}$$

The government budget constraint states that the realized tax revenue R_t has to equal the sum of the costs of educational investment $A_t N_t C(q_t)$ and social security benefits of b_t per member of the cohort of the size N_{t-2}: $R_t(\tau_t, \tau^e_{t+1}, q_t, q_{t-1}) = A_t N_t C(q_t) + N_{t-2} b_t$. Social security benefits can be solved as a function of τ_t, τ^e_{t+1}, q_t, and q_{t-1}:

$$b_t(\tau_t, \tau^e_{t+1}, q_t, q_{t-1}) = \frac{R_t(\tau_t, \tau^e_{t+1}, q_t, q_{t-1}) - A_t N_t C(q_t)}{N_{t-2}}. \tag{3}$$

Financing education from the tax revenue used to finance social security benefits instead of having separate tax rates for the two captures the idea of competing uses for the tax revenue. It is not required that $b_t > 0$. If $\tau_t = 0$ and education is publicly financed, b_t would be negative by the government's budget constraint. However, it turns out that in equilibrium, b_t is never negative.

3 Political Equilibria

When citizens decide the wage tax rate and the quality of public education, the problem of multidimensionality arises. The preferences cannot be guaranteed to be single-peaked, and the preferences toward the wage tax rate and the quality of education are not perfectly correlated. This implies that there need not be a Condorcet winner if the citizens would vote on any combination of q and τ without any restrictions. However, the political process always imposes some restrictions on decision-making. Shepsle (1979) shows that including the voting rules can generate a structure-induced equilibrium even when unrestricted voting would not result in a Condorcet winner. I assume that the wage tax rate and the quality of education are chosen simultaneously by a majority vote. When voting on the wage tax rate (the quality of education), citizens have to make a conjecture on the outcome of voting on the quality of education (the wage tax rate). With rational expectations, the outcome of the voting game validates these conjectures. I assume that citizens vote in each policy dimension for their preferred alternative without abstention.[10] Assuming a simultaneous majority vote on the two issues generates a structure-induced equilibrium.

If voting behavior in any given period would not affect voting behavior in sub-

[10]Here I follow Cooley and Soares (1999) who analyze voting on whether to maintain the social security system. As citizens of measure zero would not have an economic incentive to vote with any positive voting cost if voting does not generate any other benefit in addition to its expected effect on the policy adopted, sincere voting has to be assumed. This does not seem a too restrictive assumption, as citizens cannot gain by misrepresenting their preferences. Sincere voting weakly dominates other voting strategies when voting is costless, as it would result in the better outcome than any other voting strategy if the individual's vote would be decisive and would not result in a worse outcome if this were not the case.

sequent periods, then social security and provision of public education could not be maintained with majority voting. The young and the middle-aged would prefer to have no social security benefits in place as long as they are working, and a wage tax rate that maximizes the social security benefits when they are retired.[11] If the retired are not in a majority, positive tax rates would result from the political process only when there is an explicit or implicit intergenerational contract. Such a mechanism is proposed by Cooley and Soares (1999) where a sufficient number of those workers who would gain from social security when retired are also prepared to vote in favor of social security before their retirement. But such a social contract would imply that voting takes place so that voters expect the resulting social security system to be permanent. I derive a structure-induced equilibrium first with a once-and-for-all voting system. Then I analyze repeated voting. I ask under what conditions there exists a stationary subgame perfect structure induced equilibrium, as defined by Conde Ruiz and Galasso (2003). The maintenance of a social security system and public education when there is repeated voting relies on a trigger strategy saying that if the intergenerational contract is breached, then it no longer applies and all citizens vote in each period for their preferred alternative in that period.

[11] In my formulation, the wage tax rate would be zero, implying that b_t would be negative in order to finance a public provision of education, if any.

3.1 A Once-and-for-all Voting System

I analyze simultaneous voting on the wage tax rate and public education when each generation assumes that the τ_t and q_t chosen will be in place permanently. Therefore, there is commitment to maintaining the voting outcome in future periods. In the next section, I generalize my results to repeated voting.

Definition 1 *A structure-induced equilibrium in voting with commitment to maintaining the voting outcome in period t is, with a given quality of education in the previous period, q_{t-1}, such a pair of $\widehat{q}_t$ and $\widehat{\tau}_t$ that:*
(i) when citizens expect that the quality of education chosen will be $\widehat{q}_t$, $\widehat{\tau}_t$ is a Condorcet winner when voting on the wage tax rate
(ii) when citizens expect that the wage tax rate chosen will be $\widehat{\tau}_t$, $\widehat{q}_t$ is a Condorcet winner when voting on the quality of education.

