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ON THE POLITICAL ECONOMY OF SOCIAL SECURITY AND PUBLIC EDUCATION

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JEL Classification: H52, H55, H23, I21, D72

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On the Political Economy of Social Security and Public Education

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Abstract

This paper proposes and analyzes a model of a "European economy" with three overlapping generations, redistributive social security, and public universities without tuition. Individuals differ ex ante. The effect of wage tax rate on occupational choice and the voting equilibrium of wage tax rate and educational investments are analyzed both under full certainty and with income risks facing the educated and the uneducated.

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1 Introduction

In a world with uncertainty, redistributive taxation can generate welfare gains as a solution to the problem of the missing private insurance market for dealing with income risks. Eaton and Rosen

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(1980) have shown that relying at least partly on distortionary wage taxation as opposed to solely relying on lump-sum taxation may even enhance efficiency, because it may lead to higher human capital investment by risk-averse individuals. If ex ante identical individuals choose their fiscal constitution behind a Rawlsian veil of ignorance, they should agree on redistributive taxation. For a heterogeneous population without a Rawlsian veil of ignorance, expected tax payments equal average tax payments only for a minority. Most voters can expect either to gain or lose from redistribution. 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. In their model, productivity is exogenous, and there is no uncertainty.

The presence of overlapping generations introduces additional motivations into voting on public policy. Social security benefits are a major form of redistribution in most countries. In 1995, old age cash benefits amounted to 10-11 % of GDP in France, Germany and Italy. Also in all the other member states of the European Union except for Ireland, they amounted to more than 6 % of GDP. (OECD 1999). With pay-as-you-go social security benefits, intergenerational transfers affect the willingness of the previous generation to invest in human capital of the following generation in the form of publicly provided education. Already Pogue and Sgontz (1977) argued that the unfunded pay-as-you-go social security system provides a stronger incentive for 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 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. Kemnitz (2000) analyzes the political economy of social security and public education with three overlapping generations. In his model, the government chooses the social security tax rate to finance old-age benefits and tax rate to finance public education for children. All agents belonging to a generation are ex ante identical, and the only form of uncertainty concerns whether

the agent lives to the third period or not. As government decides on human capital investment, there is no occupational choice. The government maximizes a politically weighted sum of the utilities for workers and pensioners. Pay-as-you-go social security system may stimulate public education expenditures, as workers expect that they will benefit during their old age of the next generation's higher productivity. Holtz-Eakin et al. (2000) analyze voting on publicly provided education under full certainty and in the absence of social security. They allow for a distribution of abilities within each generation. The median voter belongs to a young generation as long as they outnumber the old who vote for a zero tax rate. Their analysis concentrates on the effects of demographic pressures changing the identity of the median voter.

I analyze risky occupational choices and voting on public expenditures in a world with a heterogeneous population and three overlapping generations. The young choose between occupation as uneducated worker, studying, and untaxed activities. The middle-aged work as educated or uneducated labor or engage in untaxed activities. The old are retirees. Wage tax revenue is used to finance both education and old-age benefits. The model can thus be interpreted as a discrete choice between lower-level and higher-level education in a "European economy" in which students do not pay for tuition. I study two alternative social security regimes: with generational budget constraint, each generation finances over its lifetime its education and social security benefits. With pay-as-you-go social security, wage tax revenue from the current young and middle-aged generations is used to finance education for the young and old-age benefits for the old.

I first analyze how taxation and resources devoted to educational institutions affect a discrete educational choice, say a decision on whether to obtain a college degree, when both the educated and the uneducated face income risk. Then I show how the median voter would select the tax rate. In order to keep the decision problem unidimensional, I analyze separately vote on taxation with given educational resources per student, and vote on resources per student with given tax rate. As

in the seminal work by Eaton and Rosen (1980), I restrict my analysis to proportional taxation.[1] This restriction implies that there is only one dimension in the political decision-making. If the tax system was allowed to be non-linear, the possibility of Condorcet cycles arises.[2] Redistributive taxation creates dead-weight loss, as citizens may engage in lower-productivity untaxed activities in order to escape their tax burden.

Kanbur (1981), Christiansen (1988) and Boadway et al. (1991) introduce models in which linear taxation affects occupational choice. My model has most in common with Boadway et al. (1991) in which heterogeneous households choose between becoming workers or entrepreneurs hiring workers at the market wage. Workers have no income risk, whereas entrepreneurs face a non-diversifiable risk. My model allows income risks in both occupations. Boadway et al. allow occupations to differ in non-pecuniary terms. They analyze optimal linear income tax rate chosen by a social planner, whereas I consider voting equilibrium. They show that optimal linear income tax rate depends on efficiency, equity, and insurance considerations. Workers are distributed between firms created by entrepreneurs. In my model, an individual's productivity is independent of occupational choices by others.

The structure of the paper is as follows. Section 2 presents the model of occupational choices and public expenditures. Section 3 analyzes the effect of redistributive taxation on risky occupational choice. Section 4 examines the voting equilibrium on wage tax rate and public resources per student with generational budget constraint and pay-as-you-go social security system. Section 5 concludes.

[1] Progressive taxation would provide more complete income insurance than proportional taxation, but it would also mean that returns to education would be taxed more heavily than its costs. Nielsen and Sørensen (1997) argue that if capital income is subject to a positive tax rate and there is no uncertainty, progressive labor income tax is desirable on efficiency grounds. They argue that proportional tax on labor income and a positive tax on capital income would distort investment decisions towards excessive human capital investment. Progressive taxation could negate this distortion.

[2] Voting equilibrium is also less restrictive in that it allows to find a political equilibrium with very mild assumptions concerning the ability distribution. In order to find a solution for a utilitarian social planner, one would need to specify the ability distribution and utility function in detail.

