Why do education expenditures differ across countries? The role of income inequality, human capital, and the inclusiveness of the education system.**

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Abstract: This paper provides a simple model of hierarchical education to study the political determinants of the public education budget and its allocation between different stages of education (basic education and advanced education). The model integrates private education decisions by allowing parents, who are differentiated according to income and human capital, to opt out of the public system and enrol their offspring at private universities. Majority voting decides the size of the budget allocated to education and the expenditure composition. The model exhibits a potential for multiple equilibria and 'low education' traps. Income inequality, the distribution of the adult population's human capital and the inclusiveness of the education system play a fundamental role in deciding the equilibrium public education budget and its allocation between different tiers of education. The main predictions of the theory are broadly consistent with cross-country evidence collected for OECD countries and help to explain why some OECD countries, such as Italy, seem to remain stuck in a 'low education' equilibrium.

Keywords: Education Funding, Political Economy, Majority Voting, Opting Out, Income Inequality, Redistribution.
JEL codes: H23, H26, H42, H52, I28.

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1. Introduction

Why do education expenditures substantially differ even among developed countries? Not only does the share of GDP devoted to education vary but also the type of financing (public vs. private) and the allocation of education expenditures across hierarchical stages (primary/secondary vs. tertiary).

The aim of this paper is to provide a positive theory of education spending which integrates the political determination of public education funding and its allocation between different stages of education with private education decisions. We adopt a political economy approach by recognising that public education funding and the allocation of the public budget across education stages is the result of the interaction of market forces and political decisions involving groups with conflicting preferences.

Against this background, our research questions are as follows: What is the majority-preferred level of funding for public education when private options for advanced education are available? What is the majority-preferred allocation of public funds across educational tiers? How do income inequality and households' heterogeneity in human capital affect political equilibrium? How do features of the education system, such as its inclusiveness, influence the political equilibrium?

Public provision of education is usually justified as a means of redistributing income (redistribution in kind). Accordingly, the position on the income ladder should determine conflicting preferences for public investment in education, and in majority voting settings, large income inequality should create strong support for public education.[1] However, empirical evidence does not fully support these predictions. Benabou (1997) and Soares (1998) have demonstrated that more unequal and more heterogeneous societies spend less on public goods. De la Croix and Doepke (2009) have focused on education expenditures for primary and secondary schools and found that in countries with higher income inequality, average public funding is lower. In addition, regression results have demonstrated that societies that are more unequal tend to spend comparatively more on higher

[1] See, for example, Saint-Paul and Verdier (1993); Gradstein and Justman (1997); Epple and Romano (1996a).

levels of education and thus have a less redistributive way `of spending (Zhang, 2008). Analogous results were found for developing countries (Birdsall, 1996; Gradstein, 2003).

The point made in this paper is that to address the political economy of public education funding, the hierarchical nature of the education process must be explicitly recognised. Tertiary education is very different from K-12 education: first, it is not mandatory and, more importantly, access is not universal. The level of educational attainment during the first stage rations the participation in the second stage, generating an endogenous participation constraint that is stricter for children from households of lower socioeconomic status. [2] The same applies to the college drop-out phenomenon. The importance of the family background in withdrawal decisions has been well documented in the literature, and students having low educated parents have a higher probability of dropping out of college compared to those with graduate parents.[3] Thus, not only the size but also the composition of public spending across educational tiers is a critical policy issue.

This paper provides a simple model of hierarchical education to study the political determinants of the size and composition of the public education budget. The model integrates private education decisions, allowing parents to opt out of the public system and enrol their offspring at private universities. Households consist of one parent and one child and are differentiated according to a parent's income and human capital. Children are educated in a hierarchical schooling system that features two levels of education: the lower level (K-12), which is mandatory and funded exclusively by the government, and the higher level (tertiary education) which can be funded either privately or publicly. For simplicity, we assume that access to tertiary education is universal, but the probability

[2] See Glomm and Ravikumar, (1992) and (2003). In addition, empirical evidence has demonstrated that even when education fully relies on public funding, children from families with a lower socioeconomic status have lower enrolment rates at increasing levels of education. See De Fraja (2004) and Cunha and Heckman (2007). See Lagravinese et al (2020) for recent evidence of the effect of economic, social, and cultural status on educational performance.

[3] See, for example, Aina (2005). The author finds that in Italy, 'poor' family environment affects the probability of enrolling at university as well as the probability of dropping out. See also Aina et al (2021) for a review of the socio-economic literature on drop-out.

of dropping out of college is influenced by parental human capital.[4] However, the importance of family background on children's performance at university can be mitigated by the education system design. Inclusive school systems, featuring a relatively even standard of basic education and few possibilities for schools to select their pupils, might dampen the relative importance of inherited human capital in educational attainments.[5] Accordingly, we assume that the share of children who complete the tertiary education cycle is determined by the initial distribution of human capital in the adult population and by the education system design.

In our model, majority voting decides the size of the budget allocated to education and the expenditure composition. Affluent parents may find public funding of tertiary education insufficient; in this case, they opt out of the public system and enrol their children in a private university. This endogenously separates public and private university students according to household income. Finally, we assume that private education expenditures are tax deductible. This assumption is a feature observed in many OECD countries and is a driver of some of the results.

The model exhibits a potential for multiple equilibria and 'low education' traps. If households anticipate a low level of public spending on tertiary education, affluent families will opt out of the public system and, due to the tax deductibility of private education expenditures, the public budget will be reduced. The economy falls into self-reinforcing "vicious circles" with low levels of public spending confirming initial expectations (self-fulfilling prophecies).

Other key results of the model suggest that public education spending and its allocation between different education tiers is affected by income inequality and by the inclusiveness of the education system.

[4] This assumption simplifies analytical complexity but does not affect qualitative results. Rather, the latter would be strengthened by introducing not universal access to university.

[5] Features of an inclusive education system are a high degree of comprehensiveness of programs, a relatively even standard of education, a low percentage of private schools, and few possibilities for schools to select their pupils. By contrast, low inclusiveness features include formal differentiation (students are separated by ability through early tracking) and/or informal differentiation (socioeconomic segregation among schools).

The contribution of this paper is relevant for political and theoretical reasons. On the political side, because of the important involvement of governments in the education sector, understanding the political economy constraints of public education policy is crucial. Theoretically, our paper helps explain the documented differences in education expenditures across OECD countries. Specifically, the role played by agents' expectations in the multiplicity-of-equilibria result may explain the observed persistence of different education regimes and why some countries, such as Italy, seem to remain stuck in a 'low education' equilibrium. Furthermore, the paper results might be helpful in explaining trends in education policy within a country over time.

The paper is organised as follows: Section 2 briefly discusses the related literature; Section 3 presents descriptive evidence on education expenditures in OECD countries; Section 4 illustrates the theoretical model; Section 5 shows that the model's results are broadly consistent with cross-country evidence collected on OECD countries; Section 6 concludes and highlights policy implications.

2. Related literature

This paper relates to the theoretical literature on the political economy of education funding (Glomm et al., 2011). Much of this literature has assumed a single type of education[6] or focused on the political economy of spending on a particular stage, such as higher education.[7] However, some recent works have begun to model the hierarchical nature of education through an explicit two-stage technology, where the skills acquired during the first stage of education are used as inputs in the production of higher education. In this framework, optimal decisions on tertiary education participation or withdrawal depend on the level of human capital acquired in the first stage.[8] In this framework, Blankenau et al. (2007) and Viane and Zilcha (2013) have emphasised the role of

[6] See, for example, Levy (2005); De la Croix and Doepke (2009); Arcalean and Schiopu (2016).
[7] See, for example, Fernandez and Rogerson (1995); Beviá, and Iturbe-Ormaetxe, I. (2002); Di Gioacchino and Sabani (2009), Gradstein and Justman (2004), Haupt (2012), Lasraman and Laussel (2019), Hatsor and Zilcha (2021).
[8] By considering the hierarchical nature of the education process, Su (2004); Restuccia and Urria (2004); Arcalean and Schiopu (2010), and Sarid (2017) have studied how exogenous policy changes in different education sectors affect economic growth and aggregate welfare.

parents' skill profiles in shaping preferences over the allocation of public funds among education tiers. Naito and Nishida (2017) have argued that in a democracy, a tax increase to finance higher education cannot be politically feasible until the majority accumulates enough human capital. By contrast, Su (2006) argues that in less developed countries, where rich elites hold political power, higher public spending on advanced education may result in lower basic education funding.

In these models, the level of human capital produced in the last stage of education either is given or is decided by government expenditure. In the first case, the government can only choose to subsidise part of the cost of higher education, thus affecting its private cost but not its quality. By contrast, in our contribution, we consider private alternatives and thus the possibility of opting out of the public system and choosing education quality. We model the opting-out option by referring to the voting models of De la Croix and Doepke (2009) and Arcalean and Schiopu (2016), in which an endogenous income threshold separates public from private school users. However, differently from their contributions, we assume that human capital accumulates in a hierarchical education system. This assumption allows us to analyse not only the political determinants of the public education budget but also its allocation across different stages of education. In addition, we do not adopt a probabilistic voting model, as in De la Croix and Doepke (2009) and Arcalean and Schiopu (2016), but we do rely on the median voter approach, as in Romero (2009) and Naito and Nishida (2017). In this framework, differently from De la Croix and Doepke (2009), multiple equilibria might arise as self-fulfilling prophecies. This result might explain the observed temporal persistence of different education regimes.

3. Stylised facts

In this section, we provide evidence on OECD cross-country heterogeneity in education expenditures (levels and composition) and source of financing (private vs public) for the year 2016.[9] Figure 1 reports education expenditure as a share of GDP and its composition between

[9]Unless otherwise stated, data are from OECD (2019) and from http://stats.oecd.org/. Tables A1(a) and A1(b) in Appendix 2 summarise the variables used in the discussion of this section.

private and public funding. The share of GDP devoted to education was on average equal to 5%, ranging from the low values of the Czech Republic (3.4%), Italy (3.6%), and Greece (3.6 %) up to 6.5% in Norway and Denmark. In terms of composition, on average 17% of education expenditure was from private funding, with the highest values in Chile (37%), United States (32%), United Kingdom (32%), Australia (32%), Japan (29%), and South Korea (29%); at the other extreme, in Nordic countries, education expenditures were almost entirely financed with public funds.[10]

Figure 1. Education expenditures, % of GDP, public and private.

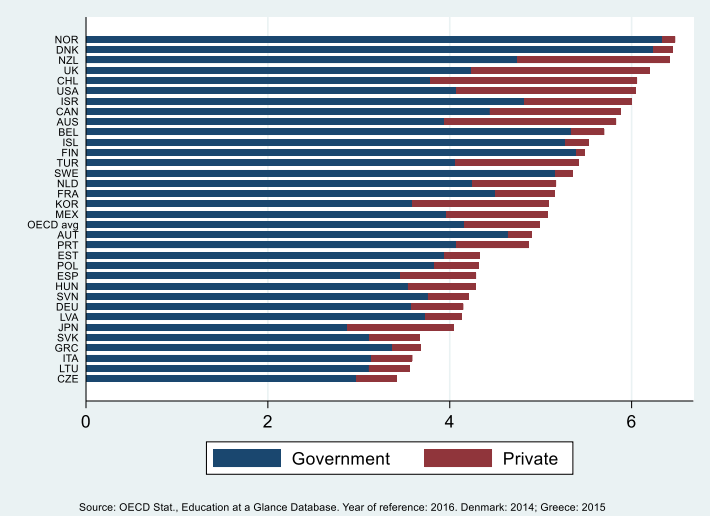
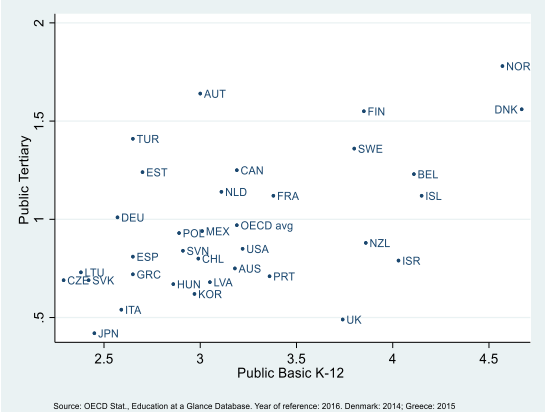


Figure 1 and additional data summarised in Appendix 2 demonstrate the substantial variability in education expenditures and the important differences in the source of funding among OECD countries. All Nordic and some continental European countries (e.g. Austria, Belgium, and France) are high spenders, mostly from public funds. Anglo-Saxon countries (Australia, the United Kingdom, the United States, and New Zealand), Chile, South Korea, and Japan are high spenders in terms of spending per student, but with a relevant share of private funding (above 29% of total spending). Lastly, countries such as the Czech Republic, Greece, Italy, Lithuania, and Slovakia are low spenders from both funding sources.