With commitment, $\widehat{q}_{t+i} = \widehat{q}_t$, $\widehat{\tau}_{t+i} = \widehat{\tau}_t \forall i \in \{1, 2, 3, ...\}$. This definition implies that

$$\widetilde{a}_t = \frac{(1+r)}{(1+g)\widehat{q}_t} + \frac{u}{\widehat{q}_t} = \widetilde{a}_{t+i} \forall i \in \{1, 2, 3...\}. \tag{4}$$

As the tax revenue, R_t, and the cost of providing public education, $A_t N_t C(q_t)$, grow at the same rate, so does their difference, $N_{t-2} b_t$. By $A_t = (1+g)^t A_0$, $N_t = (1+n)^t N_0$

and (3), future social security benefits are given by

$$b_{t+i} = (1+g)^{i-1} b_{t+1}(\widehat{\tau}_t, \widehat{\tau}_t, \widehat{q}_t, \widehat{q}_t) \forall i \in \{1, 2, 3...\}. \tag{5}$$

This implies

Lemma 2 $\forall \widehat{\tau}_t$: *if* $\widehat{q}_t = \arg \max_{q_t \in [0,\overline{q}]} b_{t+1}(\widehat{\tau}_t, \widehat{\tau}_t, q_t, q_t)$, *then* $\widehat{q}_t = \arg \max_{q_t \in [0,\overline{q}]} b_{t+i}(\widehat{\tau}_t, \widehat{\tau}_t, q_t, q_t)$ $\forall i \in \{1, 2, 3, ...\}$.

Proof. Follows as multiplier $(1+g)^{i-1}$ in (5) does not depend on q_t. ■

By Lemma 2, the same value of q_t which maximizes social security benefits with a given τ_t in the following period, maximizes social security benefits with the same τ_t in all future periods. For the old voting in period t, however, social security benefits are given by

$$b_t(\widehat{\tau}_t, \widehat{\tau}_t, \widehat{q}_t, q_{t-1}) = \frac{R_t(\widehat{\tau}_t, \widehat{\tau}_t, \widehat{q}_t, q_{t-1}) - A_t N_t C(\widehat{q}_t)}{N_{t-2}}.$$

It is worth emphasizing the double role of individuals. As citizens, they vote for the τ and q they would prefer, given the conjecture they make on the equilibrium in voting in the other dimension. As consumer-producers, they take the voting outcome as given when making their career choices. The citizens vote in order to maximize the net present value of their current and future incomes. I denote the value of this function as corresponding to the political equilibrium for a citizen of age k, k being y for the young, m for the middle-aged and o for the old, by V^k. For the young citizens,

V^y depends on the individual's own ability a, the quality of education q_t and the wage tax rate τ_t. In case of becoming educated, V_t^y is given by

$$V_t^y(a, q_t, \tau_t) = \frac{(1-\tau_t)A_{t+1}aq_t}{1+r} + \frac{b_{t+2}(\tau_t, \tau_t, q_t, q_t)}{(1+r)^2},$$

whereas for those who remain uneducated, it becomes:

$$V_t^y(a, q_t, \tau_t) = (1-\tau_t)A_t + \frac{(1-\tau_t)A_{t+1}u}{1+r} + \frac{b_{t+2}(\tau_t, \tau_t, q_t, q_t)}{(1+r)^2}.$$

The preferred quality of education and wage tax rate for a young citizen with ability a are given by

$$\begin{aligned} q_t^*(\widehat{\tau}_t) &= \arg\max_{q_t \in [0,\overline{q}]} V_t^y(a, q_t, \widehat{\tau}_t) \\ \tau_t^*(\widehat{q}_t) &= \arg\max_{\tau_t \in [0,1]} V_t^y(a, \widehat{q}_t, \tau_t). \end{aligned}$$

These reaction functions specify the preferred choice in one dimension conditional on the equilibrium outcome in the other dimension. Note that the preferences of the young on the quality of education are not single-peaked. With a conjecture $\widehat{\tau}_t$ assumed to be in place permanently, there is a cut-off level of q_t at which the citizen would be indifferent between becoming educated or not. Denote this cut-off level by q_t^c. If a citizen does not become educated, he or she prefers the quality of education which maximizes the social security benefits, that is, satisfies $q_t^l = \arg\max_{q_t \in [0,\overline{q}]} b_{t+2}$. If

a citizen becomes educated, then he or she prefers the quality of education satisfying $q_t^h = \arg\max_{q_t \in [0,\overline{q}]} \left[\frac{(1-\tau_t)A_{t+1}a}{1+r} + \frac{1}{(1+r)^2} b_{t+2} \right]$. Clearly, $q_t^h > q_t^l$.[12] For a citizen who has a marginally lower ability than a citizen with the cut-off level of ability $q_t^l < q_t^c$ and also $q_t^h > q_t^c$. The preferences are not single-peaked as $q_t^l < q_t^c < q_t^h$ and, however, both q_t^l and q_t^h are preferred to q_t^c.

