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The growth-distribution nexus in a mixed regime of education with a status motive: On the macroeconomics of the welfare state*

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Abstract

We develop a growth model with human capital accumulation to study the effects of status-driven motivation on individuals' choice between public or private education. This choice interacts with and exacerbates the effects of status, with implications for growth and distribution. More motivated individuals work harder and choose private education. In a majority voting/median voter setup, individuals choose a public education size for which there is no trade-off between long-term growth and inequality. We also highlight the conflict of interest between individuals with respect to the size of the public education sector and the tax rate that supports it. We thus highlight important interactions between the macroeconomy, social attitudes and educational institutions and derive results of interest in a variety of contexts. We end by drawing policy conclusions among which, the idea that in democracies, higher growth and lower inequality are mutually compatible when the government promotes public education.

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1 Introduction

It has been recognised for some time that, in addition to individual consumption postulated by standard theory, an agent's utility function may also depend on the individual's position in the distribution. Such a dependence, which is empirically supported (Clark and Oswald, 1996; McBride, 2001; Falk and Knell, 2004), is often thought to be captured by the individual's relative consumption, and has been variously termed "keeping up with the Joneses" or "status-seeking" (Abel, 1990; Corneo and Jeanne, 1997; Ljungqvist and Uhlig, 2000). It is by now widely thought that such motives may have important effects related to education (Fershtman, Murphy and Weiss, 1996) and growth and distribution (Futagami and Shibata, 1998; Garcia-Peñalosa and Turnovsky, 2008; Alvarez-Cuadrado and Van Long, 2012).

The objective of this paper is the continued investigation of the effects and aspects of "status seeking". We seek to explore how such status seeking behaviour interacts with and affects the choice of education of individuals. As Section 4.2 below describes in more detail, advanced industrialised economies are characterised by a mixed educational system, with the coexistence of public and private provision; moreover, the exact proportions in the mix vary between countries. Our reading of the literature is that the determinants of this mix have not been as thoroughly analysed as necessary; this paper makes a contribution in that direction. We build an infinite-horizon growth model with heterogeneous individuals. Agents differ by their degree of status-seeking motivation; they choose the regime of education, as well as labour. Public education is free and offers a standard level of human capital; private education on the other hand involves a fee but offers higher human capital. From the chosen level of human capital and labour supply, growth and income distribution follow. Throughout, we take 'public' to mean 'provided by the state'; in other words, 'public' and 'state' are used interchangeably here.

We therefore introduce a mixed educational regime whereby publicly-provided education coexists with private education, and individuals make a choice between them. The mix of public and private is endogenous; again, this is an innovation of ours. The binary choice of education (public or private) can have important consequences for the accumulation of human capital (private education is likely to be of a higher standard, to justify the extra expenditure on it) and therefore on growth and distribution. The interaction with the binary educational decision is an additional channel by which status works, which has, we believe, been overlooked in the economic literature,[1] although several authors have discussed the issue in the field of sociology (Bernal, 2005; Ball, 1993; 1997). To study this interaction and show the effects of status on growth and distribution via this

[1] Fershtman et al. (1996), though, have investigated the idea that "status" considerations affect individuals's choice of education. However, they do not consider the binary educational choice, as we do here.

channel forms the core of our contribution.

Besides the aforementioned contributions, there are a number of related works to the theme we are exploring here. We might effectively argue that our paper builds on the branch of the literature on the choice of education initiated by Glomm and Ravikumar (1992), Saint-Paul and Verdier (1993) and Zhang (1996). These authors analyse the merits of public versus private education systems and conclude that public education is likely to reduce both income inequality and long-term growth. The analysis of these contributions and their comparison with more recent literature, however, lead us to make two comments. First, in their model, only one system of education, chosen via a majority voting system, prevails in equilibrium: either this is a pure public education regime or this is a pure private one. Second, their result has been challenged on the empirical side by Blankenau et al. (2007) and the World Bank (1993). This latter notably argues that, in promoting public education and in guaranteeing public education for all, governments of several Asian countries contributed to the rise in skills of their populations, leading in turn to the high levels of growth observed during the period 1965-1990 and a reduction in inequalities.[2]

In its structure which recognises that in equilibrium a mixed educational system prevails, our framework can be related to that of Cardak (2004) and Chen (2005).[3] These authors also argue that the structure of the educational system is an important determinant of growth and inequality. Cardak's (2004) article, however, mainly focuses on heterogeneity in initial endowment of human capital to explain the polarization in income distribution. In our setup, instead, the heterogeneity of individuals is coming from their status motivation. This corresponds to the every day notion that individuals can be more or less "driven", i.e. respond differently to the need to catch up or even forge ahead of others. That is, we highlight the role of status-seeking not only as a source of externalities, but in addition as a source of heterogeneity across individuals.[4]

As is well known, the preferences of individuals for social status induce a greater work effort, whereby each individual's greater hours of work and consumption advancement lead to a loss of status (drop in utility) to others who respond in a similar manner. In that sense, this aspect of our model is closer to Chen (2005) in which individuals differ in

[2] Glomm and Ravikumar (1992) also argue that public education can lead to higher growth. However, their result occurs only if the initial inequality between individuals is high or if the production function for human capital is sufficiently concave.

[3] The present article is also related to Tournemaine and Tsoukis (2015) in which public and private education co-exist. By letting the share of individuals opting for public and private education be determined endogenously, we are able to greatly extend the results obtainable by that approach.

[4] Greiner (2008) also analyses the impact on growth and distribution of a fiscal policy aimed at funding human capital accumulation in a model with heterogeneous agents. However, this work does not consider the case of separate sectors of human capital accumulation either publicly funded (through taxation) or privately funded as we do here.

both their abilities and human capital endowment. However, while the focus of Chen is on credit market imperfections, in the present article, the underlying educational choice is influenced by status considerations. Thus, our paper may be seen as complementing this last strand of literature. We analyse in effect how this behaviour interacts with the educational choice (public-private), and how, as a result, growth and distribution are jointly affected. Thus, this paper joins a long list of others that emphasise the need to put distributional considerations at the heart of macroeconomic models (Garcia-Penalosa and Turnovsky, 2006).

Last, but by no means least, the paper should be seen as a contribution towards a macroeconomics of the welfare state. In sub-Section 4.2 below, we document the cross-country disparities in educational provision. Such disparities also exist in health, to which the arguments made here can be extended; together, these two sectors constitute the bulk of welfare state provision. Moreover, the welfare state continues to evolve over time; this evolution as a whole has been studied by political economists (Iversen and Cusack, 2000) and sociologists (Korpi, 2003). But welfare service provision is bound up with aspects of macroeconomics such as growth and inequality, or distribution, as well as cultural traits like status and the selection process of democratic politics. Though aspects of the macroeconomics of the welfare state have been studied before (Atkinson, 1995; Sinn, 1995), no comprehensive framework has been built that can account for its cross-country and evolutionary aspects. Our paper offers a theory in this direction.