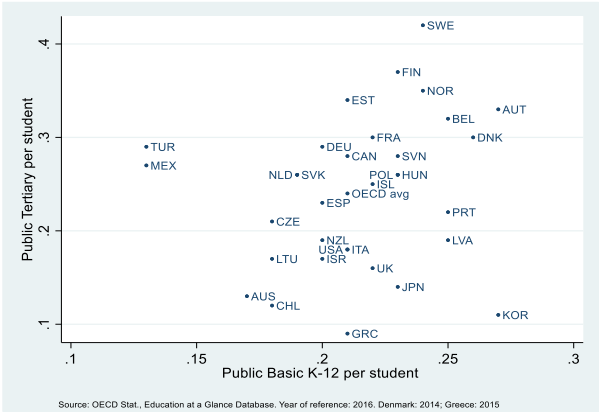
[10] We do not consider Luxembourg and Ireland because they are outliers in terms of GDP. In the case of Ireland, GDP is not a satisfactory measure of the country's income because of the large income outflow (in 2015, Irish GDP was over 150% of Irish GNI). Moreover, we rule out Switzerland because data on private expenditures are missing over the period 2010-2016.

Figure 2 shows the allocation of public expenditure in basic and tertiary education. It considers public expenditure as a share of GDP and public expenditure per student as a share of GDP per capita (panels *a* and *b*, respectively). [11] A positive relationship between public spending on the two tiers of education is observed: countries spending more on basic education tend to also spend more on tertiary education. Moreover, high private spenders tend to concentrate public spending on basic education (e.g. United Kingdom), which is expected because private spending is concentrated on tertiary education. High public spenders (e.g. Nordic countries, France, Belgium, Austria) tend to either have a balanced composition or be slightly biased towards tertiary education. Low spenders, especially low public spenders, are biased towards basic education; the exceptions are Turkey and Mexico, which are biased towards tertiary education.

Figure 2. Public spending, basic versus tertiary education



Panel a: expenditure as % of GDP



Panel b: expenditure per student as % of GDP per capita

To examine the composition of public spending more deeply, in Tables A1(a) and A1(b) in Appendix 2, we have computed for each country a 'public tertiary bias' index, by comparing the ratio of tertiary to basic public spending with the OECD average ratio. A value of the index greater

[11] Compared with panel a, panel b also considers the numerosity of the student population and thus, indirectly, the demographic structure and the length of the compulsory education period; furthermore, spending per student is sometimes considered a proxy for the quality of education (see, for example, De la Croix and Doepke, 2009). An open question is which variable should be considered when discussing political preferences for education spending. For example, in Japan, education spending is extremely low, if considered as a share of GDP, but less so when examining per capita values, particularly from private funding. Another example is Israel, where education expenditure as a share of GDP is high (almost 6%), but public spending per student as a share of GDP per capita is relatively low.

(smaller) than one suggests that the country is biased towards tertiary (basic) education. The values of this index confirm our analysis.

In summary, the evidence presented in this section highlights the existence of four education models (see Di Gioacchino et al., 2022). In the first model, education spending is high, almost entirely financed by public funds, and the budget is balanced between the two tiers of education. In the second model, education spending is high, but a large part, mostly at the tertiary level, is financed by private funds. In the third model, spending is low from both funding sources and biased towards basic education. In the fourth model, spending is relatively low and biased towards tertiary education. The first model includes Nordic countries and some continental countries. The second model includes Anglo-Saxon countries, Chile, Japan, and South Korea. The third model includes Italy, Greece, and the Czech Republic, as the most significant examples. The fourth model consists of Turkey and Mexico.

In the next section, we present a political economy model that helps explain the evidence discussed in this section.

4. The model

We consider a two-period economy with a continuum of households of mass one. Each household comprises one parent and one child.[12] Parents are differentiated according to human capital and income, which are exogenously given. Human capital has two levels: high ($h_p = 1$), if the parent has graduated from university, and low ($h_p = h < 1$), if the parent has not. Let *K* be the share of graduate parents, while the complementary share (1-*K*) is that of non-graduate ones. Parents' income consists of a common stochastic rate *x* multiplied by one's human capital h_p. The common stochastic rate *x* is uniformly distributed over the interval $[(m-\delta),(m+\delta)]$, with $m > \delta$.[13] The

[12] We are aware of the trade-off between quantity and quality of children, but in this model, we do not address fertility decisions.
[13] This assumption is consistent with the idea of efficiency units of labour. We thank a referee for this suggestion.

parameter δ can be thought of as a measure of income inequality.[14] Thus, the economy's average income is $M = (1 - K)hm + Km$.[15]

We assume that in the first period parents save the whole of their income and thus consume only in the second period.[16] Household utility is derived from consumption of the numeraire good, *c*, and child's human capital, h_c, according to the following utility function:

$$U(c, h_c) = ln(c) + \gamma\,[ln(h_c)] \qquad \textbf{(1)}$$

The parameter γ ∈R++ is the weight attached to the child's human capital.

4.1 Children's human capital formation

This section describes children's human capital formation by emphasising its dependence on parental education and the potential role of the education system in mitigating this dependence. Human capital formation is modelled as a two-stage process. The first stage (basic education), which corresponds to primary and secondary education, is mandatory and depends on the government's expenditure on basic education, G_B, with no direct costs to the parents.[17] The human capital accumulated in the first stage also depends on parental human capital h_p.[18] This dependence, (intra-family externality), is mitigated by the inclusivity of the school system, and in a perfectly inclusive system, all children can fully exploit returns from public education, independently of their parent's education. We denote by h_B the (basic) human capital accumulated during the first stage and assume the following production function:

$$h_B = \begin{cases} {h_p G_B}^{\alpha} & if\ the\ system\ is\ non-inclusive \\ {G_B}^{\alpha} & if\ the\ system\ is\ inclusive \end{cases}$$

where α, the elasticity of human capital wrt spending on basic education, is an efficiency parameter.

[14] We have chosen a uniform distribution of income for analytical tractability. We are aware that in this case, under majority voting, the standard Metzler and Richard (1981) redistribution issue disappears. As we discuss later, in our model, the effect of income inequality on public education budget does not depend on the distance between median and average income, but on the parameter δ.

[15] Income consists of a general consumption good that will serve as numeraire.

[16] A sure-return linear storage technology exists which earns a gross return equal to 1, for each unit of income saved.

[17] Hereafter, we assume that the price of one unit of education (both publicly of privately provided) is equal to 1 in terms of the numeraire good.

[18] We do not consider the role of children's innate ability; although this is obviously an important factor of the learning process, it is realistic to imagine that they are equally distributed among children with different social backgrounds.

For simplicity, we assume that all children enrol at university, but only a share of them complete their advanced studies.[19] In a non-inclusive system, the probability of completing a tertiary education cycle depends on the human capital accumulated in the first stage.[20] Specifically, denoting by $\eta(h_B)$ the probability of graduating from university, we assume:

$$\eta(h_B) = \begin{cases} \eta < 1 & if\ h_B = hG_B{}^{\alpha} \\ 1 & if\ h_B = G_B{}^{\alpha} \end{cases}$$

Thus, in a non-inclusive system, children with a non-graduate parent have a probability $\eta < 1$ of graduating from university (the drop-out rate is 1- η >0), while children whose parents have a university degree complete tertiary education with a probability equal to 1.[21]

The probability η can be interpreted as a measure of the inclusiveness of the education system. Indeed, in an ideal, perfectly inclusive system, the probability of graduating from university should not depend on parental education, since human capital accumulated in the first stage would not depend on family background.

We assume that parents can opt out of the public university system and pay for their children's tertiary education. In this case, they freely choose the amount of private education expenditure, denoted by *e*. We assume that *e* is tax deductible; deductibility simplifies the analysis and it is a feature observed in many OECD countries. By contrast, the public university system provides a uniform education that depends on the level of public expenditures G_T.[22]

Denoting by h_T the human capital accumulated at the second stage, we posit:

[19] Here, we do not consider the enrolment decision. In other words, we are assuming that the opportunity cost to enrol at university is zero, overlooking the trade-off involved in balancing out (opportunity) costs and benefits from enrolment in higher education. As explained in footnote 4, this assumption simplifies the analysis but does not affect qualitative results.

[20] It is worthwhile to note that, in addition to accumulated education, other (non-modelled) inherited cultural and economic factors might affect university achievement and justify the assumption that children with non-graduate parents have a higher probability of dropping out than graduate parents' children have.

[21] To have a share of graduate parents that does not change over time and it remains less than 1, we would need to introduce a positive rate of dropping out for children with graduate parents. However, assuming a dropping out probability equal to zero for children with graduate parents allows for a simpler notation without changing qualitative results.

[22] We overlook the congestion effect in higher education and assume that individual capital accumulation depends on public expenditure G_T and not on public expenditure per student. We justify this assumption by referring to empirical evidence that class size does not affect educational outcomes in undergraduate classes. On this point see Naito and Nishida (2017) and references cited therein.

$$h_T = \begin{cases} e & if\ private\ university \\ G_T & if\ public\ university \end{cases}$$

and we assume that a child's human capital builds as follows:

$$h_c = \begin{cases} max\ (h_B h_T, h_B) & if\ tertiary\ education\ is\ completed \\ h_B & otherwise \end{cases}$$

Summing up, a given level of tertiary spending -either private or public- adds to the human capital accumulated through basic education, the more so the higher is basic human capital. Note that higher education is effective, that is $h_B h_T > h_B,$ if h_T is greater than 1.

Therefore, the household expected utility function is:

$$\begin{aligned} EU(c, h_c) &= (1 - \eta(\, h_B)\,)[ln(c) + \gamma\, ln(h_B)] \\ &\quad + \eta(h_B)\left[ln(c) + \gamma\,[ln(h_B) + \ Iln(h_T)]\right] \\ &= \ ln(c) + \gamma\,[ln(h_B) + \ I\eta(\, h_B)\, ln(h_T)] \end{aligned} \qquad \textbf{(2)}$$

with I =0 for $h_T \leq 1$ and I=1 for $h_T > 1$.

Total public education expenditure is financed by a proportional income tax $\tau \in [0, \bar{\tau}]\ with\ \bar{\tau} < 1$. This tax is meant to represent the incremental impact of public education financing needs on the overall tax system. The tax rate τ and the allocation of tax revenues between basic and tertiary education are determined through a voting process described in section 4.6.

4.2 Timing of events.

In the first period, parents decide whether to enrol the child at a public or a private university and then, majority voting decides τ and the allocation of tax revenues between G_B and G_T. When making the education choice, parents have perfect foresight regarding the outcome of the voting process and the resulting public tertiary spending.[23] In the second period, households consume, children acquire basic education, and may or may not complete tertiary education.

4.3 Private education choice.

[23] As in De la Croix and Doepke (2009), we motivate such timing by the observation that public education spending can be adjusted more frequently than the choice between public versus private education, which might entail substantial switching costs.

Hereafter, we consider a non-inclusive education system where $\eta(\ h_B) = \eta < 1$ for households with non-graduate parents and $\eta(\ h_B) = 1$ for households with graduate parents. We will discuss the case of a perfectly inclusive system in section *4.6.1*.

Parents, who decide to opt out of the public system, choose *e* to maximise expected utility, given by (2), under the budget constraint

$$c = (1 - \tau)\big(h_p x - e\big) \quad \textbf{(3)}$$

and under the condition *c>0*, which implies $e < h_p x$.

Substituting (3) in (2) and setting $h_T = e \; and \; I = 1$, we obtain household expected utility if choosing private tertiary education:

$$EU(c, h_c) = ln\big[(1 - \tau)\big(h_p x - e\big)\big] + \gamma\ [ln(h_B) + \ \eta(\ h_B)\ ln(e)] \quad \textbf{(4)}$$

Straightforward computation shows that the optimal level of private education spending e^* is given by

$$e^* = \frac{\eta(\ h_B)\,\gamma}{1 + \eta(\ h_B)\,\gamma} h_p x \quad \textbf{(5)}$$

Private spending on education depends positively on income $h_p x$, and it is positive and greater than 1 only if household income is high enough, that is if

$$h_p x > \frac{1 + \eta(\ h_B)\,\gamma}{\eta(\ h_B)\,\gamma} \quad \textbf{(6)}$$

From (6), we posit:

Assumption 1:

(i) $\frac{1+\eta\gamma}{\eta\gamma} > h(m + \delta)$

(ii) $\frac{1+\gamma}{\gamma} < m + \delta$

Assumption 1 *(i)* implies that non-graduate parents $\big(\eta(\ h_B) = \eta\ ;\ h_p = h < 1\big)$ cannot afford a private investment $e > 1$, and therefore their children cannot attend a private university.

Assumption 1 *(ii)* implies that all households whose parent is a graduate ($\eta(\ h_B) = 1;\ h_p = 1$) and whose income is high enough ($x > \frac{1+\gamma}{\gamma}$) can afford to invest $e > 1$.