For the middle-aged, the income received and the taxes paid in the previous period as well as the educational choice made then are sunk. I assume that when the educational choice was made in the period $t-1$, it was made assuming then that the wage tax rate in place then would be in place also in period t. Formally, $\widetilde{a}_{t-1}$ was given by equation (1) under the assumption that $\tau_t^e = \tau_{t-1}$. In other words, the voting taking place in period t was not anticipated in period $t-1$. Therefore, V_t^m is given by

$$\begin{aligned} V_t^m &= (1-\tau_t)A_t u + \frac{b_{t+1}(\tau_t, \tau_t, q_t, q_t)}{1+r} \text{ for those with } a < \frac{(1+r)}{(1+g)q_{t-1}} + \frac{u}{q_{t-1}} \\ V_t^m &= (1-\tau_t)A_t a q_{t-1} + \frac{b_{t+1}(\tau_t, \tau_t, q_t, q_t)}{1+r} \text{ for those with } a \geq \frac{(1+r)}{(1+g)q_{t-1}} + \frac{u}{q_{t-1}}. \end{aligned}$$

[12] If b_{t+1} would be assumed to be differentiable in q_t, this would follow from assuming b_{t+1} to be a concave function. However, even such an assumption is not required. All young citizens benefit from q_t indirectly in the form of higher tax revenue in future, and bear costs as providing q_t competes for the same tax revenue as their future social security benefits. As private benefits of q_t and the costs of providing it are increasing continuous functions, those young deriving private benefit from q_t directly in the form of higher future wages find it always optimal to support at least a slightly higher quality of education than those who do not.

The preferred quality of education and wage tax rate for a middle-aged citizen with ability a are given by

$$\begin{aligned} q_t^*(\widehat{\tau}_t) &= \arg\max_{q_t\in[0,\overline{q}]} V_t^m(a, q_t, q_{t-1}, \widehat{\tau}_t) \\ \tau_t^*(\widehat{q}_t) &= \arg\max_{\tau_t\in[0,1]} V_t^m(a, \widehat{q}_t, q_{t-1}, \tau_t). \end{aligned}$$

The optimal quality of education preferred by the middle-aged is, independently of whether they are educated or not, such that solving $q_t^m = \arg\max_{q_t\in[0,\overline{q}]} b_{t+1}$.

The value function of public policies for the old is given by

$$V_t^o(q_t, q_{t-1}, \tau_t) = \frac{R_t(\tau_t, \tau_t, q_t, q_{t-1}) - A_t N_t C(q_t)}{N_{t-2}}.$$

Therefore, the preferred quality of education and wage tax rate for any old citizen are given by

$$\begin{aligned} q_t^*(\widehat{\tau}_t) &= \arg\max_{q_t\in[0,\overline{q}]} V_t^o(q_t, q_{t-1}, \widehat{\tau}_t) \\ \tau_t^*(\widehat{q}_t) &= \arg\max_{\tau_t\in[0,1]} V_t^o(\widehat{q}_t, q_{t-1}, \tau_t). \end{aligned}$$

The old oppose any provision of public education, thereby voting for $q_t = 0$. They lose from public education both directly as the financing of public education competes for the same tax revenue as social security benefits, and indirectly as a higher quality of public education induces a greater part of the young to invest in education, which

in turn decreases the wage tax revenue from the young. All the benefits from public education accrue only after the old have died. Even though the young have non-monotonous preferences concerning the quality of public education, it is possible to establish that:

Lemma 3 *In any structure-induced equilibrium, the quality of education is chosen in order to maximize the future social security benefits.*

Proof. With any given conjecture of $\widehat{\tau}_t$ on the wage tax rate, the middle-aged and the young who remain uneducated vote for the quality of education that maximizes social security benefits in future periods. By Lemma 2 and the argumentation given above, they vote for the same quality of education. The old vote for a zero quality of education and the young who are going to become educated for a higher quality of education than the middle-aged. As the old and the young who are going to become educated are always in minority by the assumption $0 \leq n < \frac{\sqrt{5}-1}{2}$, the quality of education satisfying $\widehat{q}_t = \arg\max_{q_t \in [0,\overline{q}]} b_{t+1} = \arg\max_{q_t \in [0,\overline{q}]} b_{t+2}$ is a Condorcet winner. ■

By the concavity of R_t, it is in the interest of all citizens to vote for a wage tax rate with which the net present value of their marginal remaining tax payment equals the net present value of the implied marginal increase in the benefits they receive. For a young citizen with ability a and going to become educated, this implies voting for τ_t satisfying

$$-\frac{A_{t+1} a q_t}{1+r} + \frac{\partial}{\partial \tau_t} \frac{b_{t+2}(\tau_t, \tau_t, \widehat{q}_t, \widehat{q}_t)}{(1+r)^2} = 0. \tag{6}$$

