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RESEARCH PAPER

Public Versus Private Investment in Education in a Two Tiers System: The Role of Income Inequality and Intergenerational Persistence in Education

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Abstract

This paper provides a simple political economy model of hierarchical education to study the endogenous determination of the public education budget and its allocation between different tiers of education (basic and advanced). 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 and the intergenerational persistence of educational attainments play a fundamental role in deciding the equilibrium. The main predictions of the theory are broadly consistent with descriptive cross-country evidence collected for 43 high-middle income countries.

Keywords Education funding · Majority voting · Income inequality · Intergenerational persistence in education · Tertiary education

JEL Classification H23 · H26 · H42 · H52 · I28

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1 Introduction

Education expenditures differ significantly worldwide, even among developed countries. Not only does the proportion of GDP devoted to education vary, but also the type of financing (public vs. private) and the education expenditure allocation across hierarchical stages (primary/secondary vs. tertiary).[1] This study endeavours to provide a positive theory of education spending by integrating the determination of public education funding and its allocation between different stages of education with households' private education decisions. We adopt a political economy approach, 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, in this paper we address three research questions. 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, the distribution of human capital among households, and intergenerational persistence in education affect the political equilibrium?

The majority of the theoretical literature on the political economy of education funding (see Glomm et al. 2011) has assumed a single type of education or focused on the political economy of spending on a particular stage, such as higher education.[2] However, works failing to differentiate between different stages of education might not be suitable to properly identify the demand for education and thus the determinants of the size of the public budget and of its allocation across educational tiers. Children get educated in a hierarchical education system; the level of educational attainment during the first stage (K-12) and factors related to family background generate a participation constraint in the subsequent stage (tertiary education) that is stricter for children from households of lower socioeconomic status, triggering intergenerational persistence in education.[3] The role of family background has also been well documented for the college drop-out phenomenon: students with low educated parents have a higher probability of dropping out of college compared to those with graduate parents.[4] Therefore, if the benefits from (different levels of) public education are not uniformly distributed in the population, not only the size but also the composition of public spending across educational tiers becomes a critical policy issue.[5]

[1] Figures 3 and 4 in Appendix 2 illustrate countries' heterogeneity in education expenditure (level and composition) and sources of education financing (private vs. public).

[2] For example, see Fernandez and Rogerson (1995), Epple and Romano (1996), Beviá and Iturbe-Ormaetxe (2002), Levy (2005), De la Croix and Doepke (2009), Gradstein et al (2004), Di Gioacchino and Sabani (2009), Haupt (2012), Arcalean and Schiopu (2016), Lasraman and Laussel (2019) and Hatsor and Zilcha (2021).

[3] See Glomm and Ravikumar (1992, 2003). 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 higher levels of education. See De Fraja (2004) and Cunha and Heckman (2007). See Lagravinese et al. (2020) for recent evidence on the effect of economic, social and cultural status on educational performance.

[4] See Aina et al. (2021) for a review of the socioeconomic literature on drop-out rates.

[5] The literature has also emphasised the influence of the structure of the educational system (e.g. the selection pattern) on the intergenerational educational persistence (see Chusseau and Hellier 2011 and

Building on these observations, this paper proposes a theoretical model to address the political economy of education funding, explicitly recognising the hierarchical nature of the education process. The model describes a two-period economy with a unit mass of households each consisting of one parent and one child. Parents are differentiated according to income and human capital. Children are educated in a hierarchical system that features two levels of education: the lower level (K-12) is mandatory and exclusively funded by the government; the higher level (tertiary education) can be funded either privately or publicly. The probability of completing the second stage and obtaining a university degree is lower for children of non-graduate parents; thus, the private return to public education depends on parental human capital. In addition, if the level of tertiary education publicly delivered is deemed insufficient, parents can decide to opt out of the public system and freely choose the amount of private education expenditure. We assume that private education expenditure are tax deductible. This feature, which is observed in many countries, adds complexity to the model, as the size of the public budget depends not only on the politically chosen income-tax rate, but also on agents' opting out decisions.[6]

In our setting, households' preferences over the size of the public education budget and its allocation vary according to parents' human capital and income. Majority voting decides the size of the public education budget and the expenditure composition. We assume that parents commit to education choices before the vote takes place, basing their decisions on expectations about the voting outcome. By committing to their choices, households split into groups with specific interests for or against public tertiary education, according to their income and human capital. This gives rise to expectations-driven multiple political equilibria. Namely, if graduate parents are the majority, we might observe either a fully public equilibrium, featuring a high public education budget and a high public tertiary education spending, or a political equilibrium featuring a low public budget and low public tertiary spending with many or all parents enrolling their offspring at private universities (public–private mix equilibrium or fully private equilibrium). Parents' expectations decide which equilibrium emerges. By contrast, if non-graduate parents are the majority, the political equilibrium is unique and it features a low level of public spending, unbalanced towards basic education. In this equilibrium, publicly provided tertiary education is low and many graduate parents opt out of the public system and privately pay for their offspring's tertiary education.