When deciding whether to opt out of the public system and privately pay for their children's tertiary education, parents have perfect foresight regarding the outcome of the voting process. Let G_T^e be the expected level of public tertiary education expenditure resulting from the voting outcome. If $G_T^e \leq 1$, all parents who can afford to pay $e^* > 1$ will do so. This means that all graduate parents with $x > \frac{1+\gamma}{\gamma}$ will pay for private tertiary education according to (5). Differently, if $G_T^e > 1$, to determine a graduate parent's choice between a private and a public university, we must compare the household indirect utility of the two alternatives.

Substituting (5) with $\eta(\ h_B) = 1$ and $h_p = 1$ in (4), we obtain the indirect utility of a graduate parent choosing a private university:

$$V(e^*) = ln\big((1 - \tau)(x - e^*)\big) + \gamma\,[ln(h_B) + ln(e^*)]$$

$$= ln(1 - \tau) + ln\left(\frac{1}{\gamma + 1}x\right) + \gamma\, ln(h_B) + \gamma ln\left(\frac{\gamma}{\gamma + 1}x\right)$$

If choosing public tertiary education, $h_T = G_T^e$ and the household indirect utility is

$$V(G_T^e) = ln(1 - \tau) + lnx + \gamma\, ln(h_B) + \gamma\, ln(G_T^e)$$

By imposing

$$V(e^*) = V(G_T^e)$$

we obtain the threshold income level $\hat{x}$ such that, when $G_T^e > 1$, a graduate parent with income $x = \hat{x}$ is indifferent between a public and a private university:

$$\hat{x}(G_T^e) = \frac{(1 + \gamma)^{\frac{1+\gamma}{\gamma}}}{\gamma} G_T^e$$

with $\frac{d\hat{x}(G_T^e)}{dG_T^e} > 0$.

Summing up:

$$\hat{x}(G_T^e) = \begin{cases} \dfrac{1+\gamma}{\gamma} & \text{if } G_T^e \leq 1 \\ \dfrac{(1+\gamma)^{\frac{1+\gamma}{\gamma}}}{\gamma} G_T^e & \text{if } G_T^e > 1 \end{cases} \quad \textbf{(7)}$$

Graduate parents with income $x > \hat{x}(G_T^e)$ opt out of the public system and the lower is expected public spending on tertiary education, the higher is the share of households opting out of the public system. [24]

4.4 Opting out and the public education budget

To compute the rate of opting out, we must distinguish between non-graduate and graduate parents. Given Assumption 1, non-graduate parents never opt out, because the costs of private education overcome the expected benefits.

The rate of opting out of children with graduate parents, denoted by Ω, depends on the expected level of public expenditure in tertiary education. If $G_T^e \leq 1$, graduate parents with $x > \frac{1+\gamma}{\gamma}$ enrol their children at private universities (see (7)). In this case, the rate of opting out is

$$\Omega = \begin{cases} 1 & if\ \dfrac{1+\gamma}{\gamma} \leq m - \delta \\ 1 - \dfrac{\frac{1+\gamma}{\gamma} - (m-\delta)}{2\delta} & if\ \ m-\delta < \dfrac{1+\gamma}{\gamma} < m+\delta \end{cases} \quad \textbf{(8a)}$$

If $G_T^e > 1$, from (7) the rate of opting out is

$$\Omega = \begin{cases} 1 & \hat{x}(G_T^e) \leq m - \delta \\ 1 - \dfrac{\hat{x}(G_T^e) - (m-\delta)}{2\delta} & m-\delta < \hat{x}(G_T^e) < m+\delta \\ 0 & \hat{x}(G_T^e) \geq m+\delta \end{cases} \quad \textbf{(8b)}$$

Let us now define the income threshold level as a function of the opting out rate Ω: [25]

$$\tilde{x} = (m+\delta) - 2\delta\Omega.$$

[24] There is a discontinuity in the threshold level $\hat{x}(G_T^e)$ at $G_T^e = 1$

[25] We are introducing the new notation $\tilde{x}$ for the income threshold level that separates public and private university pupils because $\tilde{x}$ and $\hat{x}$ do not exactly coincide: when $\hat{x} > m + \delta$, $\tilde{x} = m + \delta$ and when $\hat{x} < m - \delta$, $\tilde{x} = m - \delta$.

The government education budget is then given by:

$$F(\tau; K, \Omega, \delta) = (1-K)h\int_{(m-\delta)}^{(m+\delta)} \tau x \frac{1}{2\delta} dx + K\left[\int_{m-\delta}^{m+\delta} \tau x \frac{1}{2\delta} dx - \int_{\tilde{x}}^{m+\delta} \tau\left(\frac{\gamma}{1+\gamma}\right) x \frac{1}{2\delta} dx\right]$$

where the second term in the square brackets on the right-hand side is due to deductibility of private education expenditures, which reduces the available budget.

By solving the integral, we obtain

$$F(\tau; K, \Omega, \delta) = \tau\left[M - K\frac{\gamma}{1+\gamma}[\Omega(m+\delta(1-\Omega))]\right] \quad \textbf{(9)}$$

The budget increases with the tax rate ($\frac{\partial F}{\partial \tau} > 0$) and it decreases with the rate of opting out ($\frac{\partial F}{\partial \Omega} < 0$) and with income inequality ($\frac{dF}{d\delta} = \frac{\partial F}{\partial \delta} + \frac{\partial F}{\partial \Omega}\frac{\partial \Omega}{\partial \delta} < 0$). Notably, income inequality negatively affects the budget because private spending on education increases with inequality and private expenditures are tax deductible. The effect of an increase in the share of graduate parents (K) on the budget is ambiguous. Indeed, average income increases, but so do deductible private expenditures.

Given the budget $F(\tau; K, \Omega, \delta)$, a share ϕ is spent on basic education, thus $G_B = \phi\, F(\tau; K, \Omega, \delta)$; the complementary share $(1-\phi)$ determines the level of public spending on tertiary education, thus $G_T = (1-\phi)F(\tau; K, \Omega, \delta)$. Majority voting decides τ and ϕ.

4.5 Preferences

We distinguish three groups. The first group (A) comprises non-graduate parents *(h_p =h<1)*; their share in the population is $(1-\mathrm{K})$. The second group (B) comprises graduate parents *(h_p =1)* whose income is below $\hat{x}(G_T^e)$; their measure is $\mathrm{K}\,(1-\Omega)$. Group A and group B never enrol their children at private universities. The third group (C) comprises graduate parents whose income is above $\hat{x}(G_T^e)$; they opt out of the public system and their measure is KΩ.

We now compute each group's preferred tax rate and allocation of public budget between the two education tiers, that is, the couple $(\tau^P\ ,\ \phi^P)$ for $P \in \{A, B, C\}$. In so doing, we assume that there is

enough fiscal space to guarantee that the tertiary education public expenditure preferred by group A and group B is effective:

$$G_T^P = (1-\phi^P)F(\tau^P; K, \Omega, \delta) > 1 \; for \; \mathrm{P} \in \{A, B\} \qquad \textbf{(10)}$$

If this were not the case, in equation (2) it would be $I = 0$ and all groups' preferred level of public tertiary spending would be zero.

Group A's preferences (h_p =h)

Taking Ω as given, group A's preferred tax rate and allocation of the public budget, $\tau^A \; and \; \phi^A$, are given by

$$\tau^A = arg \max_{0 \le \tau < \bar{\tau}} [ln(1-\tau)hx + \gamma(\alpha \, ln \, h\phi \; F(\tau; K, \Omega, \delta) + \eta ln(1-\phi) \; F(\tau; K, \Omega, \delta))]$$

$$= \frac{\gamma(\alpha+\eta)}{1+\gamma(\alpha+\eta)}$$

$$\phi^A = arg \max_{0 \le \phi \le 1} [ln(1-\tau)hx + \gamma(\alpha \, ln \, h\phi \; F(\tau; K, \Omega, \delta) + \eta ln(1-\phi) \; F(\tau; \; K, \Omega, \delta))] = \frac{\alpha}{\alpha+\eta}$$

Thus, their preferred level of public university funding is $G_T^A = (1-\phi^A)F(\tau^A; K, \Omega, \delta)$, where $F(\tau^A; K, \Omega, \delta)$ is given by (9) substituting $\tau = \tau^A$.

Group B's preferences (h_p=1 and $x \le \hat{x}(G_T^e)$)

Taking Ω as given, group B's preferred tax rate and preferred allocation, τ^B and ϕ^B, are given by

$$\tau^B = arg \max_{0 \le \tau < \bar{\tau}} [ln(1-\tau)x + \gamma(\alpha \, ln \, h\phi \; F(\tau; K, \Omega, \delta) + ln(1-\phi) \; F(\tau; K, \Omega, \delta))]$$

$$= \frac{\gamma(\alpha+1)}{1+\gamma(\alpha+1)}$$

$$\phi^B = arg \max_{0 \le \phi \le 1} [ln(1-\tau)x + \gamma(\alpha \, ln \, h\phi \; F(\tau; K, \Omega, \delta) + ln(1-\phi) \; F(\tau; \; K, \Omega, \delta))] = \frac{\alpha}{\alpha+1}$$

Thus, their preferred level of public university funding is $G_T^B = (1-\phi^B)F(\tau^B; \; K, \Omega, \delta)$, where $F(\tau^B; K, \Omega, \delta)$ is given by (9) substituting $\tau = \tau^B$.

Group C's preferences (h_p=1 and $x > \hat{x}(G_T^e)$)

Taking Ω as given, group C's preferred tax rate and preferred allocation, τ^C and ϕ^C, are given by

$$\tau^C = arg \max_{0\le\tau<\bar{\tau}} \left[ln(1-\tau)\frac{1}{\gamma+1}x + \gamma\left(\alpha\, ln\,\phi\, F(\tau;\, K,\Omega,\delta) + ln\frac{\gamma}{\gamma+1}x\right)\right] = \frac{\gamma\alpha}{1+\gamma\alpha}$$

$$\phi^C = arg\, max_{0\le\phi\le1}\left[ln(1-\tau)\tfrac{1}{\gamma+1}x + \gamma\left(\alpha\, ln\,\phi\, F(\tau;\, K,\Omega,\delta) + ln\tfrac{\gamma}{\gamma+1}x\right)\right] \;= 1$$

Thus, their preferred level of public university funding is $G_T^C = (1-\phi^C)F(\tau^C;K,\Omega,\delta)$=0, for each Ω.

We can order the preferences of the three groups as follows:

$$\begin{matrix}\tau^B \ge \tau^A \ge \tau^C \\ \phi^B \le \phi^A \le \phi^C = 1\end{matrix} \qquad \textbf{(11)}$$

If no group has an absolute majority, then the median voter in both policy dimensions belongs to group A, the group of non-graduate parents.

4.6 Political Equilibrium.

Thus far, we have taken the rate of opting out Ω as given and solved for each group's preferred pair $(\tau^P,\ \phi^P)$, $P \in \{A,B,C\}$ .We now consider the political process in which parents vote on the income tax to finance public education and on the allocation of the public budget between the two education tiers. Since the policy space is bidimensional, majority voting might lead to cycles and non-existence of a (Condorcet) winner. To overcome this problem, we impose institutional restrictions, as in Shepsle (1979) and suppose that the voting procedure prescribes to vote separately and simultaneously on each policy dimension. In our political game, issue-by-issue voting requires to find two reaction functions for each group of households: $\tau(\phi)$ and $\phi(\tau)$. The first gives the preferred value of τ for every value of ϕ; the second, the preferred value of ϕ for every value of τ. The voting outcome is a Nash-like solution: i.e. a pair of policies (τ^*, ϕ^*) that are mutual best responses.[26] Since, as it is easy to verify from section 4.5, our groups' reaction functions are vertical and horizontal lines in the plane (τ, ϕ), if an equilibrium of the voting game exists - see propositions 1 and 2 below- it reflects the preferences of the median voter in each dimension

[26] That is $\tau^* = \tau(\phi^*)\ and\ \phi^* = \phi(\tau^*)$

(Persson and Tabellini, 2000). [27] Thus, if one group is majoritarian, the equilibrium voting outcome reflects the preferences of this group. If none of the groups is majoritarian, the equilibrium of the voting game reflects the preferences of the median voter who, given the preference ranking (11), belongs to group A for both policy dimensions.

In this framework, we define a political equilibrium in which the choice of opting out from the public system must be optimal and the expectations must be rational.

Definition 1. Political equilibrium.