For a middle-aged educated citizen with the same ability and having received a quality of education $\widehat{q}_t$, this implies voting for τ_t satisfying

$$-A_t a\widehat{q}_t + \frac{\partial}{\partial \tau_t}\frac{b_{t+1}(\tau_t, \tau_t, \widehat{q}_t, \widehat{q}_t)}{(1+r)} = 0. \tag{7}$$

These imply

Lemma 4 *With all n, g, and r, those young to be educated and those middle-aged who are already educated vote for the same wage tax rate, if they have the same abilities, and $q_{t-1} = \widehat{q}_t$.*

Proof. Follows from (6) and (7) by (5) and $A_{t+1} = (1+g)A_t$. ■

Furthermore,

Lemma 5 *The young who remain uneducated vote for the same wage tax rate as the citizens with lowest ability who are going to become educated.*

Proof. The young who remain uneducated vote for τ_t to satisfy

$$-A_t - \frac{A_{t+1}u}{(1+r)} + \frac{\partial}{\partial \tau_t}\frac{b_{t+2}(\tau_t, \tau_t, \widehat{q}_t, \widehat{q}_t)}{(1+r)^2} = 0.$$

Substituting (4) into (6) shows that the young to be educated with the lowest ability vote for τ_t to satisfy the same expression as the young who remain uneducated. ■

Lemma 6 *The middle-aged uneducated vote for a higher wage tax rate than the young uneducated with any $\widehat{q}_t$.*

Proof. As the marginal benefit of an increase in the wage tax rate is the same for the young and for the middle-aged and the marginal cost is increasing in the remaining lifetime wage income, those with higher remaining lifetime wage income always favor a lower wage tax rate. ■

We can next derive

Proposition 1 *In any structure induced equilibrium* $(\widehat{q}_t, \widehat{\tau}_t)$*, the wage tax rate* $\widehat{\tau}_t$ *is that preferred, under conjecture* $q_t = \widehat{q}_t$*, by the citizen with the median net present value of remaining lifetime income, while* $\widehat{q}_t = \arg \max_{q_t \in [0,\overline{q}]} b_{t+1}(\widehat{\tau}_t, \widehat{\tau}_t, q_t, q_t)$*.*

Proof. Follows from Lemmas 3-6. Lemmas 4,5, and 6 show that the wage tax rate preferred by the young and the middle-aged is a decreasing function of the net present value of their remaining lifetime wage income. As the old favor a higher wage tax rate, Condorcet winner on wage tax rate is that preferred by the citizen with the median net present value of remaining lifetime income. ■

The existence of a structure-induced equilibrium with a once-and-for-all voting system does not guarantee that such an equilibrium would be maintained if the voting were repeated. An equilibrium which in the future would be opposed by a majority of voters is not a plausible outcome with democratic voting. I next introduce

Definition 2 *A combination of* $(\widehat{q}_t, \widehat{\tau}_t)$ *is a steady-state structure-induced equilibrium (SSSIE) if it is a structure-induced equilibrium when* $q_{t-1} = \widehat{q}_t$*.*

In a SSSIE the outcome of the voting would not change even if the ballot were unexpectedly repeated in future. In other words, the combination of q and τ would, in every period, be supported by a majority of citizens. Whether there is a SSSIE depends on the distribution of a, as well as on $C(q)$, $L(\tau)$, u, n, g, and r. The possible SSSIE are given by

Proposition 2 *If $(\widehat{q}_t, \widehat{\tau}_t)$ is a steady-state structure-induced equilibrium, then the median voter on both q_t and τ_t is, with $q_{t-1} = \widehat{q}_t$,*

(i) a middle-aged uneducated citizen if at least the share $\frac{1+3n+n^2}{2+2n}$ of each cohort remain uneducated with $\widehat{q}_t$;

(ii) a young uneducated citizen if at least the share $\frac{1+3n+n^2}{4+6n+2n^2}$ but less than the share $\frac{1+3n+n^2}{2+2n}$ of each cohort remain uneducated with $\widehat{q}_t$;

(iii) a middle-aged educated citizen whose ability a_{iii} is given by $F(a_{iii}) = \frac{1+3n+n^2}{4+6n+2n^2}$ if less than the share $\frac{1+3n+n^2}{4+6n+2n^2}$ of each cohort remain uneducated with $\widehat{q}_t$.

Proof. Proof is given in Appendix A. ■

With $n = 0$, the population shares in Proposition 2 simplify so that a middle-aged uneducated citizen is the median voter if majority of each cohort remain uneducated, and a young uneducated citizen is a median voter if at least a quarter but less than one half of each cohort remains uneducated. If their share is less, then the median voter is a middle-aged educated citizen chose ability is at the lowest quartile of ability distribution.