Another noteworthy contribution of our paper is that, in the same spirit as Alesina and Rodrik (1994) and Rheme (2014), we discuss the distributive conflict between individuals and the resulting relationship between growth and inequalities. In our framework the conflicts arise between the beneficiaries and non-beneficiaries from public education. Those who benefit from the public education system prefer a larger public sector (i.e. more tax), while those who attend the private education system prefer a lower size. In a majority voting system whereby the choices made reflect the preference of the median voter, we show that the tax level and size of the public education system so decided involves no trade-off between growth and inequality. In other words, in contrast with Alesina and Rodrik (1994) who argue that, in an unequal society, high taxation discourages investments and in turn growth, we show, in the same line as Rheme (2014) and the empirical works by Weede (1997) and Basett et al. (1999), that higher higher taxation, synonymous with a greater size of the public educational sector in our framework, can positively impact on long-term economic growth and reduce inequality in society.

The remainder of the paper is structured as follows. We introduce the model in Section 2 and derive the steady-state equilibrium in Section 3. In Section 4, we analyse the main properties of the mixed regime of education. We conclude in Section 5.

2 Model

Building on Tournemaine and Tsoukis (2015), we consider a closed economy in continuous time comprising a mass $[0, 1]$ of infinitely-lived individuals, each denoted by k. Individuals are initially endowed with one unit of human capital for all $k \in [0, 1]$ at date zero and T units of time. Each individual engages in the production of an output, Y_{kt}, that is used to pay taxes, fund private consumption, C_{kt}, or is allocated to fund schooling activities in order to acquire new units of human capital, H_{kt} (see next).

There are two types of education: a public (publicly funded) one, and a private (privately funded) one.[5] All individuals pay an income tax at a flat rate $\tau > 0$ which is used to fund public education. The government runs a balanced budget, therefore the entire tax receipts are used to fund public education services. All individuals can benefit from public schooling if they choose to (but whether they do so or not, they pay the tax). Individuals, however, who choose to attend the private educational system must pay additional educational expenses in the form of a fraction of their income, $\varepsilon_{kt} > 0$, in order to acquire the human capital that private education endows them with. The fraction ε_{kt} is a parameter of choice for individuals who opt for private education, and who still pay the tax rate τ. Obviously, $\varepsilon_{kt} = 0$ for those who opt for public education. Thereby, the level of human capital of people depends on their choice of education (private or public).[6]

As we shall see, out of the unit mass of individuals, a mass p, (indexed by $k < p$), at one end will choose one form of education, while the rest, $1 - p$, (indexed by $k > p$), will choose the other form. An important step of the model will be the determination of the endogenous share p. This is the key departure from the precursor paper by Tournemaine and Tsoukis (2014) where this parameter was assumed exogenous; as mentioned, we believe there is little precedent in the literature in endogenising the public-private education mix. This allows us to go further in the analysis of the growth-distribution nexus and welfare notably because a change in the level of the income tax will affect the share of individuals in each regime of education. For notational clarity, we will use the superscript "*pub*" and "*pri*" when an emphasis needs to be added to denote any variable of an individual in public and private education ($k < p$ or $k > p$, respectively).

Following Saint-Paul and Verdier (1992), output technology is given by: $Y_{kt} = AL_{kt}H_{kt}$, where $A > 0$ is a productivity parameter and L_{kt} is the labour-time an individual allocates

[5] In other words, 'public' here means state provided. This usage of the term 'public' should be contrasted to the usage in the UK and elsewhere where 'public' essentially means private; this is not the sense in which we use the word here.

[6] Throughout the paper, the human capital attainable from eiher public or private schooling should be understood in broad terms to encompass cultural and/or sports achievements and social networking, as well as pure academic achievement. In this paper, our point of departure is that individuals who invest in private education surely expect a return in terms of this broadly understood definition of human capital.

to output production. Thus, the budget constraint of individual k is given by

$$C_{kt} = (1 - \varepsilon_{kt} - \tau) A L_{kt} H_{kt}, \tag{1}$$

where $\varepsilon_{kt} = 0$ ($\varepsilon_{kt} > 0$) if individuals opt for public (private) education.

Following Glomm and Ravikumar (1992) and de la Croix and Michel (2002, Chapter 5), we set the technology of public human capital as

$$\overset{\bullet}{\overline{H}}{}_t^{pub} = \phi \left(\tau \overline{Y}_t\right)^{1-\varphi} \left(\overline{H}_t\right)^{\varphi}, \tag{2}$$

where $\phi > 0$ is a productivity parameter, $0 < \varphi < 1$ is the weight of existing human capital relative to material resources (degree of spill-over effect) and $\overline{Y}_t$ and $\overline{H}_t$ are the average level of output and human capital in the economy.[7] For technical simplicity, we follow the aggregation rule defined by Abel (2005), whereby we assume a geometric aggregation rule for any variable. We have: $\overline{Y}_t = \exp[\int_0^1 \log Y_{kt} dk]$ and $\overline{H}_t = \exp[\int_0^1 \log H_{kt} dk]$.[8]

Symmetrically, the law of motion of human capital in the private education sector is:

$$\overset{\bullet}{H}{}_{kt}^{pri} = \phi \left(\varepsilon_{kt} Y_{kt}\right)^{1-\varphi} \left(\overline{H}_t\right)^{\varphi}. \tag{3}$$

Finally, following King, Plosser and Rebelo (1988), preferences are given by[9]

$$U_{kt} = \int_0^\infty e^{-\rho t} \left[\log\left(C_{kt}\right) + \Delta_k \log\left(C_{kt}/\overline{C}_t\right) + \beta\left(T - L_{kt}\right)\right] dt, \tag{4}$$

where $\rho > 0$ is the rate of time preference, $\beta > 0$ denotes the constant-marginal disutility of work, and $\left(C_{kt}/\overline{C}_t\right)^{\Delta_k}$ is the status function of an individual, where $\overline{C}_t = \exp[\int_0^1 \log C_{kt} dk]$ is taken as given by any individual (see below for more details). A notable feature in (4) is that the "status function" is specific to the individual k, i.e. the

[7] The number of individuals who attend public education does not matter for the law of motion (2). In other words, public schooling is a pure public (non rival) good. We can argue that a more general technology for the production of public human capital could be such that $\overset{\bullet}{\overline{H}}{}_t^{pub} = \phi \left(\tau \overline{Y}_t / p\right)^{1-\varphi} \left(\overline{H}_t\right)^{\varphi}$, to account for the idea that class sizes matter: in this case, a reduction of the number of individuals attending the public education system is beneficial for all the remaining ones. Though interesting, the possibility of rivalry would quickly make the model intractable, particularly at the point of endogenising the share of individuals in public education, p.