A political equilibrium comprises an income threshold $\hat{x}$ *satisfying (7), a private education spending decision for graduate parents,* $e^* = 0$ *for* $x \leq \hat{x}$*, and* $e^* = \frac{\gamma}{\gamma+1}x$ *for* $x > \hat{x}$*, and aggregate variables* $(\tau^*, \phi^*, \Omega(G_T^e))$*, where* $\Omega(G_T^e)$ *is given by (8a) or (8b), and the pair* (τ^*, ϕ^*) *is the outcome of the majority voting game, such that the perfect foresight condition holds:*

$$G_T^* = (1-\phi^*)F(\tau^*; K, \Omega(G_T^e), \delta) = G_T^e \qquad \textbf{(12)}$$

and, if G_T^* *is positive, it must be greater than 1 (effectiveness).*

The conditions for the existence of an equilibrium of the voting game are established by the following two propositions.

Proposition 1 (Existence of a unique fixed point).

For $P \in \{A, B\}$*, if (10) holds for* $G_T^e > 1$*, there exists a unique fixed point* G_T^{P*} *such that the perfect foresight condition (12) holds, that is:*[28]

$$G_T^{P*} = (1-\phi^P)\tau^P \left[M - K\frac{\gamma}{1+\gamma}\Omega(G_T^{P*})\left(m + \delta(1-\Omega(G_T^{P*}))\right)\right] \qquad \textbf{(13)}$$

[27] Moreover, with vertical and horizontal reaction functions, sequential voting would lead to the same result (see Persson and Tabellini, 2000).

[28] Note that for $P \in \{A, B\}$, if $0 \leq G_T^e \leq 1$ even if a fixed point existed, it could not be an equilibrium of the voting game. In fact, since $G_T^P > 0$, the perfect foresight condition would only be satisfied for $0 < G_T^P \leq 1$: the investment in tertiary public education would not be effective and would not receive political support.

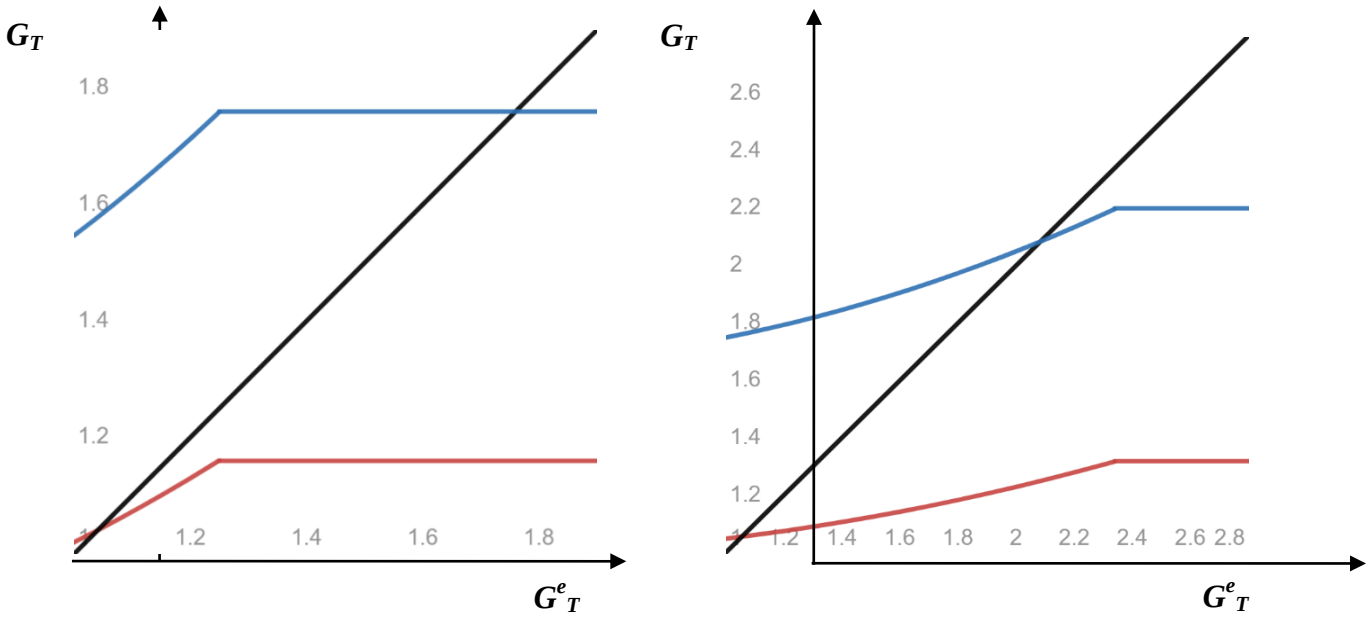
with $1 < G_T^{P*} \leq z^P M$ *and* $G_T^{A*} < G_T^{B*}$. *Moreover,* $\frac{dG_T^{P*}}{d\eta} > 0$ *and* $\frac{dG_T^{P*}}{d\delta} < 0$.

For P =C, there exists a unique fixed point $G_T^{C*} = 0$

Proof. *See Appendix 1.*

The two figures below, give a graphical representation of proposition 1 showing the fixed points for various values of the model parameters. In Figure 1, the fixed-point mapping for group A is in red and the fixed-point mapping for group B is in blue. In the left panel, the model parameters' set is: $(\alpha = 0.5;\ \gamma = 0.33; h = 0.5;\ \delta = 2; K = 0.6; m = 10;\ \eta = 0.6)$. In this case, the fixed-points are G_T^{A*} =1.04 and $G_T^{B*} = z^P M = 1.77$. In the right panel, the parameters are: $(\alpha = 0.4;\ \gamma = 0.4; h = 0.3;\ \delta = 7; K = 0.6; m = 12;\ \eta = 0.53)$. For these parameters' values, the fixed points are G_T^{A*} =1.06 and G_T^{B*} =2.08.

Figure 1: Groups A (red) and B (blues) fixed-point mappings.

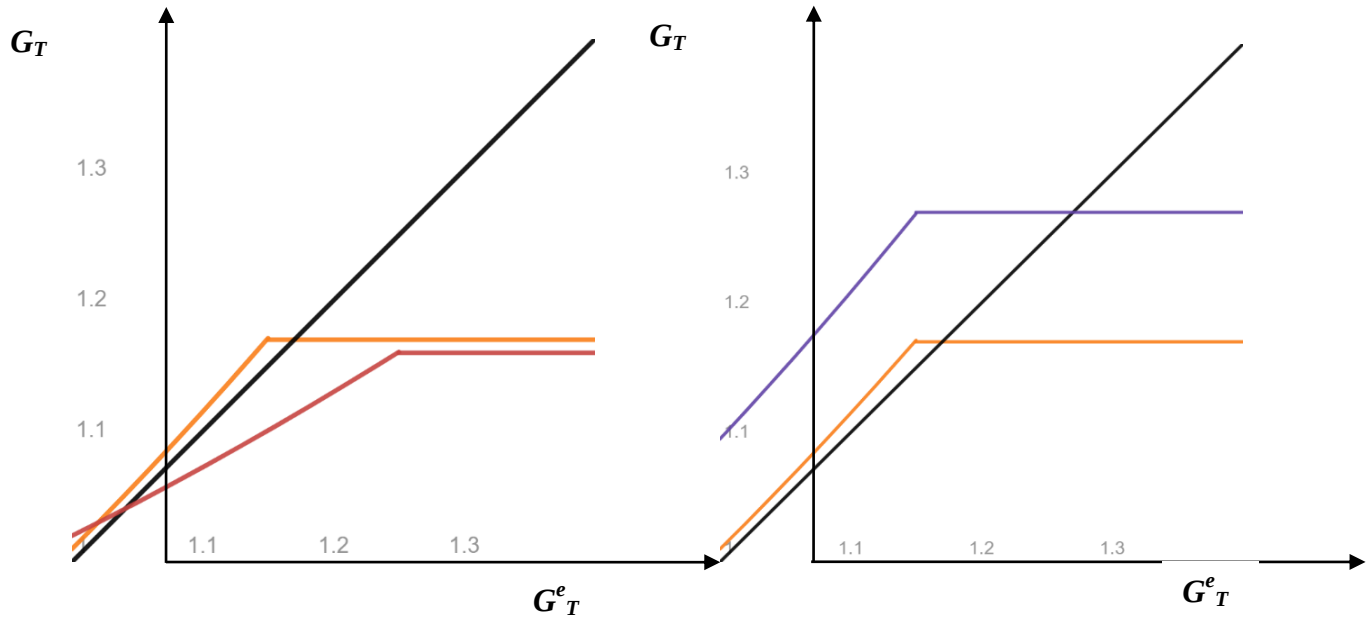


Focusing on group A's fixed-point mapping,[29] Figure 2 shows how the fixed-point changes with δ and η. Keeping fixed the other parameters $(\alpha = 0.5;\ \gamma = 0.33; h = 0.5;\ K = 0.6; m = 10)$, the

[29] Analogous graphs can be obtained for group B, changing δ

left panel suggests that increasing δ the fixed-point G_T^{A*} decreases and the right panel shows that increasing η the fixed-point G_T^{A*} decreases.

Figure 2: group A's fixed-point mapping.



Panel A ($\eta = 0.6$): Red $\delta = 2$; Orange $\delta = 1$ **Panel B ($\delta = 1$): Purple $\eta = 0.67$; Orange $\eta = 0.6$**

Proposition 2 (Existence of equilibria)

2.1 If group A is majoritarian (i.e. $1 - K > \frac{1}{2}$*), then there exists a unique equilibrium of the voting game:* $[\tau = \tau^A,\ \phi = \phi^A]$ *with* $G_T^e = G_T^{A*}$.[30]

2.2 If group A is not majoritarian, then multiple equilibria might arise as self-fulfilling prophecies. Three equilibria are possible:

$[\tau = \tau^A,\ \phi = \phi^A]$ *with* $G_T^e = G_T^{A*}$, *if (i)* $1 - \Omega(G_T^{A*}) < \frac{1}{2K}$ *and* $\Omega(G_T^{A*}) < \frac{1}{2K}$;

$[\tau = \tau^B,\ \phi = \phi^B]$ *with* $G_T^e = G_T^{B*}$, *if (ii)* $1 - \Omega(G_T^{B*}) > \frac{1}{2K}$;

$[\tau = \tau^C,\ \phi = \phi^C]$ *with* $G_T^e = G_T^{C*}$, *if (iii)* $\Omega(G_T^{C*}) > \frac{1}{2K}$.

[30] Note that, in the extreme case of $\eta = 0$, the preferences of non-graduates (group A), as for public tertiary spending, would coincide with those of the rich educated élite (group C). This result recalls Epple and Romano's (1996b) 'ends-against-the-middle' type of equilibrium.

Proof. *See Appendix* 1.

4.6.1 *Inclusive education system*

In an ideal perfectly inclusive system, where $\eta = 1$, the income constraint given by (6) would be less binding and some non-graduate and rich enough parents might afford to opt out of the public system. In this perspective, we substitute Assumption 1 by

Assumption 1bis:

$$\frac{1+\gamma}{\gamma} < h(m+\delta)$$

In this setting, we would have only two groups: those who opt for the public system and those who opt for a private university. The maximisation problem of the first group is the same as group B's in a non-inclusive system, but they would be joined by non-graduate parents with "low income". Similarly, the maximisation problem of the second group is the same as group C's in a non-inclusive system, but they would be joined by non-graduate parents with "high income".

It is easy to show, slightly modifying Proposition 2, that if the two conditions $1 - \Omega(G_T^{B*}) > \frac{1}{2}$ and $\Omega(G_T^{C*}) > \frac{1}{2}$ are satisfied, two equilibria of the voting game exist: $[\tau = \tau^B, \phi = \phi^B]$, with $G_T^e = G_T^{B*}$, and $[\tau = \tau^C, \phi = \phi^C]$, with $G_T^e = G_T^{C*}$. Since at least one of the two conditions is satisfied, one equilibrium always exists.[31]

4.7 *Discussion of the political equilibria outcomes.*

In the previous section, we have shown that if group A is majoritarian, the unique political equilibrium features a lower level of public education expenditure relative to what group B prefers. This implies that in countries where the share of the population with tertiary education is low and the education system is not inclusive, we expect to observe low investments in public education, especially at the tertiary level. This policy choice is self-reinforcing insofar as it prevents the

[31] Suppose that $1 - \Omega(G_T^{B*}) < \frac{1}{2}$, then $\Omega(G_T^{B*}) > \frac{1}{2}$. Noting that, by Proposition 1, $G_T^{B*} > G_T^{C*}$, and therefore $\Omega(G_T^{C*}) > \Omega(G_T^{B*}) > \frac{1}{2}$. If $\Omega(G_T^{C*}) < \frac{1}{2}$, then, by the same argument it follows that $1 - \Omega(G_T^{B*}) < \frac{1}{2}$.

graduate population from growing and it keeps the economy from switching to an equilibrium supported by a graduate pivotal voter, likely belonging to group B, with a strong preference for tertiary public education.[32] Nevertheless, and interestingly enough, our model shows that, even when graduate households are the majority, the economy might remain stuck in an equilibrium characterised by low public education spending. Indeed, in this case, the model exhibits a potential for multiple equilibria, and a low public education spending equilibrium would be consistent with low public education budget expectations. This scenery could describe the situation observed in countries characterised by high private education expenditures. It is important to note that the potential for multiple equilibria suggests that, by affecting expectations about public education expenditures, a policy-maker could build the conditions to switch to a higher public spending equilibrium. Namely, by announcing the will to increase the investment in public education, especially at the tertiary level, a higher share of graduate households would opt for the public system and would make the increase in public spending feasible**.** The likelihood of a high public spending equilibrium would also increase if the education system were inclusive. In this case, the interests of low-socioeconomic status households would be aligned with those of the educated middle class. Thus, by improving the inclusiveness of the education system, a policy-maker can again affect political support for high public education spending, especially at tertiary level. [33] Finally, since $\frac{dG_T^{P*}}{d\delta} < 0$ (by Proposition 1), a reduction in income inequality increases the likelihood of the emergence of an equilibrium supported by group B (the condition $1 - \Omega(G_T^{B*}) > \frac{1}{2K}$ would be more easily satisfied).