Even though there is a citizen, or a group of citizens, who is a median voter on both dimensions, such a median voter is supported by different groups in the maintaining of public education and wage taxation, respectively. The elderly always support wage taxation while opposing public education. Again, it is not possible to exclude the possibility of more than one SSSIE. A given ability distribution may support different equilibria, depending on the initial situation. Take, for example, regimes (i) and (ii). In regime (i), the remaining gross income of the median voter is $A_t u$, whereas in regime (ii), it is $A_t + \frac{A_{t+1} u}{1+r}$. Therefore, the median voter would tend to support, at any given quality of education, a higher level of taxation in regime (i). If this causes a sufficiently high level of distortions, then it might be optimal to choose a lower quality of education in regime (i) than in regime (ii). In regime (i), the economy could then maintain itself in an equilibrium with a higher wage tax rate and a lower quality of education. However, it is possible that if starting from regime (ii), the economy would remain there, because as the quality of education would be higher, this would stimulate a greater proportion of the population to become educated.

Furthermore, it is not even possible to guarantee the existence of a SSSIE. With some combinations of ability distribution and production technology, the voting game could have a tendency to cycle, if voting were repeated unexpectedly. Instability may occur if the median voter would have an interest with commitment to support a redistributive scheme which would produce a different median voter in the following period,

and if voting were unexpectedly repeated.[13] However, if a sufficiently small part of population becomes educated, it is possible to establish that:

Proposition 3 *If the ability distribution and the production technology for educational quality are such that more than the share* $\frac{1+3n+n^2}{2+2n}$ *of each cohort always remains uneducated, then there exists a SSSIE in which the median voter belongs to the group of middle-aged uneducated citizens. If the ability distribution and production technology are such that at least the share* $\frac{1+3n+n^2}{4+6n+2n^2}$ *but less than the share* $\frac{1+3n+n^2}{2+2n}$ *of each cohort remain uneducated, then there exists a SSSIE in which the median voter is a young uneducated citizen.*

Proof. *In both special cases, the identity of the median voter is constant. Then the combination of the wage tax rate and the quality of education preferred by such a voter is the Condorcet winner.* ■

3.2 Repeated Voting

In this section, I analyze an economy in which voting on q and τ takes place in every period. The main question is whether it is possible to sustain the same voting equilibrium in a system using repeated voting as in one with a once-and-for-all voting. The equilibrium is now maintained by an implicit intergenerational contract supported by a suitable trigger strategy, instead of by commitment.

[13] Hassler et al. (forthcoming) provide an example in which the majority may purposefully vote for policies changing the identity of the median voter in future. They analyze Markov perfect equilibria with repeated voting on redistribution in each period. In their model, agents live for two periods.

As an equilibrium concept, I use a stationary subgame perfect structure induced equilibrium defined by Conde Ruiz and Galasso (2003).[14] Such an equilibrium combines the idea of a structure-induced equilibrium introduced by Shepsle (1979) with the idea of an implicit intergenerational contract. A strategy for an individual is a mapping from the history of the voting outcomes to the wage tax rate τ_t and the quality of public education q_t that the individual votes for, and is subject to $\tau_t \in [0,1]$ and $q_t \in [0,\overline{q}]$. Let s_t^k be the voting strategy profile over τ_t and q_t of all individuals belonging to generation k in period t. Here k can be either y (young), m (middle-aged) or o (old). As the realized income of the middle-aged depends on the quality of education in the previous period, I denote their voting strategy by $s_t^k(q_{t-1})$ to make explicit that their voting strategy in period t depends on the quality of education in period $t-1$. Denote the first period when the game is played and when the equilibrium strategy may be established, with the education of the middle-aged corresponding to the long-run equilibrium, by 0. The history of the game at period t, h_t, reports those combinations of q and τ chosen in all previous periods starting from $t = 0$: $h_t = \{(q_0,\tau_0),(q_1,\tau_1),...,(q_{t-2},\tau_{t-2}),(q_{t-1},\tau_{t-1})\}$ when $t > 0$. The set of all possible past outcomes at time t is denoted by H_t. The following formal definition is taken, with slight modifications, from Conde Ruiz and Galasso (2003):

[14] Conde Ruiz and Galasso analyze simultanous voting on the tax rate and early retirement provisions. They restrict the decision on early retirement provisions to a binary choice between full benefits or no benefits at all, whereas I analyze a two-dimensional policy space with a continuum of alternatives in both dimensions.