[8] An arithmetic average of the form $\overline{Y}_t = \int_0^1 Y_{kt} dk$ and $\overline{H}_t = \int_0^1 H_{kt} dk$ would complicate the analysis without altering the results we derive here.

[9] It would be possible to specify a more general utility function given by $\widetilde{U}_{kt} = \int_0^\infty e^{-\rho t} \left\{ \left[\left(C_{kt}\right)\left(C_{kt}/\overline{C}_t\right)^{\Delta_k}\right]^{1-\theta} \exp[(1-\theta)\beta(T - L_{kt})] \right\} / (1-\theta) dt$, where $\theta > 0$ is the inverse of elasticity of substitution. Such a specification would complicate the analysis without bringing any new insight to the analysis.

functional form of the status function (not only the argument inside) differs between individuals.[10] In that sense, Δ_k captures the idea that some individuals are more motivated for status, or antagonistic, or rivalrous, others less so. For tractability, we assume that $\delta_k \equiv \log(1 + \Delta_k)$ is uniformly distributed on the support $[\delta^{\min}, \delta^{\max}]$ with mean $\overline{\delta}$ and variance σ^2_{δ}.[11]

3 Equilibrium

In this section, we solve two optimisation problems, for the typical individual in public education ($k < p$) and private education ($k > p$), respectively. Then, we determine which type education regime an individual chooses in the first place. Finally, we characterise the steady-state equilibrium, i.e. the state in which the growth rates of all variables are constant over time.[12] To get there, it is important to distinguish between economy-wide, private sector-wide, and public sector-wide variables. We then denote by $(\overline{\delta^{pub}},\ \sigma^2_{\delta^{mixed-pub}})$, and $(\overline{\delta^{pri}},\ \sigma^2_{\delta^{mixed-pri}})$ the endogenous average and variance of individuals' motivation opting for public and private education, respectively.

Finally, it is assumed that agents build status-seeking in consumption, as analysed, into their optimality conditions, taking $\overline{C}_t$ as given. In doing so, they are also assumed to be able to accurately forecast the relevant aggregate statistics (mean consumption) one instant ahead.[13] The outcome of this process is a Nash equilibrium, whereby agents respond optimally to aggregate outcomes and, in so doing, reproduce them (or the distributions from which aggregate statistics are drawn). The assumption of an (infinitesimal) lag between the time on which information is based and the realisation of outcomes allows us to avoid explicit game-theoretic considerations (that is, following Pollack, 1976, p. 310; and the "catching up" model of Abel, 1990).

[10] Recall that one aim of this paper is to show the importance of status motivation with respect to the choice of education of individuals. For technical simplicity, though, we have used the simplest functional form that allow us to capture this feature. Interested readers can refer to Tournemaine and Tsoukis (2009) and Tsoukis and Tournemaine (2013) for a more general way of formalising social status.

[11] Another justification for the adoption of the uniform distribution in the analysis is that even special functional forms can be useful in highlighting effects that are unlikely to go away with more general specifications.

[12] The analysis of the transitional dynamics which shows that the steady state is saddle point stable is available from the authors upon request. This is not part of the main text because of its complexity and because the insights gained from such an exercise would contribute little to our results below.

[13] This is the assumption of "rational myopic foresight", which is a standard hypothesis in macroeconomics, see e.g. Turnovsky, (1996, Ch. 3) for more discussion.

3.1 Public education

Individuals who participate in public education choose consumption, C_{kt}, and labour-time devoted to output production, L_{kt}, that maximise (4) subject to the budget constraint given by (1) where $\varepsilon_{kt} = 0$. After some manipulation, we obtain:

$$\beta = \frac{1+\Delta_k}{L_k} = \frac{\exp(\delta_k)}{L_k}, \qquad k < p, \tag{5}$$

where, as usual, the time subscript is suppressed for constant variables at the steady state.

Moreover, for future reference, we compute the growth rate of human capital attainable in public education by any individual. Equation (2) yields:

$$g^{pub} = \phi(\tau)^{1-\varphi} \frac{\left(\overline{Y}_t^{pub}\right)^{p(1-\varphi)} \left(\overline{Y}_t^{pri}\right)^{(1-p)(1-\varphi)} \left(\overline{H}_t\right)^{\varphi}}{H_t^{pub}}, \tag{6}$$

where $\overline{Y}_t^{pub}$ and $\overline{Y}_t^{pri}$ denote respectively the average level of output of those choosing the public education regime and those opting for the private one.

3.2 Private education

Individuals opting for the private education regime ($k > p$) choose consumption, C_{kt}, labour-time spent in output production, L_{kt}, but also the share of income to devote to education, ε_{kt}, and the path for human capital, H_{kt}. The current value Hamiltonian of this problem is: $CVH_{kt} = \log[(C_{kt})\left(C_{kt}/\overline{C}_t\right)^{\Delta_k}] + \beta(T - L_{kt}) + \mu_{kt}\phi\left(\varepsilon_{kt}AL_{kt}H_{kt}\right)^{1-\varphi}\left(\overline{H}_t\right)^{\varphi}$, where μ_{kt} is the co-state variable associated to the law of motion of human capital (3). The first order conditions are $\partial CVH_{kt}/\partial C_{kt} = 0$, $\partial CVH_{kt}/\partial L_{kt} = 0$, $\partial CVH_{kt}/\partial \varepsilon_{kt} = 0$, $\partial CVH_{kt}/\partial H_{kt} = -\dot{\mu}_{kt} + \rho\mu_{kt}$. The transversality condition is: $\lim_{t\to\infty} \mu_{kt}H_{kt}e^{-\rho t} = 0$.