2 The Model

2.1 Population and Career Alternatives

In each period, there are three overlapping generations who have passed childhood. The members of the youngest generation have three alternatives: (i) investing in their human capital; (ii) entering the labor market as uneducated workers; or (iii) engaging in untaxed activities. The return on these activities includes the monetary equivalent of home production and income from non-declared work. Human capital investment is modelled as a discrete choice, like a decision on whether to obtain a college degree. 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 middle-aged can work as educated or uneducated labor depending on their choices in the previous period, or engage in untaxed activities. The old are retirees, receiving social security benefits. The measure of each generation is normalized to unity, as is the length of each period. Interest rate is normalized to zero, and capital markets are perfect.

Citizens are heterogeneous in their ability and in the potential income from untaxed activities. If they go to university, their expected wage in the second period is the product of their ability a and the quality of education, denoted by q. The actual wage is the product of expected wage and one plus a random variable with an expected value of zero. The random variable consists of individual specific random term ε with expected value 0 multiplied by intensity parameter $\alpha \geq 0$. The wage for those who do not go to university is, independently of their ability, 1 in the first period and a positive random variable with an expected value $\widetilde{u}$ in the second period. The analysis is simplified by presenting the earnings prospect facing the uneducated in a similar manner to that facing the educated. Therefore, I present the second-period wage for the educated as the product of their expected lifetime income $u = 1 + \widetilde{u}$ and one plus a random variable $\beta\varepsilon$. ε

is the same underlying individual-specific random term as in a career as an educated worker, and $\beta \geq 0$ is intensity parameter. The relative size of α and β is not limited. If $\alpha > (<)\beta$, career as educated (uneducated) is associated with larger relative wage risks. To ensure positive wages in each period, it has to hold for all ε, α, and β that $\alpha\varepsilon > -1$ and $(1 + \beta\varepsilon)u > 1$.

The individual-specific ability variable follows a continuous distribution in an interval, $a \in [0, \overline{a}]$. This distributional assumption guarantees that in any level of educational investments, there are always some individuals who do not go to university. Quality of education is increasing in resources spent per student. This public expenditure per student is denoted by g. Quality of schooling, q, satisfies $q(0) = 0$, $q\prime(g) > 0$, $q''(g) \leq 0$. I analyze a "European" economy with public universities without tuition. To make the analysis non-trivial, I restrict the analysis of educational expenditure to those levels in which it is efficient that citizens with highest ability obtain education. Formally,$(\overline{a}q(g) - g) > 1 + \widetilde{u}\forall g$. As ability is not verifiable in the first period, public universities have to offer same quality of schooling to everyone. If they would offer programs of different quality without tuition, all students would prefer the best alternative.[3]

Wage tax rate t is chosen by majority vote. In a steady state, the tax rate is constant from period to period. An individual's potential income from untaxed activities is a constant proportion n of income available in taxed activities. This individual-specific proportion follows a continuous distribution on the interval between 0 and $\overline{n}, \overline{n} < 1$. It is reasonable to expect that for the majority of citizens, n is considerably below 1.[4] There is no restriction concerning correlation between a and n. Both are private knowledge, but the educated are able to signal their ability after they have completed their education in order to receive their marginal product as their wage. The assumption that $\overline{n} < 1$ implies that tax rates between 0 and $1 - \overline{n}$ do not cause

[3] One can expect that differentiated student fees would allow also public universities to offer programs of different quality. This question is, however, beyond the scope of this paper.

[4] Tax evasion is easier in some than in other occupations. Alternatively, citizens may have different psychological costs of tax evasion. Tax evasion cannot be detected in the model, so that the choice of enforcement policy can be ignored.

switching to untaxed activities. Citizens are free to divide their time between taxed and untaxed activities. However, they always choose the alternative resulting in higher net income. Production technology is linear in both types of labor, so that issues of complementarity or substitutability do not arise.[5] Furthermore, there are no non-monetary returns on or costs of education.

The modeling of distortions caused by taxation as a discrete choice between taxed and untaxed activities allows the next section to concentrate on the effect of taxation on educational choice when different choices are associated with different income risks. Also Boadway et al. (1991) ignore endogenous leisure in order to concentrate on the effects of taxation on the choice between becoming worker or entrepreneur. They show that taxation may distort occupational choice if occupations differ in non-monetary benefits or costs. We can expect comparable effects in my model, if the two careers differ in non-monetary terms, for example so that education requires also effort costs.

Individual's utility U depends only on consumption C. During his or her lifetime, each individual receives social security benefits equal to b and an exogenous income k, which may also be negative.[6] The sum of lifetime non-wage income is denoted by $y = k + b$. Therefore, C is the sum of after-tax wage income, income from untaxed activities, and y. Individuals choose their occupation to maximize their expected utility $E[U(C)]$, where E is the expectation operator. Utility function exhibits decreasing absolute risk aversion.

[5] A more general production technology would allow complementarity or substitutability between the educated and the uneducated. For models with complementarity between groups with different abilities, see Johnson (1984) and Creedy and Francois (1990).

[6] If only those who had paid wage taxes would receive social security benefits, those switching to untaxed activities would leave only part of their income unreported. This would alleviate distortions associated with taxation, and would lead into a higher wage tax rate.

2.2 Government's Budget Constraint

There is a continuum of citizens, and individual random variables are uncorrelated. Therefore, individual uncertainty terms vanish from the government's budget constraint by the law of large numbers. If nobody would switch to untaxed activities, total tax revenue would be given by

$$tF(\widehat{a}) + tF(\widehat{a}_0)\widetilde{u} + tq_0 \int_{\widehat{a}_0}^{\overline{a}} sf(s)ds,$$

where F is the cumulative distribution function of ability, and f its density function. $\widehat{a}$ is the lowest ability with which individuals choose education rather than a career as uneducated worker with tax rate t and quality of education q. $\widehat{a}_0$ is the lowest ability with which individuals chose education in the previous period, depending on t_0 and q_0 in that period. In a steady state equilibrium, tax rate and resources per student are constant and $\widehat{a} = \widehat{a}_0$. I write the budget constraint in a more general form allowing $\widehat{a}$ and $\widehat{a}_0$ to differ in order to allow an analysis in case of a change in the tax rate. The first term is the tax revenue from young uneducated workers, the second term is the tax revenue from middle-aged uneducated workers, and the third term is tax revenue from middle-aged educated workers. The cost of providing public education is $(1 - F(\widehat{a}))g$, where g is determined by $q = q(g)$.