In addition, the results of our model suggest the following relationships between variables:

[32] This result is confirmed by Dragomirescu-Gaina et al. (2015)'s empirical analysis. They focus on Europe and highlight the growing divide between the best and the low-performing countries in terms of tertiary educational attainment. Their calculations show a slower expected progress for the lagging countries, and a faster expected progress for the high-performing countries.

[33] Note that, a political equilibrium featuring high public spending on tertiary education could also be consistent with a situation in which the private university system is absent or not sufficiently developed, the education system is not inclusive, and the pivotal voter belongs to the high social status élite, as in Su (2006). This scenery might reflect the situation observed for example in Turkey or Mexico.

i. Private spending on education is positively correlated with income inequality.

ii. Public spending on education is negatively correlated with income inequality and positively correlated with the inclusiveness of the education system. [34]

iii. The allocation of public spending between basic and tertiary education depends on the inclusiveness of the education system and on the efficiency parameter α. Namely, the share of spending on basic education decreases with the inclusiveness of the system.

iv. The share of graduate parents in the population (K) has two conflicting effects on the budget. On the one hand, a higher K indicates that a higher share of households opt out of the public system, and because they deduct private education expenditures from their tax burden, this reduces the overall budget (see eq. 9). On the other hand, a higher share of graduates has a positive effect on the budget as it increases average income. Moreover, a higher share of the population with a university degree reduces the size of group A, making it more likely for group B to be pivotal, which implies higher public education expenditures than in the equilibrium where group A is pivotal.

In the next section, focusing on education expenditures in 33 OECD countries, we seek to establish if distinctive features akin to those identified in the above discussion could be discerned.

5. Empirical evidence

Building on our theoretical results, in this section, we aim to explain countries differences, as discussed in section 3, by referring to the variation of income inequality, the inclusiveness of the education system, and the share of tertiary education graduates in the adult population. We collected data on three education spending variables (Public Basic, Public Tertiary, and Total Private) plus the share of public basic (Public Basic/Total Public) for 33 OECD countries covering two time periods. In the first period, the expenditures were computed as averages over the years 2000 to

[34] In our model, income inequality reduces the public budget through the tax deductibility of private education expenditures. However, adopting a non-majoritarian political setting, in which income inequality increases the political power of the rich educated elite, the increase in income inequality would reduce the public budget even without the tax deductibility of private education expenditures. See, for example, the probabilistic voting model of De la Croix and Doepke (2009).

2006; in the second period, averages were computed over the years 2010 to 2016 (see table A3 in Appendix 2).

To support our arguments, we examine correlations between education expenditures and the variables that in our model affect the level and the composition of these expenditures in the political equilibrium, namely income inequality, inclusiveness of the education system, and the share of graduates in the population**.** One concern here is a reverse causality link whereby low public expenditure in education leads to more inequality, lower inclusiveness, and a lower share of graduates. To try to address this problem, and to strengthen our interpretation of the results in terms of the effects of these variables on the equilibrium outcome of the political game, we consider values of income inequality, of the inclusiveness of the education system, and of the share of tertiary education graduates that precede the observed values of education expenditures.[35] Income inequality is measured by the variable GINI, which is the Gini index of disposable income for the years 2000 and 2010.[36] To assess inclusiveness, we use the variable COR, which measures the correlation between the years spent on education by parents and those by the child. We use data from the 2018 Global Database on Intergenerational Mobility of the World Bank (GDIM, 2018) for the 1970s and 1980s cohort.[37] Higher COR indicates higher intergenerational persistence in education, lower relative mobility, and lower inclusiveness.[38] Finally, the variable SHARE, the share of tertiary education graduates in the adult population, refers to the years 2000 and 2010, respectively, for the first and for the second period (see table A2 in Appendix 2).

[35] A similar approach is followed by De la Croix and Doepke (2009).

[36] As discussed in section 4, in our model, income inequality affects the public budget only through the tax deductibility of private expenses, which are decided based on perfectly foresighted public expenses. Therefore, redistribution affects private expenditure decisions. For this reason, in the correlations we use the Gini index computed for disposable income.

[37] COR measures intergenerational persistence in education by using Pearson's correlation coefficient between the years of education of parents and children. In GDIM (2018), data are available for different cohorts; the 1980s (1970s) cohort refers to the generation born between 1980 (1970) and 1989 (1979) and their parents. For parents' educational attainment, we take the subpopulation 'max', which represents the greatest available values among parents. For children's educational attainment, we consider 'all' the respondents who belong to the cohort. Further information is available on the Description of Global Database on Intergenerational Mobility (GDIM, 2018).

[38] All the results in this section are unchanged if using the beta coefficient between the years of schooling of parents and children available in the GDIM (2018).

Table 1 reports the outcome of a pooled linear regression between four spending variables (Public Basic, Public Tertiary, Total Private, and Public Basic/Total Public) and our two main variables of interest (COR and GINI). To control for time effects, we add a dummy that takes value 0 in the first period and value 1 in the second. Consistently with the model's results, public expenditure on education (as percentage of GDP) is negatively correlated with COR and GINI: higher persistence in education and higher income inequality are associated with lower public education expenditure at both education levels. COR is significant in the relationship with basic education (column 1) while GINI is relevant in both equations (columns 1 and 2). In column 3, we add an interaction term between COR and GINI. The coefficient is positive and significant, implying that the negative relationship between COR and tertiary public lessens as inequality increases.[39] To clarify this relationship, we computed marginal effects (figure A1 in Appendix 2). These marginal effects suggest that for tertiary education, the effect of COR on public tertiary spending depends on income inequality. The sign of the marginal effect of COR on public tertiary spending is negative for low values of GINI and becomes positive for high values. In light of the descriptive evidence reported in section 3, our suggested interpretation is that countries with a level of income inequality above the OECD average are also biased towards private expenditure at the tertiary level (e.g. UK and US). In these countries, the relationship between COR and public tertiary spending is very weak. This interpretation is consistent with the regression that considers private education spending as the variable of interest (column 4). Finally, and interestingly enough, the marginal effect of COR on tertiary public spending becomes strongly positive for very high levels of income inequality. This fact seems to capture what we observe for example in Mexico and Turkey, where the inclusiveness of the education system is extremely low (very high COR) and, notwithstanding the remarkably high level of income inequality, the private education sector is not well developed. Only the élite, therefore benefits from tertiary public spending; the more so the less inclusive is the system. A

[39] Also, the negative relationship between GINI and Public Tertiary is less strong when COR increases.

political equilibrium with public spending biased towards tertiary education seems therefore to be supported by the well-educated élite of these countries. [40]

As further evidence, in the last column of table 1, we examine the share of public education spending devoted to basic education. As we have observed, spending on both education levels increases if the system is more inclusive (a negative sign in the COR coefficient). However, our model suggests that spending on tertiary education increases more, so that the share of basic education decreases (see point *iii* in section 4.7). The negative sign in column (5) is consistent with this theoretical result. Lastly, the time dummy suggests a negative trend in basic education expenditure and a positive, although not always significant, trend in tertiary education expenditure, both public and private. Consistently, the share of basic public shows a small decrease.

Table 1

	(1) Basic K-12 Public	(2) Tertiary Public	(3) Tertiary Public	(4) Total Private	(5) Basic Public/Total Public
Cor	-1.721**	-.046	-5.629***	-1.473*	-.089
	(.851)	(.401)	(2.048)	(.761)	(.066)
Gini	-2.179*	-2.014***	-10.118***	5.877***	.237**
	(1.187)	(.559)	(2.969)	(1.06)	(.093)
d2010	-.268*	.019	.014	.122	-.017
	(.151)	(.071)	(.068)	(.135)	(.012)
Cor#Gini			17.805***		
			(6.416)		
_cons	4.877***	1.655***	4.174***	-.597	.739***
	(.449)	(.212)	(.93)	(.401)	(.035)
Observations	66	66	66	66	66
R-squared	.168	.188	.279	.343	.122

*Standard errors are in parentheses. *** p<.01, ** p<.05, * p<.1*

Notes: COR is the Pearson's coefficient between parents' and children's years of education. The values of COR refer to individuals born in the cohorts 1970s and 1980s. GINI is the Gini net disposable in 2000 and 2010. d2010 is a time dummy that takes value 0 in the first period and 1 in the second period. All expenditures are computed as averages over the years 2000-2006 and 2010-2016. See tables A2 andA3 in Appendix 2 for further details. Source: own elaboration based on OECD, Eurostat, Barro – Lee (2013), World Bank and GDIM (2018) data.

Next, we consider the role of the share of tertiary education graduates in the adult population. Adding SHARE for the years 2000 and 2010, as a third variable in the regressions, results in most

[40] As rightly stressed by a referee, the rich may send children overseas for private education. Looking at the outbound mobility ratio, that is the "number of students from a given country studying abroad, expressed as a percentage of total tertiary enrolment in that country", in 2016 Mexico and Turkey had very low mobility compared with the other countries in our dataset (UNESCO Institute for Statistics (http://data.uis.unesco.org/)).

coefficients of COR being not significant. This is not surprising, given the high correlation between SHARE and COR (-0.50).[41] Table 2 reports the coefficients of the linear regressions using SHARE instead of COR. The results suggest a positive and significant relationship between the share of graduates in the adult population and spending on education. According to our model, this result indicates that where the education level of the population is higher, the median voter is more educated and the demand for education is higher.

Table 2

	(1) Basic K-12 Public	(2) Tertiary Public	(3) Tertiary Public	(4) Total Private	(5) Basic Public/Total Public
Share	.026***	.007*	.09***	.022***	0
	(.008)	(.004)	(.018)	(.007)	(.001)
Gini	-2.009*	-1.801***	2.963***	6.009***	.21**
	(1.109)	(.535)	(1.1)	(.998)	(.093)
d2010	-.425***	-.036	-.054	-.009	-.017
	(.154)	(.074)	(.064)	(.138)	(.013)
Share#Gini			-.249***		
			(.052)		
_cons	3.547***	1.411***	-.227	-1.722***	.706***
	(.434)	(.209)	(.388)	(.39)	(.036)
Observations	66	66	66	66	66
R-squared	.253	.235	.443	.401	.098

*Standard errors are in parentheses. *** p<.01, ** p<.05, * p<.1*

Notes: SHARE is the share of population aged 25–64 with tertiary education in 2000 and 2010. Source: own elaboration based on OECD, Eurostat, Barro – Lee (2013), World Bank and GDIM (2018) data.

Adding an interaction term between SHARE and GINI confirms our theoretical conjecture (*point iv*): as income inequality increases, the positive effect of a high share of graduates on tertiary public expenditure becomes weaker, up to the point in which it becomes negative (figure A2 in Appendix 2). This is because, in the presence of higher income inequality, a high share of graduates in the population boosts private expenses and reduces the public budget allocated to advanced studies.

The previous discussion suggests that the empirical evidence presented here is consistent with the results of our model as summarised in section 4.7. Countries whose public expenditure is remarkably high and where private expenditure is almost non-existent have a very inclusive

[41] Results not shown and available from the authors.

education system (low COR), a high share of tertiary education graduates in the population, and a low level of inequality. By contrast, high private spenders have a Gini index and a COR value above the OECD average. Moreover, a high share of graduates boosts education expenditures, public as well as private. In low-spending countries, except for Turkey and Mexico, income inequality is around the average or slightly above, the inclusiveness of the education system is generally low, and they have a level of graduates around or below the average. In line with our model, these features translate into a political equilibrium featuring low education expenditures, particularly at the tertiary level. By contrast, Turkey and Mexico, where income inequality is remarkably high, are biased towards public tertiary education. We interpret Turkey's and Mexico's situation, as the equilibrium outcome obtained when political power is granted to the rich and well-educated élite and private alternatives in the tertiary sector are not fully developed (Su, 2006).