Under the assumption that the economy is in steady state, simple manipulations of the first order conditions yield:

$$\beta = \frac{\exp(\delta_k)}{L_k}\frac{1-\tau}{1-\tau-\varepsilon_k}, \qquad k > p, \tag{7}$$

where we used $\delta_k \equiv \log(1+\Delta_k)$; and

$$\frac{1-\tau-\varepsilon_k}{\varepsilon_k} = \frac{\varphi g_k + \rho}{(1-\varphi)g_k}, \qquad k > p. \tag{8}$$

Moreover, from equation (3), individual's k growth rate of human capital in private education, g_k^{pri}, is given by:

$$g_k^{pri} = \phi\left(A\varepsilon_k L_k\right)^{1-\varphi}\left(\frac{\overline{H}_t}{H_{kt}}\right)^{\varphi}, \qquad k > p. \tag{9}$$

3.3 Choice of education: Determination of the endogenous p

Having set out the optimisation of each type of individual conditional on the choice of type of education, we now determine what type of education the individual chooses in the first place. To proceed, we compare the level of utility attained under the two regimes for the marginal individual p, i.e. the one who is indifferent between public and private education. To avoid complexity, we assume that the choice between education regimes happens only once (at date zero) and that the system is in steady state. This presupposes perfect foresight, an assumption in line with the deterministic nature of our model.

An important property of the steady state is that the growth rates attainable in the public and private educational systems must be equal. This outcome results from the presence of the human capital spill-over in the technologies of production of human capital (2) and (3): This implies that, as the level of human capital in private education forges ahead of $\overline{H}_t$, it acts to slow down its growth rate. We thus have: $g^{pub} = g_k^{pri} = g$, $\forall k \in [0,1]$, where a "g" without any superscript will henceforth indicate the steady-state growth rate in the mixed regime, common across the sectors and individuals.

The marginal individual, with ambition Δ_p, is such that:

$$\int_0^\infty \left[(1+\Delta_p)\log\left(C_{pt}^{pri}/C_{pt}^{pub}\right) - \beta\left(L_p^{pri} - L_p^{pub}\right)\right] e^{-\rho t} dt = 0. \tag{10}$$

Equation (10) is derived from the utility function (4) applied to the cases of the individual following private and public education. It shows the surplus utility from public over private education, and equates to zero for the marginal individual denoted with the subscript p. Had equation (10) been greater (lower) than zero, the utility from private (public) education would be greater, as would be the case for all $k > p$ ($k < p$). In other words, equation (10) is used to define the threshold status-seeking, or rivalry, level Δ_p of the agent who is exactly indifferent between the two regimes.

Using (1) and (5), with $\varepsilon_k = 0$ when individuals are in public education ($k < p$) and $\varepsilon_k = \varepsilon = [(1-\tau)(1-\varphi)g/(\varphi g+\rho)]/[1+(1-\varphi)g/(\varphi g+\rho)] > 0$ when they are in private ($k > p$),[14] we can simplify the critical condition (10) to obtain:

$$\log \frac{H_{pt}^{pri}}{\overline{H}_t^{pub}} = \frac{(1-\varphi)g}{(\varphi g+\rho)}, \tag{11}$$

where H_{pt}^{pri} is the level of human capital through private education obtained by the marginal individual who has the level of motivation Δ_p. Equation (11) embodies the choice of educational regime. Formally, on the right hand side we have elements that are given for individual p, and on the left hand side we have her response in terms of choice of relative human capital which depends on the degree of motivation of that individual, Δ_p.

[14] Equality of the share of resources devoted to private education (i.e. $\varepsilon_k = \varepsilon$ for all $k \in [0,1]$) follows directly from the property of common steady-state growth rates across individuals (see equation 8).

We can derive another equation in relative human capital by using (3). We obtain:

$$\log \frac{\overline{H}_t^{pri}}{H_{kt}} = \frac{(1-\varphi)}{\varphi}\left(\overline{\delta^{pri}} - \delta_k\right), \qquad k > p. \tag{12}$$

Then, combining (11) and (12) in which we set $k = p$, we obtain:

$$\log \frac{\overline{H}_t^{pri}}{\overline{H}_t^{pub}} = \frac{(1-\varphi)}{\varphi}\left(\overline{\delta^{pri}} - \delta_p\right) + \frac{(1-\varphi)g}{(\varphi g + \rho)}. \tag{13}$$

The log-difference between average human capital of those attending private education and the human capital attainable in public education is decomposed into an intra-group component and a between-groups component: the intra-group component (first term on the right hand side of 13) is ultimately motivation related as it is given by the difference between the average human capital in private education and the human capital of the $p-th$ individual also in private. The between-group component (second term on the right hand side of 13) is given by the difference in human capital of the $p-th$ individual across the two educational regimes of education: that is, the term $(1-\varphi)g/(\varphi g + \rho)$ represents the size of the structural break highlighted in Proposition 1. We will come back in more detail on the nature and importance of this term in sub-section 3.4.2 when we discuss about the nature of the structural break occurring at $k = p$.

3.4 Steady state

3.4.1 Characterisation

To characterise the steady state, we first compute the average log-labour supply of individuals in public and private education: $\overline{l^{pub}} \equiv E_{k<p}(\log L_k)$ and $\overline{l^{pri}} \equiv E_{k>p}(\log L_k)$. Then, we characterise the shares of individuals opting for both regimes of education, p and $1-p$, the steady-state level of growth in the mixed regime education, g, the relative average human capital of individuals following the two regimes of education, $\overline{H}_t^{pub}/\overline{H}_t^{pri}$ and the economy-wide level of inequality defined as the variance of individual income relative to total output $(\overline{Y}_t)$, $\sigma^2_{y^{mixed}}$.[15] Results are gathered in the next Proposition.

Proposition 1 *In the mixed regime of education, a steady-state solution exists and is unique.*[16] *It is characterised by an average log-labour supply of those choosing the public education regime given by:*

$$\overline{l^{pub}} = \overline{\delta^{pub}} - \log \beta, \tag{14}$$

[15] A comparison between consumption and income inequality is available from the authors upon request.

[16] A formal proof of the existence and uniqueness is available from the authors upon request.

and symmetrically, an average log-labour supply of those opting for the private regime of education given by:

$$\overline{l^{pri}} = \overline{\delta^{pri}} + \log\left(\frac{\rho+g}{\varphi g+\rho}\right) - \log\beta. \tag{15}$$

The shares of individuals in each regime of education and long-run growth are implicitly given by solving the following two equations:

$$\left\{\begin{array}{c} g^{\varphi}\left(\varphi g+\rho\right)^{1-\varphi} \\ \times\exp\left[\frac{(1-\varphi)g}{\varphi g+\rho}\right]^{p\varphi} \end{array}\right\} = \left\{\begin{array}{c} \phi\left[\frac{A\exp\left(\overline{\delta^{pri}}\right)(1-\tau)(1-\varphi)}{\beta}\right]^{1-\varphi} \\ \times\exp\left[-\frac{(1-\varphi)}{\varphi}\left(\overline{\delta^{pri}}-\delta_p\right)\right]^{p\varphi} \end{array}\right\}, \tag{16}$$

and

$$\left\{\begin{array}{c} g\left(\frac{g+\rho}{\rho+\varphi g}\right)^{-(1-p)(1-\varphi)} \\ \times\exp\left[-\frac{(1-p)(1-\varphi)g}{\varphi g+\rho}\right] \end{array}\right\} = \left\{\begin{array}{c} \frac{\phi A(\tau)^{1-\varphi}}{\beta}\exp\left(\overline{\delta}\right) \\ \times\exp\left[\frac{(1-\varphi)}{\varphi}\left(\overline{\delta^{pri}}-\delta_p\right)\right]^{1-p} \end{array}\right\}. \tag{17}$$