Those citizens with $n > 1 - t$ earn more in untaxed activities than in the taxed labor market, and switch to untaxed activities. Therefore, part of tax revenue is lost when tax rate is increased. With schooling investment g and tax rate t, net decrease in disposable tax revenue attributable to switches to untaxed activities is in a steady state

$$\delta(t, g) = \int_{a<\widehat{a}, n>1-t} [h(a, n)u]dadn + \int_{a\geq\widehat{a}, n>1-t} [h(a, n)aq]dadn,$$

where $h(a, n)$ is the joint density of a and n. When a pay-as-you-go system is not required to be

in a steady state, decrease in disposable tax revenue attributable to switches to untaxed activities is

$$\delta_0(t,g) = \int_{a<\widehat{a},n>1-t} [h(a,n)]dadn + \int_{a<\widehat{a}_0,n>1-t} [h(a,n)\widetilde{u}]dadn + \int_{a\geq\widehat{a}_o,n>1-t} [h(a,n)aq]dadn.$$

With constant t and g, $\widehat{a} = \widehat{a}_0$ and the two are identical. $\delta(t,g)$ can be interpreted either as a periodical loss of tax revenue from the young and middle-aged generation workers, or as generational loss if analysis concentrates on one cohort. The partial derivative of δ with respect to t, δ_t, satisfies $\delta_t > 0 \ \forall t > 1 - \overline{n}$. As the cohort size is normalized to unity, the lump-sum transfer for retirees is in a steady state

$$b(t,g) = t\{F(\widehat{a})u + q\int_{\widehat{a}}^{\overline{a}} sf(s)ds\} - (1 - F(\widehat{a}))g - \delta(t,g). \tag{1}$$

b can be interpreted either as a pay-as-you-go benefit or a funded benefit with a generational budget constraint, where tax payments from each generation are funded to pay educational expenditures and pension benefits of that generation. Furthermore, b can be interpreted to include also public health care for the elderly. Subtracting the cost of providing education from tax revenues used to b instead of having separate tax rates for the two captures the idea of competing uses for tax revenue. With a pay-as-you-go system without restriction to a steady state, the lump-sum transfer for retirees is

$$b(t,g) = t\{F(\widehat{a}) + F(\widehat{a}_0)\widetilde{u} + q_0\int_{\widehat{a}_0}^{\overline{a}} sf(s)ds\} - (1 - F(\widehat{a}))g - \delta_0(t,g). \tag{2}$$

Note that it is not formally imposed that $b > 0$. If $t = 0$ and education is publicly financed, b would be negative by the government's budget constraint. In section 4, it is argued that in a voting equilibrium under reasonable assumptions, $b > 0$. Furthermore, note that $\frac{\partial b(t,g)}{\partial t} > 0$ with

sufficiently low t as $\delta_t(0, g) = 0$. On the other hand, $\frac{\partial b(t,g)}{\partial t} < 0$ with sufficiently high t, as when tax rate goes towards 1, it is profitable for everyone to switch to untaxed activities. Therefore, tax revenue is maximized with a tax rate strictly between zero and one. To exclude multiple equilibria, I assume that with any g, tax revenue first increases monotonically to a unique level in which it is maximized, and then monotonically decreases.

An increase in g has two generally opposite effects on b. On one hand, it increases both the cost per student, and the number of students. On the other hand, tax revenue from the educated increases and that from the uneducated decreases. Generally, the latter effect is positive.

3 Taxation and Occupational Choice

With full certainty, all citizens choose their occupations to maximize their after-tax lifetime income. With income uncertainty, the decision on obtaining education is made to maximize expected lifetime utility. For some individuals, an increase in the tax rate may trigger a switch to untaxed activities. I restrict my analysis to citizens who do not switch to untaxed activities at the analyzed level of taxation. The results can be generalized to cases in which these distortions are "sufficiently small". I analyze the effect of redistributive taxation in a steady state. One interpretation for redistributive taxation is redistributive social security, but the results of this section do not depend on when the tax revenue is returned to citizens, as long as it is returned as lump-sum transfers.

Traditional portfolio analysis cannot be generalized to discrete occupational choices, as Kanbur (1981) emphasizes. With discrete choice, one has to compare total utility in the two alternatives, instead of marginal utility. For a marginal citizen who is indifferent between a career as educated and a career as an uneducated worker, the expected utility has to be the same with these two choices. If the income risks and expected income are identical in the two career alternatives for

the marginal citizen, then the analysis is trivial and taxation has no effects as the two careers are identical. When the two careers have different income risks, we can expect that one associated with higher income risks has to offer higher expected income as a compensation. With given level of public financing of education and no switching to untaxed activities, an increase in wage tax rate decreases income risks proportionally in the two occupational choices, and generates redistribution between all citizens. Decrease in income risk can be expected to increase the relative attractiveness of the more risky occupation for those who are indifferent, whereas income redistribution increases the relative attractiveness of the occupation with lower expected return. I make a following assumption:

Assumption 1 *Average lifetime income of all citizens is higher than expected lifetime income for a citizen with marginal ability* $\widehat{a}$*, either as educated or uneducated worker.*

Assumption 1 holds for example if the income risk facing the educated are not much bigger than those facing the uneducated, implying that the educated have higher incomes than the educated. I analyze the effect of an increase in taxation on career choice using the geometrical approach with a (μ, σ) diagram as presented in Sinn (1983) and (1990). Sinn (1983) proves that it is possible to represent with a simple distributional assumption arbitrary von Neumann-Morgenstern preference structure as indifference curves in a diagram with expected value μ on the vertical axis and standard deviation σ on the horizontal axis. The required distributional assumption is that with all choice variables the realization has a standardized form which does not depend on the choice variable. Formally, let Y be a realization of a random variable. Let μ be the expected value of Y, σ the standard deviation of Y and d a vector of choice variables. The random variable Y belongs to a linear distribution class if Y can be presented in a standardized form $X = \frac{Y-\mu}{\sigma}$ whose properties are independent of the choice variable d. The analysis allows to prove