6. Concluding remarks and policy implications

In this paper, following a political economy approach, we investigate OECD countries' differences in education systems. The aim is to present a positive theory to explain the observed mix of public and private education spending and the allocation of public funds between basic education (primary plus secondary) and tertiary education. To analyse this issue, we propose a model where the public education budget and its allocation are endogenously determined through majority voting. Our model predicts that in countries characterised by a non-inclusive education system and by a low share of graduates in the population, the public education budget is kept at a low level and public funding for higher education is scarcely supported. The empirical evidence seems to confirm such result: the amount of resources devoted to education is low in poorly educated societies, precisely where more investment in public education is needed. This policy choice is self-reinforcing because it prevents aggregate human capital accumulation and might lock countries into 'low education' equilibria (see, for example, Italy). By contrast, in countries characterised by a high share of graduates in the population, our model exhibits multiple equilibria. We may either have a strong

public system in which many or all affluent households participate (see for example Nordic European countries), or a system characterised by a low public education expenditure (unbalanced towards basic education), where wealthy families use private providers of education, especially at the tertiary level. The divide between the two 'education models' appears to be the level of income inequality: our model indeed predicts a strong positive relationship between income inequality and the extent of private involvement in education. Such relationship is confirmed by cross-country data collected for 33 OECD countries and can explain the falling political support for public tertiary education as income inequality increases, a phenomenon observed, for example, in U.S., despite the growing number of university graduates over time.[42]

Summing up, the main policy message of our analysis is that increasing public expenditures to favour educational upward mobility might not be politically sustainable. Contrary to conventional wisdom, low social status households might oppose a rise in the level of education expenditure, especially at tertiary level. Their position can obtain the political support of the richer segment of the population, interested in reducing the public budget in favour of private expenditures. To escape a 'low education' equilibrium, rather than a generic increase in public education spending, reforms of the education system directed to improve its inclusiveness are needed. Even if these reforms are not cost-cutting, they could receive the political support of the low-educated majority, because a greater inclusiveness allows these families to benefit longer from public spending on education. In this way, a virtuous circle could be triggered that, over time, could lead to a significant increase in educational upward mobility and in the share of tertiary education graduates in the adult population.

[42] We thank Professor Joseph Joyce for stressing this point.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available at

Barro, Robert and Jong-Wha Lee, 2013. A New Data Set of Educational Attainment in the World, 1950-2010. *Journal of Development Economics*, 104, 184-198.

Eurostat Database, Gini coefficient of equivalised disposable income - EU-SILC survey, https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=ilc_di12

GDIM (2018). Global Database on Intergenerational Mobility. Development Research Group, World Bank. Washington, D.C.: World Bank Group
http://pubdocs.worldbank.org/en/791911527703565167/GDIM-May2018.csv

OECD (2003), Education at a Glance 2003: OECD Indicators, OECD Publishing, Paris, https://doi.org/10.1787/eag-2003-en

OECD (2004), Education at a Glance 2004: OECD Indicators, OECD Publishing, Paris, https://doi.org/10.1787/eag-2004-en

OECD (2005), Education at a Glance 2005: OECD Indicators, OECD Publishing, Paris, https://doi.org/10.1787/eag-2005-en

OECD (2006), Education at a Glance 2006: OECD Indicators, OECD Publishing, Paris, https://doi.org/10.1787/eag-2006-en

OECD (2007), Education at a Glance 2007: OECD Indicators, OECD Publishing, Paris, https://doi.org/10.1787/eag-2007-en

OECD (2008), Education at a Glance 2008: OECD Indicators, OECD Publishing, Paris, https://doi.org/10.1787/eag-2008-en

OECD (2009), Education at a Glance 2009: OECD Indicators, OECD Publishing, Paris, https://doi.org/10.1787/eag-2009-en

OECD (2019), Education at a Glance 2019: OECD Indicators, OECD Publishing, Paris, https://doi.org/10.1787/f8d7880d-en

OECD Statistics, Education Finance Indicators, Education at a Glance Database, https://stats.oecd.org/#

UNESCO Institute for Statistics, http://data.uis.unesco.org/

World Bank, Gini Index (World Bank estimate), https://data.worldbank.org/indicator/SI.POV.GINI

References

Aina, C., Baici, E., Casalone, G., and F. Pastore (2021). The determinants of university drop-out: A review of the socio-economic literature. *Socio-Economic Planning Sciences*, 101102.

Aina, C. (2005). Parental background and college drop-out. Evidence from Italy. *EPUNet-2005 Conference (30 junio-2 julio), Colchester, Institute for Social and Economic Research*.

Arcalean, C. and I. Schiopu (2010). Public versus private investment and growth in a hierarchical education system. *Journal of Economic Dynamics and Control*, 34(4): 604-622.

Arcalean, C., and I. Schiopu (2016). Inequality, opting-out and public education funding. *Social Choice and Welfare*, *46*(4): 811-837.

Barro, R. and J. W. Lee (2013). A New Data Set of Educational Attainment in the World, 1950-2010. *Journal of Development Economics,* 104: 184-198.

Beviá, C. and I. Iturbe-Ormaetxe (2002). Redistribution and subsidies for higher education. *Scandinavian Journal of Economics* 104 (2): 325-344.

Birdsall, N. (1996). Public spending on higher education in developing countries too much or too little? *Economic and Education Review*, 15(4), 407–419.

Blankenau, W., S. Cassou and B. Ingram (2007). Allocating government education expenditures across K-12 and college education. *Economic Theory* 31(1): 85-112.

Cunha, F. and J. Heckman (2007). The technology of skill formation. *American Economic Review*, 97(2): 31-47.

De Fraja, G. (2004). Education and Redistribution. *Rivista di Politica Economica*, V-VI:3-44.

De La Croix, D. and M. Doepke (2009). To segregate or to integrate: education politics and democracy. *Review of Economic Studies*, 76(2): 597-628.

Di Gioacchino, D. and L. Sabani (2009). Education policy and inequality: a political economy approach. *European Journal of Political Economy*, 25(4): 463-478.

Di Gioacchino, D., Sabani, L. and Tedeschi, S. (2019). Individual preferences for public education spending: Does personal income matter? *Economic Modelling*, 82: 211-228.

Di Gioacchino, D., Sabani, L. and S. Usai (2022). Intergenerational Upward (Im)mobility and Political Support of Public Education Spending. *Italian Economic Journal*, 8(1): 49-76.

Dragomirescu-Gaina, C., Elia, L., and A. Weber (2015). A fast-forward look at tertiary education attainment in Europe 2020. *Journal of Policy Modeling*, *37*(5): 804-819.

Epple, D. and R.E. Romano (1996a). Public provision of private goods. *Journal of Political Economy*, 104(1): 57-84.

Epple, D. and R. E. Romano (1996b). Ends against the middle: determining public services provision when there are private alternatives. *Journal of Public Economics*, 62(3): 297-325.

Fernandez R. and R. Rogerson (1995). On the political economy of education subsidies. *Review of Economic Studies* LXII: 249-62.

GDIM (2018). Global Database on Intergenerational Mobility. Development Research Group, World Bank. Washington, D.C.: World Bank Group.

Glomm, G. and B. Ravikumar (1992). Public versus private investment in human capital: endogenous growth and income inequality. *Journal of Political Economy 100*(4): 818-834.

Glomm, G. and B. Ravikumar (2003). Public education and income inequality. *European Journal of Political Economy*,19(2): 289-300.

Glomm, G., B. Ravikumar, and I. C. Schiopu., (2011). The Political Economy of Education Funding. *Handbook of the Economics of Education*. Vol. 4: 615-680. https://doi.org/10.1016/B978-0-444-53444-6.00009-2.

Gradstein, M., and M. Justman (1997). Democratic choice of an education system: implications for growth and income distribution. *Journal of Economic Growth, 2*(2):169-183.

Gradstein, M., 2003. The political economy of public spending on education, inequality and growth. World Bank Policy Research Working Paper, vol. 3162. *World Bank*, Washington, D.C.

Gradstein M., M. Justman and V. Meier (2004). *The Political Economy of education. Implications for Growth and Inequality*. MIT Press.

Hatsor, L. and I. Zilcha (2021). Subsidizing heterogeneous higher education systems. *Journal of Public Economic Theory*, 23(2): 318-344.

Haupt, A. (2012). The evolution of public spending on higher education in a democracy. *European Journal of Political Economy*, *28*(4): 557-573.

Lagravinese, R., P. Liberati, and G. Resce (2020). The impact of economic, social and cultural conditions on educational attainments. *Journal of Policy Modeling*, *42*(1): 112-132.

Lasram, H, and D. Laussel (2019). The determination of public tuition fees in a mixed education system: A majority voting model. *Journal of Public Economic Theory* 21(6) :1056-1073.

Levy, G. (2005). The politics of public provision of education. *Quarterly Journal of Economics* 120(4):1507-1534.

Naito, K. and K. Nishida (2017). Multistage public education, voting, and income distribution. *Journal of Economics*, 120 (1): 65-78 doi 10.1007/s00712-016-0513-5.

OECD (2019). Education at a Glance 2019: OECD Indicators, OECD Publishing, Paris, https://doi.org/10.1787/f8d7880d-en.

Persson T. and G. Tabellini (2000). *Political Economics: explaining economic policy*. MIT Press.

Restuccia, D. and C. Urrutia (2004). Intergenerational persistence of earnings: the role of early and college education. *American Economic Review* 94(5): 1354-1378.

Romero, G. (2007). Does the possibility of opting out of public education favour expenditure on basic education? University of Alicante Manuscript.

Saint-Paul, G., and T. Verdier (1993). Education, democracy and growth. *Journal of Development Economics*, *42*(2): 399-407.

Sarid, A. (2017). Public Investment in a Hierarchical Educational System with Capital–Skill Complementarity. *Macroeconomic Dynamics*, 21(3): 757-784.

Shepsle, K. (1979). Institutional Arrangements and Equilibrium in Multidimensional Voting Models. *American Journal of Political Science*, 23(1):27-59.

Soares, J. (1998). Altruism and Self-interest in a Political Economy of Public Education. IGIER working paper, Bocconi University.

Su, X. (2004). The allocation of public funds in a hierarchical educational system. *Journal of Economic Dynamics and Control*, 28(12): 2485 – 2510.

Su, X. (2006). Endogenous determination of public budget allocation across education stages. *Journal of Development Economics*, 81(2): 438-456.

Viane, J. M. and I. Zilcha (2013). Public funding of higher education. *Journal of Public Economics*, 108: 78- 89.

Zhang, L. (2008). Political economy of income distribution dynamics. *Journal of Development Economics*, 87(1): 119–139.

Appendix 1

PROOF Proposition 1

The size of the budget allocated to tertiary education depends on the identity of the pivotal group ($P \in \{A, B, C\}$) and on the rate of opting out $\Omega(G_T^e)$. To find a fixed point in tertiary public spending, define the mapping Δ^P from expected tertiary public education expenditure into the size of the budget allocated to tertiary education:

$$G_T^P = \Delta^P(G_T^e) = z^P\left[M - K\frac{\gamma}{1+\gamma}\Omega\big(E(G_T)\big)\left(m + \delta\left(1 - \Omega\big(E(G_T)\big)\right)\right)\right]$$

where $z^P = (1 - \phi^P)\tau^P$ with $z^B > z^A > z^C = 0$.

To prove Proposition 1, we must show that on the plane $[G_T^e, G_T^P]$ the mapping Δ^P crosses the 45-degree line exactly once.

We first prove that for $P \in \{A, B,\}$, when $G_T^e > 1$ there is a unique fixed point.

For $G_T^e > 1$, the mapping $\Delta^P(G_T^e)$ is continuous and weakly increasing.[43] Its minimum value is obtained for $G_T^e \to 1^+$:

$$\Delta^P(1) = z^P\left[M - K\frac{\gamma}{4\delta(1+\gamma)}\left((m+\delta)^2 - \left(\frac{(1+\gamma)^{\frac{1+\gamma}{\gamma}}}{\gamma}\right)^2\right)\right]$$

which is greater than 1 because we have assumed that (10) holds for $G_T^e > 1$.

The maximum value is obtained when $G_T^e \geq \frac{\gamma(m+\delta)}{(1+\gamma)^{\frac{1+\gamma}{\gamma}}}$ and all children with graduate parents attend public university ($\Omega = 0$). In this case, public tertiary public education spending is equal to its maximum, $z^P M$.

There are two possibilities:

(i) $z^P M < \frac{\gamma(m+\delta)}{(1+\gamma)^{\frac{1+\gamma}{\gamma}}}$

(ii) $z^P M \geq \frac{\gamma(m+\delta)}{(1+\gamma)^{\frac{1+\gamma}{\gamma}}}$

[43] Being the mapping Δ^P a monotone transformation of the budget function F, its continuity and monotonicity follows from continuity and monotonicity of *F* (see eq. (9) in section 4).