Finally, the economy-wide level of inequality is given by

$$\sigma^2_{y^{mixed}} = \sigma^2_{\delta^{mixed-pub}} + \frac{\sigma^2_{\delta^{mixed-pri}}}{\varphi^2} + p(1-p)\left[\begin{array}{c} \frac{(1-\varphi)}{\varphi}\left(\overline{\delta^{pri}}-\delta_p\right) + \frac{(1-\varphi)g}{\varphi g+\rho} \\ +\overline{\delta^{pri}} - \overline{\delta^{pub}} + \log\left(\frac{g+\rho}{\varphi g+\rho}\right) \end{array}\right]^2. \tag{18}$$

Proof. *See Appendix 6.1.* ■

Proposition 1 describes the set of equations which can be used to determine the steady-state equilibrium values of each variable in the mixed regime of education. We should keep in mind that such a solution relies on the fact that the flat-tax rate, τ, is neither too low, nor too high to avoid a corner solution whereby every individual chooses the same education regime.[17]

To give an intuition of the working-out of the model, we use equations (16) and (17). They represent the reduced-form equations for growth in the private and public regime of education and, importantly, make up a 2×2 system in the long-run level of growth, g, and share of population opting for public education, p. To avoid complexity, we perform simulation exercises. To proceed, we calibrate the model choosing benchmark parameter values so as to obtain a credible growth rate around 2 percent, but close to the standard values used in the literature (Barro and Sala-i-Martin, 2004). From numerical simulations across a wide range of values, reported in the third column of Table 1, we can draw Figure 1 which represents equations (16) and (17) in the $(g,\, p)$ space.[18]

[17] The analysis of the two polar cases of a pure public education regime and pure private education regime and their comparison are available from the authors upon request.

[18] With the benchmark parameter values given in Table 1 and setting $\tau = 0.15$, in steady state, we have: $g \approx 0.0156988$, $p \approx 0.656681$, and $\sigma^2_{y^{mixed}} \approx 0.884272$.

Table 1 here
Figure 1 here

We can note that the upward-sloping curve (16) shifts right/down with higher taxation as this latter impinges negatively on growth of human capital in the private sector; while the downward-sloping curve (17) shifts up/right with the tax as this boosts growth in the public sector. The overall result of a higher tax rate is an increase in p (more people in public education) but has an uncertain effect on growth. We will come back to this issue in more detail later. Before that, we find it interesting to discuss the nature of the structural break at p.

3.4.2 On the nature of the structural break at p

It is useful to probe a little more on what happens at the beak point of $k = p$ where the labour supply switches from $L_p^{pub} = \exp(\delta_p)/\beta$ to $L_p^{pri} = \exp(\delta_p)/\beta \times (1-\tau)/(1-\tau-\varepsilon)$. We note that if we net taxes out of the first type of labour supply and if we net taxes and educational fees out of the second type, we are left with the same quantity $\exp(\delta_p) \times (1-\tau)/\beta$. The rise in human capital across the educational regime for the same individual p can be easily shown to be: $\log(H_t^p/\overline{H}_t^{pub}) = (1-\varphi)g/(\varphi g + \rho)$ which is equation (11).

If we think of L as hours of work whereas H is the human capital-supported real wage, then we see that at $k = p$, labour supply increases such that the individual is able to pay the extra education fees from the hours of work, and devote the rise in wage (due to the higher human capital from private education) entirely to an increase in consumption.

To see this from another angle, note that the ratio of (gross) income for the marginal individual is:

$$\frac{Y_{pt}^{pub}}{Y_{pt}^{pri}} = \frac{L_p^{pub}}{L_p^{pri}} \frac{H_{pt}^{pub}}{H_{pt}^{pri}}.$$

Using equations (5) and (7), we have:

$$\frac{Y_{pt}^{pub}}{Y_{pt}^{pri}} = \frac{1}{\frac{1-\tau}{1-\tau-\varepsilon}} \frac{H_{pt}^{pub}}{H_{pt}^{pri}} = \frac{1-\tau-\varepsilon}{1-\tau} \frac{H_{pt}^{pub}}{H_{pt}^{pri}}.$$

On the other hand, in terms of consumption (alternatively: disposable income net of taxes and educational fees), the counterpart ratio is:

$$\frac{C_{pt}^{pub}}{C_{pt}^{pri}} = \frac{1-\tau-\varepsilon}{1-\tau} \frac{L_p^{pub} H_{pt}^{pub}}{L_p^{pri} H_{pt}^{pri}} = \frac{H_{pt}^{pub}}{H_{pt}^{pri}}.$$

So, we have

$$\frac{C_{pt}^{pub}}{C_{pt}^{pri}} > \frac{Y_{pt}^{pub}}{Y_{pt}^{pri}}.$$

In other words, the consumption variance is smaller than the income variance. Moreover, the rise in (gross) income across the two regimes (i.e., from public to private, keeping constant the exogenous motivation) can be usefully decomposed into two parts, the rise in labour supply that is just sufficient to pay the extra educational fees and the rise in the real wage (due to a higher human capital) that supports a higher consumption level. With this result in mind, we now turn to the analysis of the properties of the mixed regime of education.

4 Properties of the mixed regime of education

4.1 Policy implications

We study the effects of a change in the size of the public education sector, τ, on the share of individuals in each educational system, p (and $1-p$), long-run growth, g and economy-wide variance, $\sigma^2_{y^{mixed}}$. For that purpose, we suppose that the economy is initially on the balanced growth path, and the government decides to implement an unanticipated and permanent increase in τ. As before, we proceed to numerical exercises across a wide range of values, reported in the third column of Table 1, to draw Figures 2-4 that give a graphical representation of the relationship between p, g and $\sigma^2_{y^{mixed}}$ as a function of τ.

Figures 2-4

Not surprisingly, Figure 2 reveals that, as the size of the public education sector increases, so does its attractiveness and then the share of individuals attending this regime of education.