Income inequality and the intergenerational persistence of educational attainments play a fundamental role in establishing the equilibrium public education budget and its allocation between different tiers of education. Specifically, for increasing levels of income inequality a greater share of affluent parents might choose private education

Footnote 5 continued
references cited therein). Specifically, the institutional characteristics of the school system, such as formal differentiation (students are separated by ability through early tracking) and/or informal differentiation (socioeconomic segregation among schools), have a strong impact on the formation and the persistence of social segmentation (Shavit and Muller 2000 and Kerckhoff 2000).

[6] As reported by Dynarski and Scott-Clayton (2016), in 2015 US households received $19.7 billion in tax credits, which are just one of the many tax subsidies for private education. In the EU, tax incentives for education expenses, including income tax credit in some countries, are widely available (Cedefop 2009).

and fail to support public education spending. Conversely, a decrease in intergenerational persistence in education brings the interests of low-socioeconomic status households closer to those of middle-income educated households, thus increasing the political support for public education spending, particularly at tertiary level.

Our model contributes to the literature on the political economy of comparative education systems on several aspects. First, we model the effects of opting out decisions on public education by considering simultaneously tax deductibility of private education expenditure and fixed costs in the education production function. Differently from the existing literature, these features allow us to show that as opting out of the public system increases -due for example to an increase in income inequality- the quality of public education might worsen, despite the “decongestion” effect. Consequently, the utility of those choosing public education depends positively on how many households take the same action. This feature introduces a strategic complementarity between the education choices of families, and it is the driver of the multiplicity-of-equilibria result. Second, our model emphasizes the role of agents’ expectations in selecting an equilibrium. Indeed, the key determinant of which equilibrium actually gets established is agents’ expectations about the quality of public education. Finally, the introduction of this important element of self-fulfilling expectations helps explaining why countries with similar characteristics might end up with very different education systems.

The remainder of this paper is organised as follows. Section 2 relates this paper to the existing literature; Sect. 3 presents our theoretical model and Sect. 4 derives the political equilibrium. Section 5 concludes and highlights policy implications. All proofs are in Appendix 1. Appendix 2 contains descriptive evidence for 43 high-middle income countries.

2 Related Literature

In the last two decades, a strand of the literature on the political economy of education has begun to model the hierarchical nature of education applying explicit two-stage technology.[7] This framework includes the research of Su (2006), Blankenau et al. (2007), Viane and Zilcha (2013), Naito and Nishida (2017). These contributions have emphasised the role of parents’ education in shaping preferences over the allocation of public funds among education tiers. Specifically, Viane and Zilcha (2013) and Naito and Nishida (2017), in a majority voting framework, have argued that a tax increase to finance higher education cannot be politically feasible until the majority accumulates sufficient human capital. Likewise, Su (2006) has shown that higher public spending on advanced education, resulting in lower basic education funding, can be sustainable in equilibrium only if the political power is biased towards the rich élite. In these models, the level of human capital produced in the last stage of education is either fixed or depends on the amount of government expenditure. By contrast, Romero (2012) and Di Gioacchino et al (2022) study the majority-preferred allocation of public funds across educational tiers introducing private alternatives.

[7] Considering the hierarchical nature of the education process, Su (2004), Restuccia and Urria (2004), Arcalean and Schiopu (2010) and Sarid (2017) have used a similar approach to examine how exogenous policy changes in different education sectors affect economic growth and aggregate welfare.