Proposition 1 *If the educated and the uneducated face different income risks, an increase in redistributive taxation encourages a greater part of population to choose the riskier career path with higher expected returns as long as taxation does not cause switch to untaxed activities.*

Proof. See Appendix A. ■

Proposition 1 analyzes revenue neutral reform, in which tax revenue is returned as lump-sum transfer net of exogenous public expenditures on education. The result corresponds with the Eaton and Rosen (1980) result with continuous educational choice that wage taxation increases investment in risky education. When taxation induces individuals to choose riskier career with higher expected return, it simultaneously increases total value of production and thus increases expected income for all citizens through transfers financed with wage taxes. This tends to encourage riskier choices with decreasing absolute risk aversion. On the other hand, taxation tends to cause switching to untaxed activities, thereby reducing lump-sum transfer due to lost tax revenue. This tends to discourage riskier career choice. With $0 < t < \overline{n}$, the first effect always dominates. For t close to 1, the second effect always dominates. Therefore, proposition 1 implies

Corollary 1 *Assume that the educated and the uneducated face different income risks. With sufficiently low (high) wage tax rate, an increase in wage tax rate increases (decreases) total income in economy.*

As education is assumed to be publicly financed, the only private cost of education is lost wage income. Therefore, there may be excessive investment in education at the margin as citizens compare only their private costs and returns, neglecting public cost of providing education. This implies that even if education is associated with higher income risk, an increased participation in education need not be desirable on efficiency grounds. If the uneducated face higher income risk at the margin, then increased redistribution offers additional gains through decreased educational expenditures.

While the assumption of publicly provided education is realistic in many Western European countries and approximately true also in Canada, the result does not generalize to the United States. If investment in education would also involve effort cost, the result does not necessarily hold, as shown by Konrad (forthcoming).[7] On the other hand, studying, student life, and a career as a highly educated individual may themselves offer not only better financial rewards but also more psychic benefits than comparable time spent as part of the uneducated labor force and in a career as a worker with less education.

4 Voting Equilibria

If individuals would vote on both social security tax rate and investment in universities simultaneously, a possibility of Condorcet cycles would arise, as the issue space is multidimensional. Furthermore, the analysis would become intractable once uncertainty is introduced. Therefore, I analyze first a vote on wage tax rate with given educational expense per student, and then a vote on educational expense per student with a given wage tax rate.

4.1 Social Security with a Generational Budget Constraint

I now analyze an economy with a generational budget constraint in which tax payments by a generation are funded to finance its social security benefits and to pay the costs of providing education to its members as young. $b(t, g)$ is given by (1). With generational budget constraint, there is no interest conflict between different generations.[8] There is still interest conflict within each generation between individuals of different ability levels and of different returns on untaxed activities. I assume that each generation votes on its wage tax rate before educational investments

[7] In Konrad's model, education has no opportunity cost. Poutvaara (2000) suggests that if education has both opportunity cost and some non-deductible monetary costs, taxation may either increase or decrease investment in education.

[8] For an analysis centered on intergenerational issues, see Rangel and Zeckhauser (1999) and Rangel (2000).

are made. The tax rate preferred by a young citizen who is going to remain uneducated solves

$$\max_t E\{U[(1-t)(1+\beta\varepsilon)u + k + b(t,g)]\}.$$

The first-order condition is

$$\begin{aligned} &[(F(\widehat{a})u + q\textstyle\int_{\widehat{a}}^{\overline{a}} sf(s)ds - u)] + \frac{\beta u}{E(U')} \times (-cov(U',\varepsilon)) \\ &+t\{u\textstyle\int_{n\leq 1-t} h(\widehat{a},n)dn - q\int_{n\leq 1-t} h(\widehat{a},n)dn\}\frac{d\widehat{a}}{dt} = \delta_t(t,g). \end{aligned} \tag{3}$$

The first term on the left-hand side captures that part of ex ante predictable redistribution through social security which does not include lost tax revenue attributable to switching to untaxed activities, and it is positive when the uneducated have lower than average expected income. The second term is also positive, and it captures the insurance benefit of redistribution part of the social security. The third term on the left-hand side is the increase in social security benefits as a result of increased risk-taking, and it is positive by proposition 1. The term on the right-hand side measures the decrease in tax revenue attributable to distortions caused by taxation.

The tax rate preferred by a young citizen who is going to be educated solves

$$\max_t E\{U[(1-t)(1+\alpha\varepsilon)aq + k + b(t,g)]\}.$$

The first-order condition is

$$
\begin{aligned}
&[(F(\widehat{a})u + q\int_{\widehat{a}}^{\overline{a}} sf(s)ds - aq)] + \tfrac{\alpha a q}{E(U')} \times (-cov(U', \varepsilon)) \\
&+t\{u\int_{n\leq 1-t} h(\widehat{a}, n)dn - q\int_{n\leq 1-t} h(\widehat{a}, n)dn\}\tfrac{d\widehat{a}}{dt} = \delta_t(t, g),
\end{aligned}
\tag{4}
$$

the interpretations being the same as for those who remain uneducated with the difference that for those educated whose expected earnings exceed average expected earnings, the first term capturing redistribution effect is negative. With uncertainty, even some young citizens who have higher than average expected income are going to support a positive tax rate. This follows from the introduction of the second and third term on the left-hand side. Without uncertainty, these terms go to zero. Political equilibrium results can be summarized as:

Proposition 2 *A sufficient condition for a positive wage tax rate is that the median voter has a lower than average expected lifetime wage income. Furthermore, voting leads to a higher wage tax rate in the presence of uncertainty than without it at least if the effects of uncertainty on career choices in no-taxation equilibrium are sufficiently small.*

Proof. See Appendix B. ■

If the difference between α and β is large, then the introduction of uncertainty induces a large number of citizens to switch to careers with lower expected income, and therefore redistributive gain from taxation decreases. This effect is opposite to insurance motivation and efficiency gains as taxation leads to career choices with higher expected return. Therefore, it is not possible to determine without further assumptions whether tax rate would be lower or higher with uncertainty than without it.