The most interesting results, here, concern the effects of the tax rate on long-run growth (Figure 3) and inequality (Figure 4). Starting with the growth-tax relation, at first sight, the U-shaped relation depicted in Figure 4 can seem striking. To understand the mechanisms at work, let us use a simple example. Let us suppose that the tax rate level is so low that no individual attends the public regime of education ($p = 0$). Now, let us assume that the government increases marginally the tax rate, τ, i.e. provides more resources to public education. In this case, the less motivated individuals respond by a switch from the private to the public regime of education. As depicted in the standard literature (Glomm and Ravikumar, 1992; Saint-Paul and Verdier, 1993; Zhang, 1996), the effect on growth is negative. In our model, though, the reason is that those who have switched education regime choose to work less and obtain a lower relative level of human capital. As the tax rate continues to increase, however, a larger share of the population (more motivated) opts for the public education regime, thereby increasing the weight of the contribution of the public education system to long-run growth. For a tax rate level sufficiently high, such effect would eventually offset the negative effect of growth meaning that $dg/d\tau > 0$.

Regarding inequality, we note that expression (18) shows that the economy-wide variance is given as a within- and between-groups decomposition of income heterogeneity. It is the sum of the variances between individuals choosing the same education system ($\sigma^2_{\delta^{mixed-pub}}, \sigma^2_{\delta^{mixed-pri}}$) plus a measure of the income gap between the two separate cohorts of individuals in the mixed regime of education. Using the uniform distribution property for δ_k and equation (18), we can show that the change in the income variance is given by:

$$\frac{d\sigma^2_{y^{mixed}}}{d\tau} = \left[\frac{\left(\delta_p - \delta^{\min}\right)}{6} - \frac{1}{\varphi^2}\frac{\left(\delta^{\max} - \delta_p\right)}{6}\right]\frac{d\delta_p}{d\tau} + \left[\begin{array}{c} 2p(1-p)\frac{\overline{Y}_t^{pub}}{\overline{Y}_t^{pri}}\log\left(\frac{\overline{Y}_t^{pri}}{\overline{Y}_t^{pub}}\right)\frac{d(\overline{Y}_t^{pri}/\overline{Y}_t^{pub})}{d\tau} \\ +(1-2p)\left[\log\left(\frac{\overline{Y}_t^{pri}}{\overline{Y}_t^{pub}}\right)\right]^2\frac{dp}{d\tau} \end{array}\right].$$

This expression shows that a positive change in τ raises the income variance of those in public education (first term in the first square brackets), and reduces the income variance of those in private (second term in the first square brackets). We can easily check that the difference of these two effects is negative. The effect on the income gap between the two cohorts (second square brackets), on the other hand, cannot be a priori signed. Therefore, as Figure 4 shows, $d\sigma^2_{y^{mixed}}/d\tau$ can be of either sign. However, we can note that the first term is likely to be negative as a greater size of the public sector should induce a reduction of income gap across individuals. Furthermore, the second term is also negative at least if $p > 1/2$, i.e. those in public education are more numerous than those in private. It thus follows that the negative outcome seems the most plausible scenario. Gathering the above results, we can then summarise the main implication of the model regarding the properties of the mixed regime of education as follows:

Proposition 2 *At the steady state, in a mixed regime of education:*
a) The (growth, tax) graph is a U-shaped one;
b) A larger public education regime will, under plausible assumptions, lead to a higher level of growth and an evening of inequality;
c) A larger public education regime is compatible with a higher level of growth and an evening of inequality.

The noteworthy property of the positive relation between growth and equality depicted in Proposition 2 is that it occurs in a mixed regime of education.[19] Though interesting, obtaining this result is not, a priori, as evident as it may seem. A greater amount of

[19] Glomm and Ravikumar (1992) and Saint-Paul and Verdier (1993) also show that an increase in the size of the public education sector can reduce inequality and simultaneously increase growth. The crucial difference with our paper, however, is that their result is obtained in a pure public education regime.

resources devoted to public education means in effect a rise in the opportunity cost of private education as it takes away resources from the more motivated individuals which could have been invested in private education. Therefore, this has a negative impact on investments in human capital accumulation in the private education sector and may be growth reducing. The reason why higher growth and lower inequality are compatible in our model is that, in the case where the tax rate is sufficiently high, the productivity of additional resources devoted to public education offsets the negative impact of lower resources devoted to private education: the economy is on the upward part of the curve describing the relation between growth against the tax rate (see Figure 4). Importantly, we will see in the next sub-section that this outcome appears as the most plausible scenario in a democratic system where the size of the government is made by a median voter.

4.2 Choice of public education size in a democratic system

We can observe large disparities across countries with respect to the amount of resources spent in education. Data of OECD (2008) shows that there is a variety of public-private education mixes across countries. More precisely, OECD countries spend on average 5.8 percent of their GDP in education, with 84.7 percent coming from public sources and the remaining share coming from private sources. Some countries have public education shares well above ninety percent, sometimes very close to a hundred percent such as Norway, Finland, Italy, France. In contrast, a number of countries put a larger responsibility on the private education system like in Japan, South Korea, UK, US and Canada among others. These large differences raise implicitly the issue concerning the choice of the government size, i.e. the actual choice of the tax rate, τ. Accordingly, the aim of this sub-section is to determine the choice of tax rate, τ, that is the size of the public education sector and analyse its implications for growth and inequality. To tackle the issue, we assume the existence of a majority voting system, whereby the tax rate level, τ, is chosen by the median voter who is referenced by $k = 0.5$. To conduct the analysis, as previously, we assume that the economy has reached the steady state. In this context, the long-run level of utility of the median voter, $k = 0.5$, is given by $U_{0.5} = (1 + \Delta_{0.5}) \log(C_{0.5})/\rho - \Delta_{0.5} \log(\overline{C}_0)/\rho - \beta L_{0.5} + g/\rho^2$. After straightforward manipulations, we have

$$U_{0.5} = \frac{(1 + \Delta_{0.5}) \log(1 - \tau) A L_{0.5} H_{0.5} - \Delta_{0.5} \log(\overline{C}_0) - \beta L_{0.5}}{\rho} + \frac{g}{\rho^2}. \tag{19}$$

To determine the choice of tax by the median voter, we must distinguish between two cases: either, the median individual attends public education in which case, $dL_{0.5}/d\tau = 0$ (see equation (14)), or the median individual attends the private regime of education implying that $dL_{0.5}/d\tau > 0$ (see equation (15)). Using this information, we can derive

(19) with respect to τ, where $\overline{C}_0$ and $H_{0.5}$ are taken as given, to obtain

$$\rho\frac{dU_{0.5}}{d\tau} = -\frac{(1+\Delta_{0.5})}{(1-\tau)} + \frac{1}{\rho}\frac{dg}{d\tau} + \left[\frac{(1+\Delta_{0.5})}{L_{0.5}} - \beta\right]\frac{dL_{0.5}}{d\tau}. \tag{20}$$

As shown by the first two terms on the right hand side of expression (20), a change in τ has two common effects to every individual. They correspond to the consumption loss induced by a higher income tax rate (first term) and the growth effect of such policy change (second term). The third term, which by use of (7) and (8), is strictly negative as it equals $-\beta(1-\varphi)g/(g+\rho) \times dL_{0.5}/d\tau$ and $dL_{0.5}/d\tau > 0$, concerns only individuals who choose the private regime of education. It represents the welfare loss coming from the additional amount of labour allocated to working activities compared to the alternative situation where individuals would opt for the public regime of education.