Romero (2012) is the contribution most closely related to our work, as it integrates public spending with private education decisions by allowing parents to opt out of the public system.[8] Our paper differs from Romero on three important aspects. First, Romero (2012) assumes that only the size of the public budget is decided by majority voting, while the policymaker maximizes a Benthamite social welfare function to decide on the allocation of the budget between the two tiers of education. Differently, in our model both the size and the allocation of the public budget are decided by majority voting.[9] Second, we explicitly consider the effects on the political equilibrium of increasing income inequality and the effects on the public budget of the existence of tax deductibility of private education expenditure. Finally, we assume that parents commit to education choices before the vote takes place, basing their decisions on expectations about the voting outcome. In our framework, differently from Romero (2012), we obtain expectations-driven multiple political equilibria, which might help explain the different education models empirically observed.[10]

Our model is also related to the probabilistic voting model of De la Croix and Doepke's (2009). Differently from us, their focus is on fertility and school decisions and they do not consider the allocation of public education spending on different tiers of education. However, we model the opting out decision in a similar way. In their model, an increase in income inequality rises the quality of public education through decongestion effects due to an increase in opting out of the public system. This leads to the result that more segregation in education improves the welfare of poor agents. In our model, we obtain the opposite result for two reasons. First, we consider the negative effects on the public budget of the existence of tax deductibility of private education expenditures; second, we recognize that fixed costs in the education production function lower the positive impact of decongestion on the quality of public education as opting out increases. Note that this result would be amplified considering the adverse effects of opting out by children from affluent families on the quality of education due to peer effects.[11] Finally, De la Croix and Doepke derive a multiplicity result similar to ours in a probabilistic voting framework assuming that the political power is concentrated in the hands of rich agents. By contrast, we obtain the multiplicity result in a majority voting context, without introducing any bias in the distribution of political power among agents, which is a framework better suited to represent democratic environments. Our qualitative results appear to be robust to changes in the assumptions about the political process (see Sect. 4.2).

[8] In Di Gioacchino et al (2022) parents cannot opt out of the public system, but they can top up public spending with private expenditure.

[9] Although, a political equilibrium with a multidimensional policy might not exist (Persson and Tabellini 2000), in our model, we are able to characterise the political equilibrium in a majority voting framework.

[10] For a classification of education models elaborated applying a cluster analysis on OECD countries, see Di Gioacchino et al. (2022).

[11] See Lülfesmann and Myers (2011) on this point. They argue that the quality of public goods might not be positively related to opting out decisions (through decongestion effects) when adverse selection imposes negative externalities on public users. This argument is valid above all in applications such as education and health.

3 The Model

We consider a two-period economy with a continuum of households of mass one, in which each household comprises one parent and one child.[12] Parents are differentiated according to human capital and income, which are exogenously given.[13] Parents' human capital, denoted by h_p, 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. Parents' income consists of a common stochastic component x multiplied by parents' human capital h_p.[14] The common stochastic income rate x is uniformly distributed over the interval $[(m - \delta), (m + \delta)]$, with $0 < \delta \leq m$.[15] Thus, the economy's average income is $M = (1 - K)hm + Km$. The parameter δ can be considered a measure of income inequality.[16]

We assume that parents save the whole of their income in the first period, consuming only in the second period.[17] Household utility derives from consumption of the numeraire good (c) and the child's human capital (h_c) according to the following utility function:

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

Where the parameter $\gamma \in (0, 1]$ is the weight attached to the child's human capital.[18]

3.1 Children's Human Capital Formation

This section describes children's human capital formation, emphasising its dependence on parental education. In modelling human capital formation, we make a series of simplifying assumptions, which are discussed at the end of this section.

Human capital formation is modelled as a two-stage process. The first stage (basic education) corresponds to primary and secondary education, which is mandatory and depends on the government's expenditure on basic education (G_B), with no direct costs to parents. Thus, the (basic) human capital accumulated during the first stage is:

$$h_B = G_B^{\alpha} \tag{2}$$

12 We do not address fertility decisions in this model, although we are aware of the trade-off between quantity and quality when choosing to bear children.

13 We justify this assumption by referring to empirical evidence. By using data from the International Social Survey Programme (2006) for OECD countries, Di Gioacchino et al. (2019) have found that the correlation between individual income and human capital is positive, but below 0.5.

14 This assumption is consistent with the idea of efficiency units of labour.

15 Income consists of a general consumption good that serves as the numeraire.

16 We select a uniform distribution of income for analytical tractability. We are aware that under majority voting the standard Meltzer and Richard (1981) redistribution issue disappears. As we later discuss, 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.

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

18 Assuming a double-log utility function implies that the elasticity of the marginal utility of the two "goods" is constant and equal to one.

Where $\alpha > 0$, the elasticity of child human capital with respect to public spending on basic education, is an efficiency parameter.