Definition 3 *A voting strategy profile* $s = \{(s_t^y \cup s_t^m \cup s_t^o)\}_{t=0}^{\infty}$ *is a stationary subgame perfect structure-induced equilibrium (SSPSIE), if the following conditions are satisfied:*

(i) s *is a subgame perfect equilibrium.*

(ii) At every period t*, the equilibrium outcome associated with* s *is a structure-induced equilibrium of the static game with commitment.*

(iii) In any period and for any history, $h_t \in H_t$*, the sequence of equilibrium outcomes induced by* s *is constant.*

Conde Ruiz and Galasso (2003) assume a trigger strategy, specifying that the voting outcome converges to a complete abolition of the social security system in the case of the result in one period differing from the subgame perfect equilibrium with a once-and-for-all voting. In an intergenerational game with public provision of education, such a threat strategy would not always maintain the subgame perfect structure-induced equilibrium, resulting from once-and-for-all voting, when there is instead repeated voting. The reason for this is that the high-ability young citizens with higher than average income would like to have wage taxation eliminated after they have completed their education. With a threat strategy demanding a zero wage taxation following any deviation, the young expecting to pay more in taxes than they receive back in social security benefits may find it optimal to deviate. With a once-and-for-all voting system, they prefer a lower wage tax rate than the median voter. By voting for a higher wage tax rate than the median voter, they would change the identity of the median voter in regime (iii) of Proposition 2. In this way, they would cause an upward deviation in

wage taxation during their youth when they do not pay taxes, triggering an elimination of public expenditures in the following period when they would otherwise pay taxes. However, there is a threat strategy which allows the outcome of once-and-for-all voting to be maintained also with repeated voting. This is:

Definition 4 *In the implicit intergenerational contract voting strategy (IICVS) related to an equilibrium* $(\widehat{q},\widehat{\tau})$*, a citizen* i*, who prefers* $q_t^i(\widehat{\tau})$ *and* $\tau_t^i(\widehat{q})$ *in a once-and-for-all voting, votes for this quality of education and wage tax rate in period* $t=0$*, as well as in period* $t>0$*, provided that the history for the previous periods satisfies* $q_j=\widehat{q}$ $\forall j\in\{0,1,...,t-1\}$ *and* $\tau_j\geq\widehat{\tau}\,\forall j\in\{0,1,...,t-1\}$*. If these conditions are not satisfied, the citizen votes for the* τ_t *and* q_t *he or she preferred in period* t*, assuming that the (other) young and middle-aged citizens no longer vote for a positive wage tax rate due to the collapse of the implicit intergenerational contract. The individual-specific superscript* i *captures both age and ability.*

IICVS states that any other deviation from the intergenerational contract except for a deviation to a higher wage tax rate than associated with the implicit contract leads to the break-down of the intergenerational contract. Once the trust in the maintenance of the intergenerational transfer institutions is lost, they will collapse. If voting in some period would produce a higher wage tax rate than in the equilibrium, then the IICVS specifies that this does not violate the contract. Neither does it give a reason for changing the q and τ specified by the contract. Intuitively, working generations

are not punished by an abolition of future social security if their voting would lead to paying higher social security benefits than specified by the contract.[15] The strategy I specify turns out to be sufficient to support a SSSIE also with repeated voting:

Proposition 4 *If there exists a SSSIE* $(\widehat{q},\widehat{\tau})$ *with a once-and-for-all voting system, then this same equilibrium is maintained as a SSPSIE with IICVS.*

Proof. Proof is given in Appendix B. ■

4 Conclusion

I have analyzed simultaneous voting on the wage tax rate and investment in public education in a "European" economy in which the private cost of education is limited to the opportunity cost of lost wage income. The part of the tax revenue which is not used to finance public education is distributed to the old as social security benefits. When voting, citizens choose an optimal policy in each dimension, the wage tax rate and the quality of public education, subject to a conjecture of the outcome in the other dimension. In any equilibrium with a pay-as-you-go system, the median voter is supported by the old in the maintenance of the wage taxation and opposed by the

[15] An alternative trigger strategy would specify that all agents vote for $q = 0$ and $\tau = 0$ if the contract has been violated in the previous period. While this would lead to the same outcome as the strategy I have specified, voting for $q = 0$ is weakly dominated by voting for $\widehat{q}(0)$ for the young with high abilities who would like to become educated. Likewise, for the old voting for $\tau = 0$ is weakly dominated by voting for the rate of τ which maximizes the wage tax revenue for the social security benefits. In the trigger strategy I specify, no citizen votes for a weakly dominated strategy.

old in the maintenance of public education. The middle-aged support, independently of their ability, the same quality of education that maximizes social security benefits in any steady-state equilibrium associated with a pay-as-you-go system. That quality of education is the Condorcet winner as long as both the young and the old are in minority. An interesting avenue for further research would be to study a richer model of the political process, for example by allowing interest group formation and negotiation between groups representing citizens of different ages and abilities. Another extension would be to allow for uncertainty concerning lifespan or income.