4.2 Pay-as-you-go Social Security

I now analyze an economy in which the government's budget is balanced in each period, and social security benefits are financed of current wage taxes, as is also public financing of education. $b(t, g)$ is given by (2). There is no longer any restriction to rule out intergenerational redistribution. I analyze a vote on social security benefits, when each generation assumes that the social security system chosen will be in place permanently.[9] This implies that after social security tax rate is chosen, all young generation making their educational choice face the same maximization problem as in section 3. All potential intergenerational effects of a change of the tax rate would accrue to generations who have passed the first period of their life. Therefore, the members of the young generation face the same incentives as with generational budget constraint.

Voting behavior of middle-aged citizens depends on their wage rate and on their potential income if they would switch to untaxed activities. As long as he or she does not plan to switch to untaxed activities, a middle-aged citizen with a wage rate w_2 votes for t to maximize $(1 - t)w_2 + b(t, g)$, where $b(t, g)$ is a steady-state social security benefit. As the young generation in a current period already makes the same choices as young generations make in a steady state equilibrium, the steady state social security benefit is available already to those who are middle-aged when the tax rate is chosen. Uneducated living in the second period prefer higher wage tax rate than uneducated living in the first period, as they compare $b(t, g)$ to tax payments in the second period, only. Without uncertainty, the educated living in the second period prefer the same wage tax rate as they would have preferred in the first period, as for them lifetime wage income is equal to second-period wage income. With uncertainty, the middle-aged vote according

[9] If vote on social security would take place in each period, then younger generations would prefer to have zero tax rate in place as long as they are working, and tax rate maximizing social security benefits while retired. If the retired are not in majority, positive tax rates would result from the political process only when there is an explicit or implicit generational contract, where a sufficient number of those workers who would gain from social security as retired are prepared to vote in favor of social security also before their retirement. But such social contract would imply that voting takes place so that voters expect the resulting social security system to be permanent.

to their realized second-period income. In case of switching to untaxed activities, optimal tax rate would maximize $b(t, g)$. Call the tax rate maximizing b t_b. A rational citizen would calculate both potentially optimal tax rate without a switch to untaxed activities and t_b and prefer the one that maximizes utility. Note that preferences are not single-peaked. A citizen may prefer to have a "low" tax rate t_1, and switch to untaxed activities with t_2, so that $t_1 < t_2 < t_b$. In that case, both t_1 and t_b are preferred to t_2. Retirees, on the other hand, prefer the tax rate which maximizes current tax revenue net of expenses on education. Voting equilibrium with three generations satisfies

Proposition 3 *With pay-as-you-go social security, equilibrium social security tax rate is positive if the median voter has a lower than average lifetime wage income.*

Proof. The old and those who switch to untaxed activities always vote for a positive wage tax rate, guaranteeing more than 1/3 of votes. By proposition 2, majority of the young votes for a positive wage tax rate, guaranteeing more than 1/6 of total and therefore being sufficient for a majority. Furthermore, those middle-aged voters whose realized second-period income is less than average lifetime income, vote for a positive wage tax rate. ■

With pay-as-you-go social security, political equilibrium may result in positive wage tax rate even when median voter would have a higher than average lifetime income. It is not possible to tell in general, whether pay-as-you-go system leads to a higher wage tax rate than with a generational budget constraint. On one hand, the old push for higher tax rates. On the other hand, the redistributive motivation of the middle-aged who do not switch to untaxed activities depends only on their realized second-period wage income. The middle-aged have no longer insurance motivation. Those middle-aged who have higher (lower) second-period wage than average lifetime wage income vote against (for) a positive wage tax rate, possibly joined by those young to be educated who have sufficiently high expected earnings. Without uncertainty, it is possible to

establish

Proposition 4 *If there is no wage uncertainty and median lifetime income is lower than average lifetime income, voting with pay-as-you-go social security system leads into higher wage taxation than voting with generational budget constraint would.*

Proof. *(i) Assume first that the uneducated and those switching to untaxed activities form a majority. Then median voter is uneducated and generational budget constraint leads into t which maximizes $(1-t)(1+\widetilde{u})+b(t,g)$. With pay-as-you-go system, the old and those switching to untaxed activities vote for the tax rate maximizing $b(t,g)$. They form more than $1/3$ of voters. The median voter belongs to the middle-aged uneducated workers who prefer tax rate to maximize $(1-t)\widetilde{u}+b(t,g)$. This is a higher tax rate than with generational budget constraint. (ii) Assume next that majority of a cohort becomes educated workers. Then the winning coalition with generational budget constraint consists of the uneducated, those switching to untaxed activities, and a sufficient number of low-ability students to reach a majority. The tax rate is chosen to maximize the lifetime income of the median voter who is a student. With pay-as-you-go system, the majority consists of the old and those switching to untaxed activities supplemented with a sufficient number of low-income voters. The low-income voters participating in the coalition are recruited in the following order: first the uneducated living in the second period, then the uneducated living in the first period, and only if these groups are too small to give the coalition a majority, a sufficient number of educated workers and students with lowest ability. When the old participate in voting, the median voter has a lower income in present and in future than with a generational budget constraint, and therefore tax rate is higher.* ■

4.3 Financing Universities

Those young citizens who do not plan to go to universities vote for public financing of universities that maximizes the difference between lifetime tax revenue from their generation, and the cost of providing education. Formally, they vote for g to maximize $b(t,g)$ given as (1). Those young citizens who plan going to university vote for a higher public financing of universities. For a citizen with ability a planning to go to university, optimal g satisfies

$$\max_g E\{U[(1-t)(1+\alpha\varepsilon)aq + k + b(t,g)]\}.$$

Also the educated take into account the effect of g on $b(t,g)$. Those with intermediate ability have to compare optimal g if they do go to university and optimal g if they do not. Therefore, their preferences concerning g are not single-peaked. Thus, it is not possible to rule out Condorcet cycles in cases in which a majority may or may not include those to be educated. For other case, it is possible to establish