As for the second stage, we assume that all children enrol at university, but only a proportion of them complete their advanced studies and that the probability of completing the tertiary cycle, denoted by π, depends on parental human capital.[19] Normalising to 1 the probability of completing university for children of graduate parents, we posit:

$$\pi = \begin{cases} 1 \; if \; h_p = 1 \\ \eta \; if \; h_p = h \end{cases} \tag{3}$$

With $\eta < 1$.[20] We interpret η as a proxy for intergenerational educational mobility of non-graduates' offspring. The higher is η the higher upward mobility is.

After the child has completed the first stage, the parent must choose whether to enrol the child at a private or a public university. Public university provides a uniform education that depends on the level of public expenditure G_T. Public education spending is financed by a proportional income tax $\tau \in [0, 1)$.[21] Parents opting for a private university pay for their children's tertiary education and freely choose the amount of education expenditure, e, which we assume to be tax deductible.[22]

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

$$h_T = \begin{cases} e \; if \; private \; university \\ G_T \; if \; public \; university \end{cases} \tag{4}$$

A given level of tertiary education spending -either private or public- adds to the human capital acquired through basic education, and we assume that youngster's human capital accumulates as follows:

$$h_c = \begin{cases} max(h_B h_T, h_B) \; if \; tertiary \; education \; is \; completed \\ h_B \qquad\qquad\qquad otherwise \end{cases} \tag{5}$$

Higher education is effective (that is, $h_B h_T > h_B$) if h_T is greater than 1.[23]

[19] We assume that access to tertiary education is universal, but the probability of dropping out of college is influenced by parental human capital. Results would not change by introducing non-universal university access and assuming that the access probability were dependent on parental human capital as well.

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

[21] This tax represents the incremental impact of public education financing needs on the overall tax system.

[22] We assume that education expenditure can be entirely deducted from the income tax base. This assumption simplifies the analysis without affecting qualitative results.

[23] The literature on hierarchical education has modelled the human capital accumulation assuming different production functions, which substantially differ for the degree of substitutability/complementarity between the two education stages. In Su (2004 and 2006), Romero (2012) and Naito and Nishita (2017), the human capital of a tertiary graduate student is given by the sum of basic and advanced education. Differently, in Arcalean and Schiopu (2010), Viane and Zilcha (2013), Chusseau and Hellier (2011) and Sarid (2017), advanced education adds to basic education in a multiplicative way. Other differences in the assumed

From the above discussion, the household expected utility function is as follows:

$$
\begin{aligned}
EU\left(c, h_B, h_T\right) &= (1-\pi)\left[\ln(c) + \gamma \ln\left(h_B\right)\right] + \pi\left[\ln(c) + \gamma\left[\ln\left(h_B\right) + \boldsymbol{I} \ln\left(h_T\right)\right]\right] \\
&= \ln(c) + \gamma\left[\ln\left(h_B\right) + \boldsymbol{I}\pi ln\left(h_T\right)\right]
\end{aligned} \tag{6}
$$

Where $\boldsymbol{I} = 0$ for $0 \leq h_T < 1$ and $\boldsymbol{I} = 1$ for $h_T \geq 1$.[24]

In deriving the child human capital production function, we have made assumptions that deserve to be discussed.

First, we abstract from the impact of parental human capital on capital accumulated in the first stage of education. While we recognise, in line with the literature on hierarchical education, that parental human capital plays an important role in all stages of human capital acquisition, here the focus is on the role of family background in the acquisition of advanced education and we assume that the drop-out probability is higher for children of non-graduate parents. Students whose family background is characterised by low (no) participation in higher education may find it difficult to comply with the academic culture as they cannot benefit from better information and network effects offered instead by parents who already had a similar experience (Aina et al. 2021).[25] This is confirmed by the empirical evidence showing that parental background (proxied by parents' education) is negatively correlated to university drop-out.[26]

A second assumption that deserves some discussion, regards human capital acquisition in public tertiary education, which we assume to depend on total public spending regardless of the number of students.[27] In so doing, we overlook decongestion effects arising as the number of students in public universities declines, which might positively affect human capital acquisition in higher education. Although we recognise that not all costs are fixed, there is a wide consensus that there are considerable economies of

Footnote 23 continued
human capital production function refer to whether or not basic and/or advanced education depend on family background (e.g. parental education) and on whether or not to access advanced studies a minimum level of basic education is required.