Denoting by $\tau^{med-pub}$ and $\tau^{med-pri}$ the tax rate level chosen by a median voter attending public and private education, respectively, we can use (20) to establish:

Proposition 3 *In steady state, in a mixed regime of education, the democratic system sets a tax rate verifying*

$$0 < \tau^{med-pri} < \tau^{med-pub} < 1. \tag{21}$$

where

$$\frac{1}{\rho}\frac{dg}{d\tau^{med-pri}} = \frac{(1+\Delta_{0.5})}{(1-\tau^{med-pri})} - \frac{\beta(1-\varphi)g}{g+\rho}\frac{dL_{0.5}}{d\tau^{med-pri}} > 0, \tag{22}$$

and

$$\frac{1}{\rho}\frac{dg}{d\tau^{med-pub}} = \frac{(1+\Delta_{0.5})}{(1-\tau^{med-pub})} > 0. \tag{23}$$

Proof. *See Appendix 6.2.* ■

Proposition 3 is interesting for several reasons. First, it highlights the conflict between those in public education who are likely to wish to have a higher tax rate to support it, and those in private education, who are likely to prefer less rather than more tax. This conflict stems from the fact that the latter group helps finance public education from which they do not benefit except indirectly (via the educational spillover). This conflict of interest may be heightened during crisis times with important consequences (Jensen, 2011). Interestingly, it also shows that, the median voter, whether he/she attends public or private education, always chooses a tax rate level verifying $dg/d\tau > 0$. This means that our result fits with the empirical fact discussed in the Introduction whereby there seems to be a positive relationship between government expenditures in education and the level of economic growth. Then, we can summarise:

Corollary: In democracies, we are likely to observe positively-correlated growth and equality rates.

Another interesting implication of our analysis concerns welfare. We can easily check that a tax rate which is below (above) the preferred rates of both groups, i.e. $\tau < \tau^{med-pri}$ ($\tau^{med-pub} < \tau$), increases (decreases) the welfare of all individuals. In other words, in either of these cases, there is no conflict of interest, and the tax rate should be changed in the direction that increases welfare. If, however, $\tau^{med-pri} < \tau < \tau^{med-pub}$, i.e. the tax rate is between the preferred rates of the two groups, a rise in the tax rate will increase long-term growth and equality but welfare-wise will only benefit the less motivated, as the welfare of the more motivated will decline. This conflict stems from the fact that the latter group helps finance public education from which they do not benefit except indirectly (via the educational spillover).

This result has a straightforward implication: no group has an incentive to set a tax rate, τ^w, that maximises societal welfare given by, at date zero, $W_0 = \int_0^p U_{k0} dk + \int_p^1 U_{k0} dk$ (see equation 19). Since, $\tau_k = \arg\max U_{k0}$, $k = 1, 2$, it follows that $0 < \tau^{med-pri} < \tau^w < \tau^{med-pub} < 1$, where $\tau^w = \arg\max W_0$. Thus, the preferences of the two groups differ, on either side of the maximum welfare, but none has an incentive to vote for it. Furthermore, if we assume that the less motivated group is more numerous $(0.5 < p < 1)$ to capture the stylised fact of a right-skewed motivation (and therefore income distribution), we conclude that the chosen tax-rate is given by $\tau^{med-pub}$ and verifies $\tau^{med-pub} > \tau^w$. The actual tax rate is greater than the one maximising societal welfare. Therefore, in this situation, a greater societal welfare would necessarily go along with a reduction of long-run growth and an increase of inequalities.

5 Conclusions

We develop an infinite-horizon growth model with human capital accumulation to study the effects of status-driven motivation on individuals' choice between public or private education. We therefore introduce a mixed educational regime whereby publicly-provided education coexists with private education, and individuals make a choice between them. Public education is free and offers a standard level of human capital; private education on the other hand involves a fee but offers higher human capital. The choice of educational regime interacts with and exacerbates the effects of status, with implications for growth and distribution. More status-minded ('motivated') individuals work harder and choose private education.

Our main analytical innovation and contribution is that the mix of public and private is endogenous; as this has not been pursued in prior literature, our results generalise and synthesise various existing results. The endogenous choice of education (public or private), binary at the individual level but continuous in the aggregate, can have important consequences for the accumulation of human capital (private education is likely to be of a higher standard, to justify the extra expenditure on it) and therefore on growth and distribution. The interaction with the binary educational decision is an additional channel by which status works, which has, we believe, been overlooked in the economic literature. For analytical tractability, and for the purpose of establishing a first set of relevant results, we have opted for the simplest model, which was rich enough to provide interesting results on the interaction between private and public investments in human capital accumulation through the sociological point of view of the quest for higher social status.

Our main results are summarised in a series of Propositions. We show first that the growth rate and the tax rate are in principle related in U-shaped graph; a higher tax provides a disincentive to work and may be responsible for the early (downward-sloping) part of the graph; but, once a sufficient size of the public education sector has been established, the spillovers associated with public education dominate and the effect of yet more support for public education leads to higher growth. At the same, a rise in the public sector reduces (consumption) inequality unambiguously. Thus, there need not be a growth-equality trade-off. In fact, under plausible assumptions, a larger public education regime leads to a higher level of growth and an evening of inequality; democratic decision-making, under the assumption that choices reflect the median voter's preferences, are likely to result into positively-correlated growth and equality rates. We conclude by highlighting the social conflict between the preferences of those in public education (for higher taxes) and those in private education (for lower ones).

The obvious policy conclusion here is that the size of the public sector should be sufficient so as to fully capture the spillover effects (externalities) from public education; only a sufficiently large public education sector can reconcile the objectives of a higher growth rate with that of equality and the ideal of an inclusive society. A public education sector that is smaller than this notional critical value will generate tendencies for sharply diverging growth and equality experiences. In contrast, a public sector bigger than the notional critical size will be in a best position to reconcile the conflicting preferences of diverse segments of society. Furthermore, our results constitute important countervailing considerations to the retrenchment of the welfare state that is under way in many countries due to strained public finances. Our results suggest that this retrenchment should be as limited as possible.