Proposition 5 *With pay-as-you-go social security, educational budget per student g is chosen to maximize $b(t,g)$. If majority of voters are going to remain uneducated, then also generational budget constraint leads to the same g as pay-as-you-go system.*

Proof. *With given wage tax rate, all uneducated young voters and all middle-aged voters prefer educational investment that maximizes their social security benefit. There is no generational conflict between them, as both generations pay same wage taxes and receive steady-state social security benefits. The old would prefer $g = 0$ as they do not benefit from educational investments by the young, but they form only $1/3$ of voters. Those to be educated would prefer higher educational investments. Therefore, the median voter with pay-as-you-go system belongs to the coalition*

formed by all middle-aged workers and young voters who remain uneducated. With generational budget constraint, an uneducated majority implies that g is chosen to maximize $b(t, g)$. ■

Public financing of education with pay-as-you-go system requires a sufficient level of wage taxation and sufficiently productive educational technology to ensure that tax revenue net of educational expenses is higher than tax revenue would be without educational expenses. The same holds with generational budget constraint when the uneducated are in majority. Therefore, it seems plausible to assume that there is a range of tax rates in which an increase in wage tax rate encourages the uneducated majority to devote more resources to universities in order to generate more tax revenue. The incentives of the middle-aged generation parallel closely to those identified by Pogue and Sgontz (1977) and Kemnitz (2000). They show that social security systems may affect public investment in human capital through intergenerational transfers. In my model, pay-as-you-go system and funded system with generational budget constraint lead to same choice of public financing of education, if majority of each generation remains uneducated.

In Kemnitz's (2000) model, retirees are indifferent towards education. Therefore, education policy is determined entirely by workers' preferences. In my model, heterogeneous workers have different preferences, and also the young generation votes. The old dislike educational expenses, as they compete of the same tax revenue which is used to finance social security benefits. If part of old-age transfers is given in the form of publicly provided health care, then the opposition of retirees to public education would stem from competing uses of public expenditures even with given social security benefits.

Financing universities with general tax revenue means potentially regressive redistribution, as the uneducated participate in financing education. Furthermore, it may generate excessive investment in education, as potential students do not take into account other than the opportunity cost of education. Non-deductible tuition, on the other hand, can be expected to lead to too low

participation in higher education as students would compare after-tax return to the sum of (tax deductible) opportunity cost and non-deductible tuition. An arrangement in which the educated would themselves pay for their education through tax-deductible tuition can be expected to lead to more efficient educational investment. Australia has adopted a system in which education is financed partially publicly, and partially through loans whose repayment is conditional on income.[10] Boadway et al. (1996) discuss the potential of educational policy.

5 Conclusion

This paper analyzed the effects of redistributive social security and public financing of education in a "European" economy in which the private costs of education are limited to the opportunity cost of lost wage income. Redistributive taxation turns out to encourage risky occupational choice with a higher expected private return. The result is expected to hold in countries with publicly financed higher education, independently of how the tax rate is chosen.[11] Tax revenue from those switching from less risky to riskier career choice increases. On the other hand, higher taxation may induce some citizens to engage in untaxed activities. This causes distortions and decreases tax revenue.

The paper proves that a sufficient condition for a positive wage tax rate is that the median voter has a lower than average expected wage income. Without uncertainty, the only motivations affecting vote on wage tax rate are redistribution and dead-weight loss associated with taxation. With uncertainty, there is also a positive insurance motivation and positive motivation from a

[10] Students have an option to pay in cash with a 25 % discount. For an analysis of the Australian Higher Education Contribution Scheme, see Chapman (1997).

[11] In a model where education requires both time, monetary costs, and effort, there might be a trade-off between the breadth and intensity of educational investments. Higher redistribution might lead to lower efforts spent on education, as suggested by Konrad (forthcoming), and at the same time, increase investment in education leading to riskier career paths. It remains for empirical analysis to find out to what extent reduced intensity of studying may cancel the gains of more extensive educational investments in a more redistributive system. However, universities and colleges may mitigate possible shirking effects on educational investments by the appropriate design of academic requirements.

desirable increase in the part of the population choosing the riskier career. However, it is not possible to prove that an introduction of uncertainty would always lead into a higher wage tax rate than without uncertainty even with generational budget constraint. The reason for this surprising result is that if the two careers differ in their risk characteristics, when a bigger part of population chooses the less risky career associated with lower expected income than would be chosen without uncertainty or when the two careers are associated with similar income risks for those who are indifferent between them. This implies a lower total production, and therefore reduces redistributive gains from taxation. However, it is possible to show that if the two careers do not differ too much in their risk characteristics, then majority vote with generational budget constraint leads to a higher tax rate with uncertainty.

The paper also reveals that with pay-as-you-go social security system, coalitions across generations and ability types may be different for a vote on wage tax rate and for a vote on educational investment. If there is no uncertainty, voting leads to higher wage tax rate with pay-as-you-go system than with generational budget constraint. The winning coalition with pay-as-you-go system contains the old, those switching to untaxed activities, the uneducated and, if necessary, those to be educated with lowest expected income. If vote is on educational investment, then the old belong to the minority with their opposition to public education. If the uneducated are in majority, generational budget constraint leads to the same outcome as pay-as-you-go social security system, the majority consisting of the uneducated workers.

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Appendix A. Proof of Proposition 1.

I first show that my model belongs to a linear distribution class. Y is total lifetime consumption, and d is the discrete choice between career as educated and career as uneducated. Denote the standard deviation of ε by σ_ϵ. With an ability a and random variable ε, total lifetime consumption is $(1-t)(1+\alpha\varepsilon)aq+y$ as educated and $(1-t)(1+\beta\varepsilon)u+y$ as uneducated worker. The expected value of total lifetime consumption is $(1-t)aq+y$ as educated and $(1-t)u+y$ as uneducated worker. The respective standard deviations are $(1-t)aq\alpha\sigma_\varepsilon$ and $(1-t)u\beta\sigma_\varepsilon$. With either career choice, standardized random variable is $X=\frac{\varepsilon}{\sigma_\varepsilon}$, and therefore all attainable distributions of total lifetime consumption belong to the same linear class.