There may be more than one steady-state structure-induced political equilibrium in which the voting takes place only once with commitment, but the outcome of the voting would not change if the voting were unexpectedly repeated in some future period. In the possible equilibria, the median voter is either a middle-aged uneducated, a young uneducated or a middle-aged educated citizen. If there is such an equilibrium, then there is an implicit intergenerational contract which can maintain this equilibrium as a stationary subgame perfect structure induced equilibrium with repeated voting. This implicit intergenerational contract requires citizens to vote for their preferred alternative with once-and-for-all voting also with repeated voting. The implicit intergenerational contract that I identify can be maintained with sustained demographic change and productivity growth, provided that the productivity of the educated as well as that of the uneducated grow at the same rate as the costs of providing education of a given quality.

Appendix A. Proof of Proposition 2

As the quality of education chosen is given by Lemma 3 and is that preferred by the claimed median voter in each regime, it suffices to analyze voting on the wage tax rate. In period t, there are $(1+n)^2 N_{t-2}$ young citizens, $(1+n)N_{t-2}$ middle-aged citizens and N_{t-2} old citizens. Therefore total population size is $(3+3n+n^2)N_{t-2}$.

(i) $\frac{1+3n+n^2}{2+2n}(1+n)N_{t-2} + N_{t-2} = (3+3n+n^2)N_{t-2}/2$, and therefore the old and the middle-aged uneducated alone are sufficient to form a majority. All other voters would prefer a lower wage tax rate by Lemmas 4, 5, and 6.

(ii) The old and the middle-aged uneducated alone are not enough to form a majority in this case. Together with a sufficient number of the young uneducated, they form the majority. Median voter is then young uneducated citizen by Lemmas 4, 5, and 6.

(iii) Those young and middle-aged educated with ability higher (lower) than a_{iii} favor a lower (higher) wage tax rate by Lemmas 4, 5, and 6. As $\frac{1+3n+n^2}{4+6n+2n^2}(1+n)^2 N_{t-2} + \frac{1+3n+n^2}{4+6n+2n^2}(1+n)N_{t-2} + N_{t-2} = (3+3n+n^2)N_{t-2}/2$, the citizen with ability a_{iii} is now a median voter. As the quality of education chosen is that preferred by the middle-aged and the young uneducated, the median voter is a middle-aged citizen with ability a_{iii} and not a young citizen with a_{iii}, the latter preferring a higher q.

Appendix B. Proof of Proposition 4

Assume that $(\widehat{q}, \widehat{\tau})$ is a SSSIE with voting with commitment. It is sufficient to prove that with IICVS, the citizens either do not want to deviate or if they would like to

deviate, then their deviation does not change the outcome of the voting in a way that would result in the collapse of the intergenerational contract. The old have clearly no interest in deviating from voting for the τ and q which would maximize their current social security benefits. Neither do the middle-aged have any incentive to deviate from the τ and q they would prefer with commitment. A deviation downward in the wage tax rate or the quality of education would only result in them losing their social security benefits in the following period. The young uneducated, on the other hand, already vote for the q and t that would maximize their lifetime utility, so they have no incentive to deviate. As for the young citizens who are going to become educated, they are in any case in minority when voting on the quality of education, so any deviation in that dimension by them would have no effect on the voting outcome. When voting on the wage tax rate, the young who are going to lose from income redistribution would prefer to have the wage taxation and public provision of education abolished in future. However, they are already voting for a lower wage tax rate than the median voter, so that any deviation downward would not affect the outcome of the voting. The only way in which the young who prefer a lower wage tax rate than that preferred by the median voter can change the outcome of voting is by voting for a higher wage tax rate than that preferred by the median voter. By the definition of IICVS, a deviation upward would not cause the abolition of wage taxation and public provision of education. Therefore, the young who will become educated cannot gain anything by deviating from voting for their preferred wage tax rate with once-and-for-all voting. The threat

point of the voting equilibrium $(0, 0)$ following a punishable deviation is also a subgame perfect Nash-equilibrium. If the young and the middle-aged expect that social security benefits will not be maintained in future, they have no interest in maintaining them after a deviation. This implies that the middle-aged would join the old in opposing any investment in public education. The old would still vote for $\tau > 0$ and the young with high ability for $q > 0$, but both are in minority.

References

[1] Benabou, R., 1996. Heterogeneity, stratification, and growth: Macroeconomic implications of community structure and school finance. American Economic Review 86, 584-609.

[2] Bernheim, B.D., Nataraj, S., 2002. A solution concept for dynamic problems in political economy. Manuscript. Stanford University.

[3] Boadway, R.W., Wildasin, D.E., 1999. A median voter model of social security. International Economic Review 30, 307-328.