A natural avenue for future research concerns the optimal size of government and optimal taxation. The choice between public and private education analysed here may be thought of as a parable for the provision of public goods in general, so that the results derived here may have a broader appeal. It has been observed in the literature that externalities of the kind studied here give scope for corrective taxation (Choudhary et al., 2007). Additionally, in the context of a simple growth model with public services, Barro (1990) has emphasised that such services should receive a share in GDP equal to their weight in production via taxation and public expenditures. Our analysis can therefore approach the optimal tax rate from both these two complementary angles. Furthermore, as mentioned in the Introduction, our model provides a framework for understanding the cross-country and intertemporal evolution of the welfare state. It can contribute to the broad quest for understanding the political and cultural institutions that shape economic life, which is the subject of much ongoing (and often fuzzy) investigation in economics and the wider social sciences.

6 Appendix

6.1 Proof of Proposition 1

Equations (14) and (15) follow directly from (5) and (7). To obtain (16), we combine (7), (9), (13) and use $\overline{H}_t = (\overline{H}_t^{pub})^p(\overline{H}_t^{pri})^{1-p}$. Similarly, (17) is the outcome of the manipulation of (6) with (5), (7), (13) and $\overline{H}_t = (\overline{H}_t^{pub})^p(\overline{H}_t^{pri})^{1-p}$.

To characterise the variance of log-income, we must solve the following equation: $\sigma^2_{y_{mixed}} = E_{k|k<p}(\log Y_{kt}/\overline{Y}_t)^2 + E_{k|k>p}(\log Y_{kt}/\overline{Y}_t)^2$. Trivial decomposition yields: $\sigma^2_{y_{mixed}} = E_{k|k<p}[\log(Y_{kt}/\overline{Y}_t^{pub}) - \log(\overline{Y}_t/\overline{Y}_t^{pub})]^2 + E_{k|k>p}[\log(Y_{kt}/\overline{Y}_t^{pri}) - \log(\overline{Y}_t/\overline{Y}_t^{pri})]^2$. Since each parenthesis is a constant for each individual cohort separately, and using the fact that $\log \overline{Y}_t = p \log \overline{Y}_t^{pub} + (1-p)\log \overline{Y}_t^{pri}$, we can simplify this expression to obtain:

$$\sigma^2_{y_{mixed}} = \sigma^2_{y_{mixed-pub}} + \sigma^2_{y_{mixed-pri}} + p(1-p)\left(\log \overline{Y}_t^{pri}/\overline{Y}_t^{pub}\right)^2,$$

where $\sigma^2_{y_{mixed-pub}}$ and $\sigma^2_{y_{mixed-pri}}$ denote the variances between individuals choosing the same education system.

To compute $\sigma^2_{y_{mixed-pub}}$ and $\sigma^2_{y_{mixed-pri}}$, we note that $\log Y_{kt}/\overline{Y_t} = \log L_{kt} - \log \overline{L} + \log H_{kt}/\overline{H}_t$. If $k<p$, we have $H_{kt} = \overline{H}_t^{pub}$. Therefore, the variance of income of those who opt for public education is given by: $Var(\log Y_{kt}/\overline{Y_t})_{k<p} = Var(\log L_{kt})_{k<p} = \sigma^2_{\delta_{mixed-pub}}$. If $k>p$, we have

$$Var(\log Y_{kt}/\overline{Y_t})_{k>p} = Var(\log L_{kt})_{k>p} + Var(\log H_{kt}/\overline{H}_t)_{k>p} + 2Cov(\log L_{kt}, \log H_{kt}/\overline{H}_t)_{k>p}.$$

Using (7), (8), (9), the steady-state property $g_k = g$ for all $k \in [0,1]$, and taking logarithm, we obtain:

$$\log g = \log \phi + (1-\varphi)\log\left(A\frac{(1-\tau)}{\beta}\frac{(1-\varphi)g}{\varphi g+\rho}\right)^{1-\varphi} + (1-\varphi)\,\delta_k - \varphi \log\left(\frac{H_{kt}}{\overline{H}_t}\right),$$

which implies

$$Var\left[\log\left(H_{kt}/\overline{H}_t\right)\right]_{k>p} = \frac{(1-\varphi)^2}{\varphi^2}\sigma^2_{\delta_{mixed-pri}}.$$

As $Var(\log L_{kt})_{k>p} = \sigma^2_{\delta^{mixed-pri}}$, we finally obtain:

$$Var(\log Y_{kt}/\overline{Y_t})_{k>p} = \frac{\sigma^2_{\delta^{mixed-pri}}}{\varphi^2}.$$

To complete the computation, we need to determine the value of $\log \overline{Y}_t^{pri}/\overline{Y}_t^{pub}$. Using (14) and (15), straightforward manipulations yield:

$$\log\left(\frac{\overline{Y}_t^{pri}}{\overline{Y}_t^{pub}}\right) = \overline{\delta^{pri}} + \log\left(\frac{\rho+g}{\varphi g+\rho}\right) - \overline{\delta^{pub}} + \log\left(\frac{\overline{H}_t^{pri}}{\overline{H}_t^{pub}}\right).$$

Combining this equation with (13), we obtain:

$$\log\left(\frac{\overline{Y}_t^{pri}}{\overline{Y}_t^{pub}}\right) = \frac{(1-\varphi)}{\varphi}\left(\overline{\delta^{pri}} - \delta_p\right) + \frac{(1-\varphi)g}{\varphi g+\rho} + \overline{\delta^{pri}} - \overline{\delta^{pub}} + \log\left(\frac{g+\rho}{\varphi g+\rho}\right),$$

which allows us to find (18).

6.2 Proof of Proposition 3

The median voter chooses a level of tax so that equation (20) is equal to zero. This allows us to find expressions (22) and (23). Then, the ranking in (21) follows directly from inspection of (20) applied to a median voter attending public and private education, recalling that $dL_{0.5}/d\tau > 0$. While the strict positivity of (23) is obvious, that of (22) requires the use of (7). After some computations, we obtain

$$\left[\frac{1}{\rho} + \frac{\beta(1-\varphi)g}{g+\rho}\frac{1+\Delta_{0.5}}{\beta}\frac{\rho(1-\varphi)}{(\varphi g+\rho)^2}\right]\frac{dg}{d\tau^{med-pri}} = \frac{(1+\Delta_{0.5})}{(1-\tau^{med-pri})} > 0.$$

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