With marginal ability a, expected utility has to be the same with the two career choices. Therefore, these have to be on the same indifference curve. Higher indifference curves are associated with higher utility. Sinn (1983, 1990) proves that with a decreasing absolute risk aversion,

(P1) an increase in μ with given σ decreases the slope of an indifference curve; and

(P2) a decrease in μ with given σ decreases the slope of an indifference curve.

I analyze first the case in which the career as educated is associated with higher income risk than career as uneducated, and therefore $\alpha>\beta$. In that case, we can present the career choices with different levels of taxation and no switching to untaxed activities as figure 1.

FIGURE 1

In figure 1, line BD depicts the (μ, σ) combinations available as educated for each ability type without taxation, and E is the combination available as uneducated without taxation. C is the point in which indifference curve drawn through E crosses BD line. Therefore, it gives the ability with which a citizen is indifferent between obtaining education and a career as uneducated. A is the average lifetime consumption associated with career choices without taxation. Variance associated with A is zero by the law of large numbers. If taxation would not affect career choices, A would also be the point associated full income equalization, that is, $t = 1$. To find the (μ, σ) combinations available with proportional tax rate t, we shrink the AB, AD and AE lines by proportion t. For an arbitrary t, $0 < t < 1$, FH line denotes the (μ, σ) combinations available for the educated and I that for the uneducated if career choices are not affected by taxation. The positions of these are determined so that $t = \frac{FB}{AB} = \frac{HD}{AD} = \frac{IE}{AE}$. Note that E can be on either side of FH line.

If we denote the σ coordinate of point P by P_σ and μ coordinate by P_μ, then the slope between E and C is $\frac{C_\mu - E_\mu}{C_\sigma - E_\sigma}$. As GI is parallel with CE and AI is parallel with AE, this is also the slope between I and G. As the indifference curve going through I is associated with both an increased μ and a decreased σ compared to that going through E, the slope of the indifference curve going through I is smaller than the slope of the indifference curve going through E. The same holds for the indifference curves going through G and C. Therefore, the indifference curve going through I goes below G. Thus, an individual who was indifferent between career as educated and uneducated worker without taxation, strictly prefers the career as educated worker with a positive tax rate. By continuity of ability distribution, also some individuals who would choose a career as uneducated worker without taxation, choose a career as educated worker with taxation.

I next analyze the case in which the educated face lower income risks than the uneducated,

and therefore $\alpha < \beta$. In that case the figure is of the following form:

FIGURE 2

Symbols are as in figure 1. By P1 and P2, we can show that the indifference curve going through I crosses the FG line above G. Thus, an individual who was indifferent between a career as educated and a career as uneducated worker without taxation, strictly prefers career as uneducated with taxation. By continuity, also some individuals who would choose a career as educated worker without taxation, choose a career as uneducated worker with taxation.

Appendix B. Proof of Proposition 2

$\delta_t(0, g) = 0$ as it is assumed that a tax rate sufficiently close to zero does not cause withdrawal to untaxed activities. Therefore, a positive left-hand side of (4) and (3) implies a positive t independently of who is median voter.

(i) If there is no uncertainty ($\alpha = \beta = 0$), the second and the third term on the left-hand side of (4) and (3) go to zero. In voting equilibrium, redistributive gain for the median voter is equal to loss from distortions caused by taxation.

(ii) If $\alpha = \beta > 0$, career choices are the same as without uncertainty, and the third term on the left-hand side of (4) and (3) capturing efficiency effects of taxation through changes in educational choices goes to zero. The difference compared to a first-order condition without uncertainty comes entirely from the positive second term, and therefore also the right-hand side has to be higher than without uncertainty. This implies that tax rate is higher than without uncertainty. Even voters whose expected income is somewhat higher than average income prefer a positive tax rate if insurance gains exceed redistributive losses.

(iii) If $\alpha \neq \beta$, the third term on the left-hand side is positive in both (3) and (4). The second term is positive for all those citizens who choose a risky career. On the other hand, the presence

of uncertainty discourages the career choice promising a higher expected income at the margin. Therefore, differences in uncertainty decrease redistributional gains compared to the case without uncertainty. If the difference between α and β is sufficiently small, the positive effects of uncertainty on the second and the third terms exceed the negative effect on the first term on the left-hand side. Therefore, voting equilibrium results in a higher wage tax rate with uncertainty than without it.