[4] Boldrin, M., Montes, A., 2002. The intergenerational state. Education and pensions. Manuscript. University of Minnesota, Department of Economics.

[5] Boldrin, M., Rustichini, A., 2000. Political equilibria with social security. Review of Economic Dynamics 3, 41-78.

[6] Browning, E.K., 1975. Why the social insurance budget is too large in a democratic society. Economic Inquiry 13, 373-388.

[7] Casamatta, G., Cremer, H., Pestieau, P., 2000. The political economy of social security. Scandinavian Journal of Economics 102, 503-522.

[8] Conde Ruiz, J.I., Galasso, V., 2003. Early retirement. Review of Economic Dynamics 6, 12-36.

[9] Cooley, T.F., Soares, J., 1999. A positive theory of social security based on reputation. Journal of Political Economy 107, 135-160.

[10] Creedy, J., Francois, P., 1990. Financing higher education and majority voting. Journal of Public Economics 42, 181-200.

[11] De Fraja, G., 2001. Education policies: Equity, efficiency and voting equilibrium. Economic Journal 111, C104-C119.

[12] Diamond, P.A., Mirrlees, J.A. 1986. Payroll-tax financed social insurance with variable retirement. Scandinavian Journal of Economics 88, 25-50.

[13] Fernandez, R., Rogerson, R., 1995. On the political economy of education subsidies. Review of Economic Studies 62, 249-262.

[14] Glomm, G., Ravikumar, B., 1992. Public versus private investment in human capital: Endogenous growth and income inequality. Journal of Political Economy 100, 818-834.

[15] Glomm, G., Ravikumar, B., 2001. Human capital accumulation and endogenous public expenditures. Canadian Journal of Economics 34, 807-826.

[16] Hassler, J., Krusell, P., Storesletten, K., Zilibotti, F., 2003. The dynamics of government: a positive analysis. Manuscript, Institute for International Economic Studies, Stockholm University.

[17] Hassler, J., Rodríguez Mora, J.V., Storesletten, K., Zilibotti, F., forthcoming. The survival of the welfare state. American Economic Review.

[18] Hassler, J., Rodríguez Mora, J.V., Zeira, J., 2002. Inequality and mobility. Manuscript, Institute for International Economic Studies, Stockholm University.

[19] Kaganovich, M., Zilcha, I., 1999. Education, social security, and growth. Journal of Public Economics 71, 289-309.

[20] Kemnitz, A., 2000. Social security, public education, and growth in a representative democracy. Journal of Population Economics 13, 443-462.

[21] Konrad, K.A., 1995. Social security and strategic inter-vivos transfers of social capital. Journal of Population Economics 8, 315-326.

[22] Meltzer, A.H., Richard, S.F., 1981. A rational theory of the size of government. Journal of Political Economy 89, 914-927.

[23] Miles, D., Timmermann, A., 1999. Risk sharing and transition costs in the reform of pension systems in Europe. Economic Policy 14, 251-286.

[24] Nataraj, S., 2002. Age bias in fiscal policy: Why does the political process favor the elderly? Manuscript. Occidental College.

[25] Pogue, T.F., Sgontz, L.G., 1977. Social security and investment in human capital. National Tax Journal 30, 157-169.

[26] Rangel, A., forthcoming. Forward and backward intergenerational goods: Why is social security good for the environment? American Economic Review.

[27] Shepsle, K.A., 1979. Institutional arrangements and equilibrium in multidimensional voting models. American Journal of Political Science 23, 27-59.

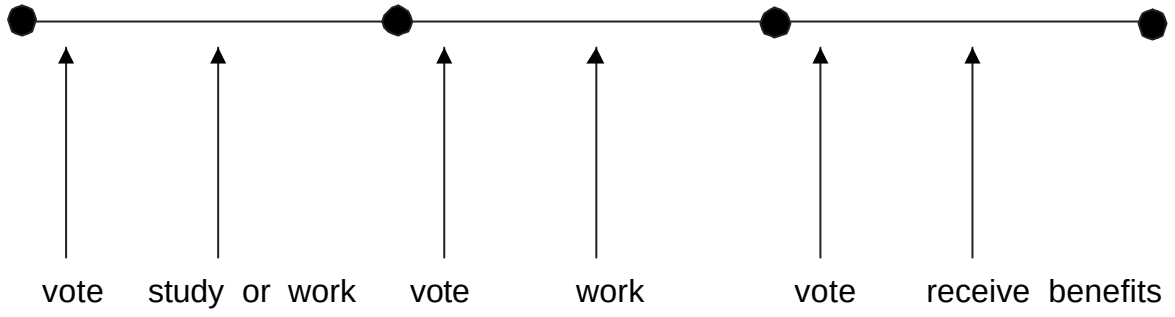

FIG 1. - Individual life-cycle