In the first case (i), $\Delta^P\ (G_T^e) <\ G_T^e$ when $G_T^e = \frac{\gamma(m+\delta)}{(1+\gamma)^{\frac{1+\gamma}{\gamma}}}$. Therefore, the mapping Δ^P crosses the 45-degree line only once for $G_T^e < z^P M$ and the fixed point G_T^{P*} lies in the interval

$$1 < G_T^{P*} < z^P M.$$

In the second case (ii), $\Delta^P\ (G_T^e) >\ G_T^e$ when $G_T^e = \frac{\gamma(m+\delta)}{(1+\gamma)^{\frac{1+\gamma}{\gamma}}}$. The mapping Δ^P crosses the 45-degree line at $G_T^e = z^P M$ and the fixed point is $G_T^{P*} = z^P M$.[44]

To prove that for $P \in (A, B)\ \ \frac{dG_T^{P*}}{d\eta} \geq 0\ and\ \frac{dG_T^{P*}}{d\delta} < 0$, consider the following function

$$Z(G_T^{P*}, \eta, \delta) = G_T^{P*} - z^P \left[\left[M - K\frac{\gamma}{1+\gamma}\Omega(G_T^{P*})(m + \delta(1 - \Omega(G_T^{P*})))\right]\right] = 0$$

We first show that

$$\frac{dG_T^{P*}}{d\eta} = -\frac{\frac{dZ}{d\,\eta}}{\frac{dZ}{dG_T^{P*}}} \geq 0$$

when $G_T^{P*}$is an interior solution.

Indeed, the numerator $(\frac{dZ}{d\,\eta})$ has negative sign for *P=A* and it is zero for *P=B (Z* does not depend on η). The denominator $(\frac{dZ}{dG_T^{P*}})$ has positive sign because, when $G_T^{P*}$is an interior solution, the mapping $\Delta^P(\cdot)$ has a positive slope smaller than 1, in the interval considered ($G_T^{P*} < z^P M$).

When $G_T^{P*} = z^P M$, $\frac{dG_T^{P*}}{d\eta} = 0$ and the result follows immediately.

To prove that $\frac{dG_T^{P*}}{d\delta} < 0$, we must show that

$$\frac{dG_T^{P*}}{d\delta} = -\frac{\frac{dZ}{d\,\delta}}{\frac{dZ}{dG_T^{P*}}} < 0$$

[44] It is possible to prove numerically that when $z^P M \geq \frac{\gamma(m+\delta)}{(1+\gamma)^{\frac{1+\gamma}{\gamma}}}$ the mapping $\Delta^P(\mathrm{G_T^e})$ crosses the 45-degree line only once, when $G_T^{P*} = z^P M$.

The numerator is positive because the budget is decreasing with inequality (see discussion after equation (9) in section 4). As discussed above, the denominator has positive sign so the result follows.

For $P = C,$ since $\Delta^C(\mathrm{G_T^e}) = 0 \quad \forall G_T^e,$ there exists a unique fixed point $G_T^{C*} = 0$ for $\mathrm{G_T^e} = 0$.

PROOF Proposition 2

2.1 For $[\tau = \tau^A,\ \phi = \phi^A]$ to be an equilibrium of the voting game, with $G_T^e = G_T^{A*}$, it must be $\Omega(G_T^{A*}) < \frac{1}{2K}$ (group C is not majoritarian), and $1 - \Omega(G_T^{A*}) < \frac{1}{2K}$ (group B is not majoritarian). If A is majoritarian, these two conditions are satisfied for any $1 < G_T^{A*} \leq z^A M$; thus, $[\tau = \tau^A,\ \phi = \phi^A]$ is the unique equilibrium.

2.2 From Proposition 1, $G_T^{C*} < G_T^{A*} < G_T^{B*}$ and $\Omega(G_T^{C*}) > \Omega(G_T^{A*}) > \Omega(G_T^{B*})$.

To show that at least one equilibrium exists, note that if neither $[\tau = \tau^C,\ \phi = \phi^C]$ nor $[\tau = \tau^B,\ \phi = \phi^B]$ are equilibria, that is if $1 - \Omega(G_T^{B*}) < \frac{1}{2K}\ and\ \Omega(G_T^{C*}) < \frac{1}{2K}$, then $[\tau = \tau^A,\ \phi = \phi^A]$ is certainly an equilibrium with $G_T^e = G_T^{A*}$. In fact, $1 - \Omega(G_T^{B*}) < \frac{1}{2K}$, implies $1 - \Omega(G_T^{A*}) < \frac{1}{2K}$, while $\Omega(G_T^{C*}) < \frac{1}{2K}$ implies $\Omega(G_T^{A*}) < \frac{1}{2K}$. In this equilibrium, group A is pivotal, although not majoritarian (see preference ranking (11)).

To show that a multiplicity of equilibria might arise, note that the conditions for the existence of perfect foresight equilibria, namely *(i)* $1 - \Omega(G_T^{A*}) < \frac{1}{2K}\ and\ \Omega(G_T^{A*}) < \frac{1}{2K}$; *(ii)* $1 - \Omega(G_T^{B*}) > \frac{1}{2K}$; *(iii)* $\Omega(G_T^{C*}) > \frac{1}{2K}$ might be simultaneously satisfied.

Appendix 2

TABLE A1 (a): Education expenditures as share of GDP

Country	Year	Total education expenditure %GDP	Public education expenditure % GDP	Public education expenditure %GDP K-12	Public education expenditure % GDP Tertiary	Bias public tertiary/public K-12	Private education expenditure %GDP	Private education expenditure %GDP K-12	Private education expenditure %GDP Tertiary
Australia	2016	5.83	3.94	3.18	0.75	0.78	1.89	0.73	1.15
Austria	2016	4.89	4.64	3.00	1.64	1.79	0.26	0.14	0.11
Belgium	2016	5.70	5.34	4.11	1.23	0.98	0.36	0.14	0.22
Canada	2016	5.88	4.44	3.19	1.25	1.29	1.44	0.34	1.10
Chile	2016	6.06	3.79	2.99	0.80	0.88	2.27	0.60	1.67
Czech Republic	2016	3.42	2.98	2.29	0.69	0.99	0.44	0.22	0.22
Denmark	2014	6.45	6.24	4.67	1.56	1.10	0.21	0.12	0.09
Estonia	2016	4.33	3.94	2.70	1.24	1.51	0.39	0.20	0.19
Finland	2016	5.48	5.39	3.85	1.55	1.32	0.09	0.03	0.06
France	2016	5.15	4.50	3.38	1.12	1.08	0.65	0.35	0.31
Germany	2016	4.15	3.58	2.57	1.01	1.28	0.57	0.38	0.19
Greece	2015	3.67	3.37	2.65	0.72	0.89	0.31	0.19	0.11
Hungary	2016	4.27	3.54	2.86	0.67	0.77	0.74	0.36	0.37
Iceland	2016	5.53	5.27	4.15	1.12	0.88	0.26	0.16	0.10
Israel	2016	6.00	4.82	4.03	0.79	0.64	1.18	0.51	0.68
Italy	2016	3.59	3.14	2.59	0.54	0.69	0.45	0.13	0.32
Japan	2016	4.04	2.87	2.45	0.42	0.57	1.17	0.21	0.96
South Korea	2016	5.09	3.59	2.97	0.62	0.68	1.50	0.48	1.02
Latvia	2016	4.13	3.73	3.05	0.68	0.73	0.40	0.08	0.32
Lithuania	2016	3.57	3.11	2.38	0.73	1.00	0.45	0.11	0.34
Mexico	2016	5.08	3.96	3.01	0.94	1.03	1.12	0.70	0.42
Netherlands	2016	5.16	4.25	3.11	1.14	1.21	0.92	0.42	0.50
New Zealand	2016	6.42	4.74	3.86	0.88	0.75	1.68	0.82	0.86
Norway	2016	6.48	6.34	4.57	1.78	1.28	0.14	0.02	0.11
Poland	2016	4.31	3.83	2.89	0.93	1.06	0.49	0.27	0.22
Portugal	2016	4.87	4.07	3.36	0.71	0.69	0.80	0.44	0.36
Slovak Republic	2016	3.67	3.12	2.42	0.69	0.94	0.55	0.27	0.28
Slovenia	2016	4.21	3.76	2.91	0.84	0.95	0.45	0.30	0.14
Spain	2016	4.29	3.46	2.65	0.81	1.01	0.83	0.42	0.41
Sweden	2016	5.34	5.16	3.80	1.36	1.17	0.19		0.19
Turkey	2016	5.42	4.06	2.65	1.41	1.74	1.36	0.88	0.48
United Kingdom	2016	6.19	4.24	3.74	0.49	0.43	1.96	0.67	1.29
United States	2016	6.04	4.07	3.22	0.85	0.87	1.97	0.31	1.66
OECD-36 average		4.99	4.16	3.15	0.97	1.00	0.83	0.34	0.50

Source: OECD Statistics and Education at a Glance Database (http://stats.oecd.org/).

Table A1 (b): Education expenditures per student as share of GDP per capita

Country	Year	Total education expenditure per student %GDP per capita	Public education expenditure per student % GDP per capita	Public education expenditure per student %GDP per capita K-12	Public education expenditure per student % GDP per capita Tertiary	Bias public tertiary/public K-12	Private education expenditure per student %GDP per capita	Private education expenditure per student %GDP per capita K-12	Private education expenditure per student %GDP per capita Tertiary
Australia	2016	0.53	0.30	0.17	0.13	0.64	0.23	0.04	0.19

Austria	2016	0.64	0.60	0.27	0.33	1.05	0.04	0.01	0.02
Belgium	2016	0.63	0.57	0.25	0.32	1.09	0.07	0.01	0.06
Canada	2016	0.76	0.49	0.21	0.28	1.13	0.27	0.02	0.25
Chile	2016	0.58	0.30	0.18	0.12	0.57	0.28	0.04	0.25
Czech Republic	2016	0.47	0.39	0.18	0.21	0.98	0.08	0.02	0.07
Denmark	2014	0.59	0.56	0.26	0.30	0.99	0.02	0.01	0.02
Estonia	2016	0.61	0.54	0.21	0.34	1.40	0.07	0.02	0.05
Finland	2016	0.61	0.60	0.23	0.37	1.40	0.02	0.00	0.01
France	2016	0.62	0.52	0.22	0.30	1.16	0.10	0.02	0.08
Germany	2016	0.57	0.49	0.20	0.29	1.27	0.08	0.03	0.05
Greece	2016	0.32	0.30	0.21	0.09	0.39	0.02		0.02
Hungary	2016	0.67	0.49	0.23	0.26	1.00	0.18	0.03	0.15
Iceland	2016	0.49	0.46	0.22	0.25	0.99	0.03	0.01	0.02
Israel	2016	0.52	0.36	0.20	0.17	0.72	0.16	0.03	0.13
Italy	2016	0.51	0.39	0.21	0.18	0.74	0.12	0.01	0.11
Japan	2016	0.71	0.37	0.23	0.14	0.54	0.34	0.02	0.32
South Korea	2016	0.60	0.38	0.27	0.11	0.33	0.22	0.04	0.18
Latvia	2016	0.53	0.44	0.25	0.19	0.65	0.10	0.01	0.09
Lithuania	2016	0.44	0.35	0.18	0.17	0.81	0.09	0.01	0.08
Mexico	2016	0.55	0.40	0.13	0.27	1.76	0.15	0.03	0.12
Netherlands	2016	0.58	0.45	0.19	0.26	1.16	0.14	0.03	0.11
New Zealand	2016	0.63	0.40	0.20	0.19	0.83	0.23	0.04	0.19
Norway	2016	0.61	0.59	0.24	0.35	1.29	0.02	0.00	0.02
Poland	2016	0.57	0.49	0.23	0.26	0.97	0.08	0.02	0.06
Portugal	2016	0.61	0.47	0.25	0.22	0.75	0.14	0.03	0.11
Slovak Republic	2016	0.58	0.45	0.19	0.26	1.14	0.13	0.02	0.10
Slovenia	2016	0.58	0.51	0.23	0.28	1.03	0.07	0.02	0.05
Spain	2016	0.57	0.43	0.20	0.23	0.96	0.14	0.03	0.11
Sweden	2016	0.71	0.65	0.24	0.42	1.53	0.06		0.06
Turkey	2016	0.57	0.42	0.13	0.29	1.98	0.14	0.04	0.10
United Kingdom	2016	0.79	0.37	0.22	0.16	0.62	0.41	0.04	0.37
United States	2016	0.75	0.39	0.21	0.18	0.76	0.36	0.02	0.34
OECD 33 average		0.59	0.45	0.21	0.24	0.99	0.14	0.02	0.12

Source: Own elaboration based on OECD Statistics and Education at a Glance Data (http://stats.oecd.org/).