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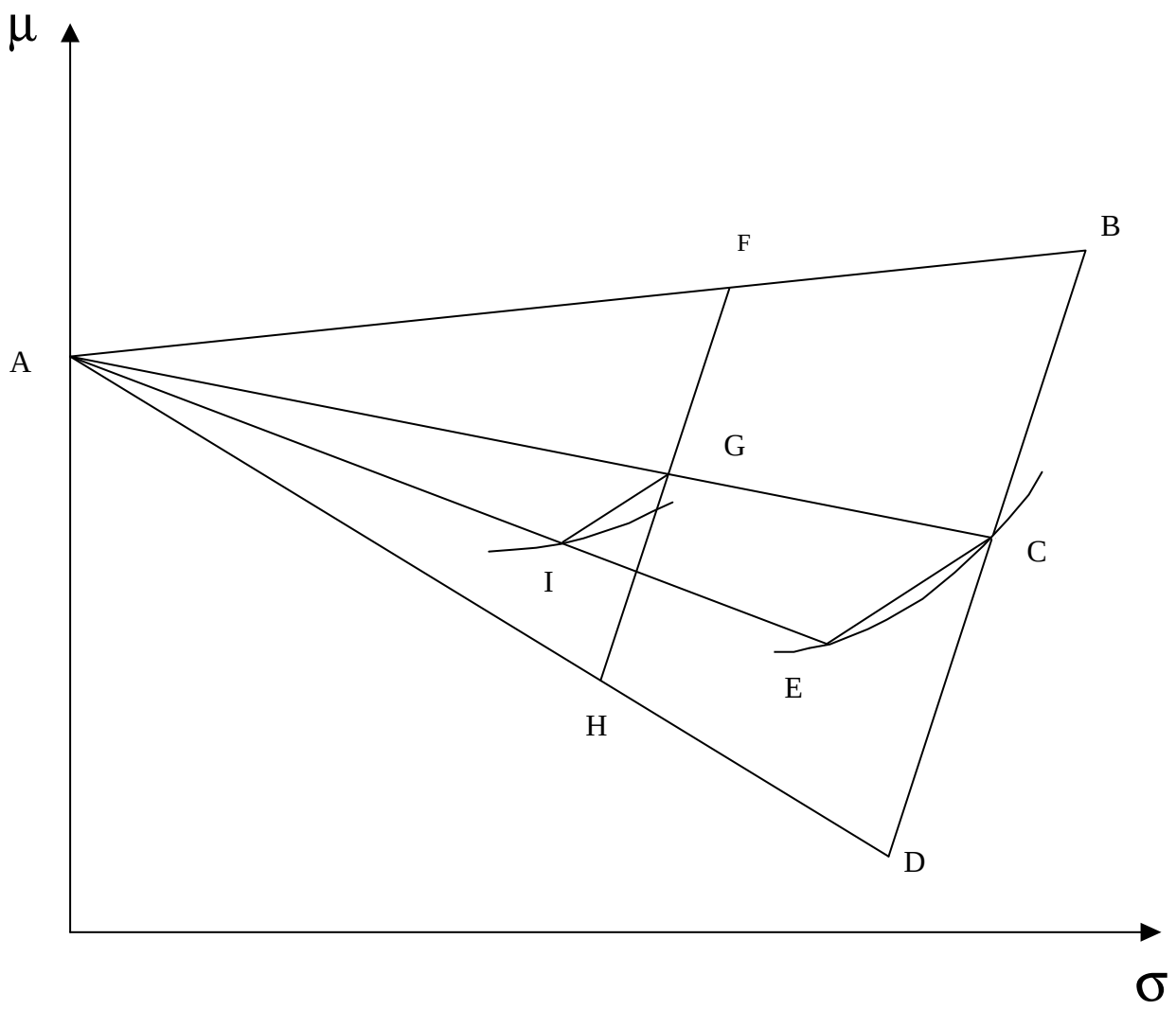

Figure 1.

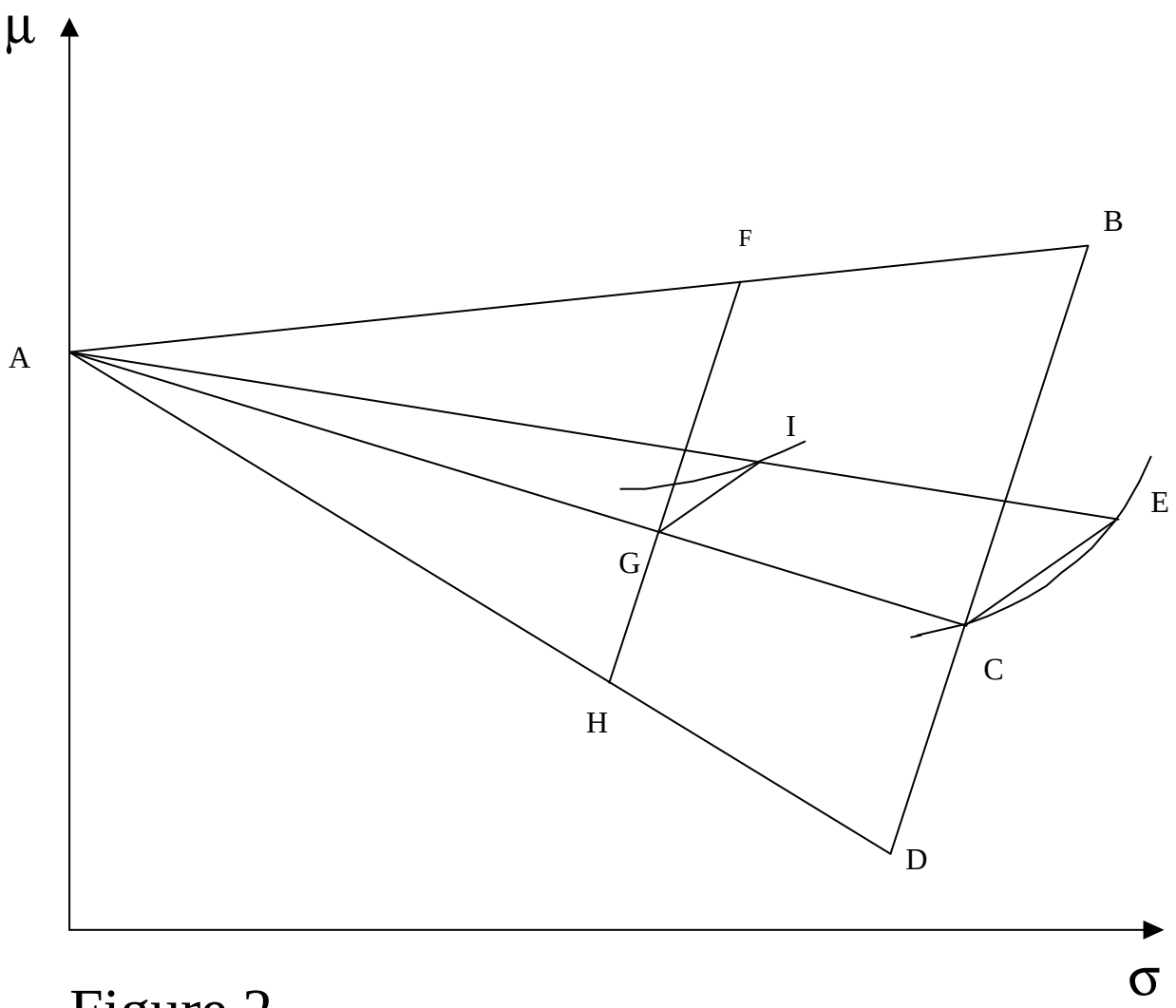

Figure 2.