Table A2

Country	COR	Gini net disposable income[45]	Share of graduates aged 25-64[46]	COR[47]	Gini net disposable income[48]	Share of graduates aged 25-64[49]
	Cohort 1970s	2000		Cohort 1980s	2010	
Australia	0.22	0.32	27.5	0.25	0.33	37.6
Austria	0.32	0.24	24.8	0.46	0.28	27.7
Belgium	0.49	0.30	27.1	0.49	0.26	35.0
Canada	0.32	0.32	40.1	0.32	0.32	50.3
Chile	0.56	0.53	10.1	0.51	0.51	17.1
Czech Republic	0.46	0.25	11.0	0.38	0.26	16.8
Denmark	0.35	0.23	25.8	0.17	0.25	33.3
Estonia	0.29	0.36	28.7	0.32	0.32	35.4
Finland	0.36	0.26	32.6	0.30	0.27	38.1
France	0.45	0.29	21.6	0.39	0.30	29.0
Germany	0.37	0.26	23.5	0.32	0.29	26.6
Greece	0.53	0.33	17.7	0.49	0.34	24.7
Hungary	0.54	0.29	14.0	0.63	0.27	20.1
Iceland	0.33	0.26	26.9	0.38	0.25	32.6
Israel	0.50	0.35	42.1	0.40	0.38	45.6
Italy	0.51	0.32	9.4	0.45	0.32	14.8
Japan	0.32	0.34	33.6	0.31	0.34	44.8
South Korea	0.36	0.31	23.8	0.35	0.31	39.0
Latvia	0.33	0.34	18.2	0.38	0.36	26.9
Lithuania	0.34	0.31	12.5	0.39	0.34	32.4
Mexico	0.46	0.51	14.6	0.50	0.47	14.7
Netherlands	0.40	0.29	23.4	0.38	0.28	32.4
New Zealand	0.21	0.34	22.8	0.21	0.32	40.6
Norway	0.41	0.26	30.7	0.28	0.25	37.3
Poland	0.48	0.30	11.4	0.45	0.31	22.5
Portugal	0.51	0.36	8.8	0.40	0.35	15.4
Slovak Republic	0.43	0.27	10.4	0.42	0.26	17.3
Slovenia	0.43	0.22	15.7	0.31	0.25	23.7
Spain	0.47	0.32	22.7	0.43	0.34	31.0
Sweden	0.45	0.24	30.1	0.39	0.27	33.9
Turkey	0.43	0.46	8.3	0.51	0.42	13.1
United Kingdom	0.38	0.35	25.7	0.27	0.34	38.2
United States	0.47	0.36	36.5	0.41	0.38	41.7
OECD 33 average	0.41	0.32	22.2	0.38	0.32	30

Source: OECD Statistics (http://stats.oecd.org/) and Education at a Glance; GDIM (2018), Barro-Lee (2013), Eurostat, World Bank data.

[45] Data for South Korea refer to 2006, for Czech Republic refer to 2001, for Iceland and Slovak Republic refer to 2004 and for Turkey to 2002. For Austria, Belgium, Czech Republic, Estonia, Greece, Latvia, Lithuania, Poland, Portugal, Slovenia, Spain and Turkey we take the Gini of equivalised income available at the Eurostat Database (https://ec.europa.eu/eurostat/data/database)because of the unavailability of the OECD data. For Chile, we take the value of Gini index from the World Bank Open Data (https://data.worldbank.org/).

[46]The value for Israel refers to 2002, for Iceland to 2003 and for Austria to 2004. Data for Lithuania, New Zealand and Chile are taken from Barro-Lee (2013) dataset on educational attainment of people aged 25-64.

[47] The correlation coefficient for New Zealand is available only for the 1970s cohort. We use the same value also for the 1980s cohort.

[48] Data for Chile, Japan, and New Zealand refer to 2009.

[49] Data for Chile refer to 2009.

Table A3

Country	Average Public Education Expenditure %GDP K-12	Average Public Education Expenditure % GDP Tertiary	Average Basic K-12/ Total Public Education Expenditure	Average Private Education Expenditure %GDP	Average Public Education Expenditure %GDP K-12	Average Public Education Expenditure % GDP Tertiary	Average Basic K-12/ Total Public Education Expenditure[50]	Average Private Education Expenditure %GDP
	2000-2006				2010-2016			
Australia	3.51	0.79	0.82	1.48	3.34	0.74	0.82	1.74
Austria	3.65	1.16	0.76	0.20	3.01	1.64	0.65	0.24
Belgium	3.90	1.20	0.76	0.27	4.14	1.23	0.77	0.32
Canada	3.22	1.48	0.69	1.22	3.31	1.33	0.71	1.56
Chile	2.96	0.41	0.88	2.56	2.70	0.70	0.80	2.32
Czech Republic	2.81	0.86	0.77	0.39	2.43	0.86	0.74	0.48
Denmark	4.22	1.70	0.71	0.13	4.46	1.59	0.74	0.22
Estonia	3.61	0.91	0.80	0.08	3.04	1.17	0.72	0.41
Finland	3.78	1.69	0.69	0.04	3.91	1.70	0.70	0.10
France	3.90	1.07	0.78	0.40	3.45	1.14	0.75	0.64
Germany	2.85	0.96	0.75	0.74	2.70	1.02	0.73	0.58
Greece	2.48	1.15	0.68	0.17	2.65	0.70	0.79	0.32
Hungary	3.14	0.91	0.78	0.45	2.60	0.73	0.78	0.61
Iceland	5.11	1.01	0.84	0.26	4.29	1.08	0.80	0.27
Israel	4.48	1.13	0.80	1.06	3.93	0.83	0.82	1.17
Italy	3.38	0.72	0.82	0.30	2.80	0.60	0.82	0.45
Japan	2.65	0.48	0.85	1.02	2.60	0.47	0.85	1.19
South Korea	3.42	0.54	0.86	2.84	2.97	0.62	0.78	1.50
Latvia	2.07	0.72	0.74	0.64	3.07	0.87	0.78	0.48
Lithuania	3.31	0.88	0.79	0.47	2.66	1.13	0.70	0.50
Mexico	3.55	0.87	0.80	0.95	3.17	0.93	0.77	1.09
Netherlands	3.20	1.03	0.76	0.46	3.19	1.14	0.74	0.95
New Zealand	4.26	0.92	0.82	0.82	3.96	0.94	0.81	1.71
Norway	4.10	1.33	0.75	0.01	4.65	1.60	0.74	0.08
Poland	3.86	1.02	0.79	0.37	3.08	1.01	0.75	0.54
Portugal	4.00	0.96	0.81	0.19	3.56	0.77	0.82	0.96
Slovak Republic	2.61	0.79	0.77	0.36	2.46	0.81	0.76	0.57
Slovenia	3.84	1.02	0.79	0.30	3.22	0.95	0.77	0.48
Spain	2.85	0.93	0.75	0.46	2.74	0.90	0.75	0.71
Sweden	4.36	1.51	0.74	0.19	3.71	1.42	0.72	0.17
Turkey	2.40	0.95	0.71	0.12	2.50	1.30	0.66	1.28
United Kingdom	3.73	0.81	0.82	0.90	3.84	0.61	0.87	1.77
United States	3.69	1.04	0.78	2.11	3.31	0.97	0.77	1.98
OECD 33 Average	3.48	1.00	0.78	0.66	3.26	1.02	0.76	0.83

Source: Own elaboration based on OECD Statistics (http://stats.oecd.org/) and Education at a Glance, various years.
Notes: Total public is computed as the sum of basic K-12 public and tertiary public. Total private is calculated as the sum of basic K-12 private and tertiary private.

[50] Since the indicator is constructed as a ratio of basic K-12 spending over public spending, we rule out values referred to a specific year whenever one of the two values is not available for that year.

Notes to Table A3

Austria	Data for 2010 and 2011 are missing.
Canada	Data for 2003 are missing.
Chile	Data for 2001 are missing.
Denmark	Data for 2015 and 2016 are missing.
Estonia	Data for 2001, 2002, and 2003 are missing. Data for 2000 and 2004 are missing for total private and tertiary private.
Greece	Data for 2006, 2010 and 2011 are missing. Data for 2016 are missing for private expenditures.
Hungary	Data for 2010 and 2011 are missing for private spending.
Japan	Data for 2013, 2014, 2015 are missing.
Korea	No data on education spending are available over the period 2010-2015.
Latvia	Data for 2001, 2002, 2003, 2004 and 2006 are missing.
Lithuania	Data for 2001, 2002, 2003, 2004 and 2006 are missing. Data for 2000 and 2005 are missing for total private and basic private. Used the tertiary private value in 2005 as a proxy for total private.
Mexico	Data for 2012 are missing for tertiary private and total private.
New Zealand	Data for 2010 and 2011 are missing. Data for 2000 and 2001 are missing for private spending.
Norway	Data for 2003, 2004, 2005, 2006 are missing for private spending.
Poland	Data for 2000 and 2001 are missing for private spending.
Portugal	Data for 2010 and 2011 are missing for private spending.
Slovenia	Data for 2000, 2001, 2002, 2003 are missing.
Turkey	Data for 2003 and 2005 are missing. Data for 2001, 2006 and 2010 are missing for private spending.
United Kingdom	Data for 2010 are missing. Data for 2011 are missing for public tertiary spending.

Table A4

Variable	Definition
COR	Pearson's correlation coefficient between parents' and children's years of education
GINI	Gini coefficient on net disposable income
SHARE	Share of population aged 25–64 with tertiary education
d2010	Time dummy that takes value 0 in the first period and 1 in the second period
Basic K-12 Public	Public expenditure in primary, secondary education and post-secondary non-tertiary education (ISCED 2011, levels 1 to 4) as a share of GDP
Tertiary Public	Public expenditure in tertiary education (ISCED 2011, levels 5 to 8) as a share of GDP
Total Private	Private expenditure in primary, secondary education, post-secondary education and tertiary education (ISCED 2011, levels 1 to 8) as a share of GDP
Basic Public / Total Public	Share of basic K-12 public on total public expenditure in education

Figure A1. Average marginal effects of COR on Public Tertiary spending for increasing values of GINI

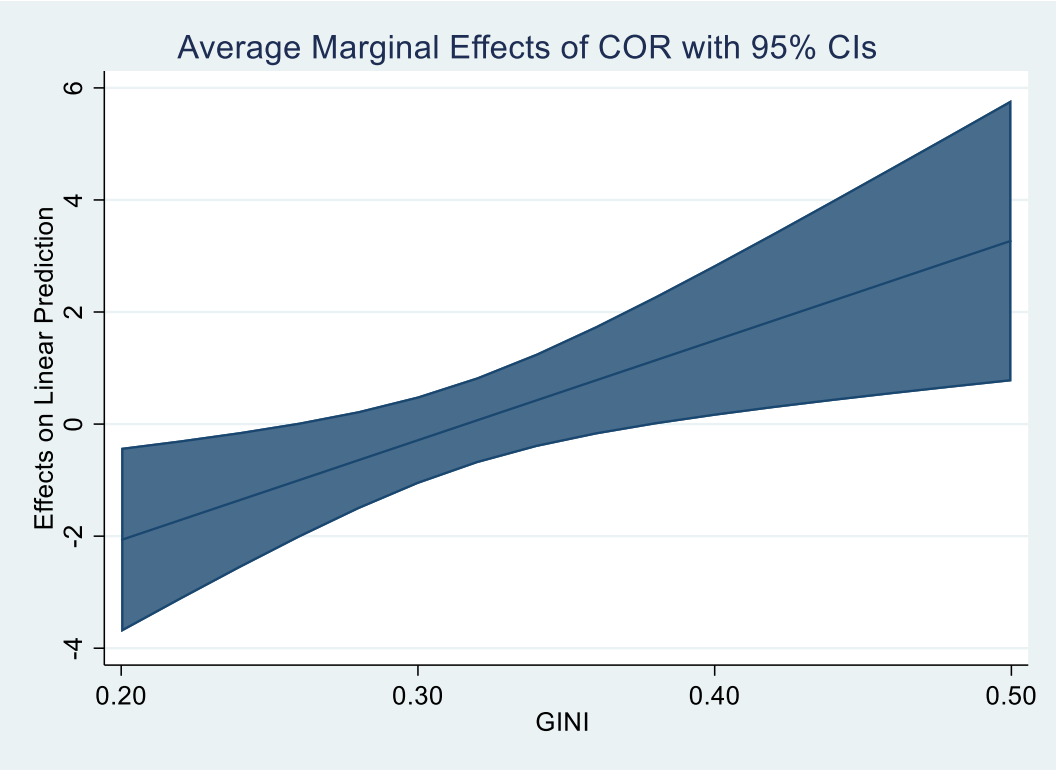

Figure A2. Average marginal effects of SHARE on Public Tertiary spending for increasing values of GINI