24 If $h_T = 0$ (which can happen in equilibrium), then $\boldsymbol{I} = 0$ and $EU(c, h_B, h_T) = ln(c) + \gamma ln(h_B)$.

25 Stinebrickner and Stinebrickner (2008) have shown that parental background has an impact on students' academic achievements per se, regardless of the effect of family financial conditions This does not rule out the importance of the lack of financial resources to pay for the (monetary) costs of tertiary education. For example, Goldthorpe (2003) writes -citing research in Sweden and Britain-that among children of average ability those from higher salaried class origin are almost twice more likely to opt for academic courses than those from working class origins. However, when tuition fees are related to family income, like in the Italian university system, Aina (2005) has found that household economic conditions do not affect dropout rates, but academic persistence is positively correlated with parental education.

26 See among others Smith and Naylor (2001), Johnes and McNabb (2004), Di Pietro and Cutillo (2008), Gury (2011), Aina (2013), Ghignoni (2017). All these contributions have shown for different countries that parental education is positively related to students' performance at university, and negatively related to the probability of dropping out.

27 The same assumption made for the first stage of education is innocuous as all children participate in public education and thus public spending per capita and total public spending coincide.

scale in the production of teaching and research at tertiary level, even larger in the production of supportive services, like libraries and administrative services.[28] Moreover, the empirical literature on the topic has shown that class size does not significantly affect academic achievement in undergraduate classes.[29] Last but not least, adverse selection effects may become detrimental for academic achievement: if privileged children from upper-middle class families opt out of the public system, this might impose a negative externality on the remaining group of public students if peer group effects play a role (Lülfesmann and Myers 2011).

Building on these observations, in Eq. (4) we consider total public spending instead of per capita expenditure. In Sect. 4 (footnote 40), we discuss how this assumption affects our results.

Finally, we do not consider the role of children's innate abilities. Although this is obviously an important factor in the learning process, it is realistic to imagine that they are equally distributed among children with different social backgrounds; thus, they should not affect social class differentials in educational attainments.

3.2 Timing of Events

In the first period, parents decide whether to enrol the child at a public or a private university, then majority voting determines τ and the allocation of tax revenue between G_B and G_T. When making the education decision, parents have perfect foresight regarding the outcome of the voting process and the resulting public tertiary spending.[30] In the second period, households consume, children acquire basic education and may or may not complete tertiary education.

3.3 Private Education Choice

Parents who are planning to opt out of the public system choose e to maximise expected utility, as given by Eq. (6), under the budget constraint.

$$c = (1 - \tau)\left(h_p x - e\right) \tag{7}$$

and under the condition $c > 0$.

Substituting Eq. (7) into Eq. (6) and setting $\boldsymbol{I} = 1$, we obtain the household expected utility if choosing private tertiary education as follows:

$$EU(c, h_B, h_T = e) = ln\left[(1 - \tau)\left(h_p x - e\right)\right] + \gamma[\ln(h_B) + \pi \ln(e)] \tag{8}$$

[28] See Brinkman and Leslie (1986), Cohn et al. (1989) and de Groot et al. (1991) for universities cost evaluation in the US and Worthington and Higgs (2011), Johnes and Schwarzenberger (2011) for recent applications to other countries.

[29] Kennedy and Siegfried (1997), Hill (1998) and Machado and Vera-Hernandez (2008) Bandiera et al. (2009).

[30] We follow De la Croix and Doepke (2009) in the specification of the timing of decisions. Such timing is motivated by the observation that public education spending can be adjusted more frequently than the choice between public vs. private education, which might entail substantial switching costs.

Where $\pi \in \{1, \eta\}$. Straightforward computation gives the optimal level of private education spending e^*:

$$e^* = \frac{\pi\gamma}{1 + \pi\gamma} h_p x \tag{9}$$

Parents, who are deciding whether to opt out of the public system and privately pay for their children's tertiary education, must compare the level of expected utility from opting out of the public system to the expected utility from opting into it. In doing so, they have perfect foresight regarding the expected level of public tertiary spending, which is denoted by G_T^e, determined by the outcome of the voting process. As education is a normal good, parents with high income are more demanding in terms of public education. Therefore, it is possible to show, (see Lemma 1, Appendix 1), that there exists a threshold $\hat{x}\left(G_T^e, h_p, \pi\right)$ of the common stochastic income rate x, defined by:

$$\hat{x}\left(G_T^e, h_p, \pi\right) = \frac{1 + \pi\gamma^{\frac{1+\pi\gamma}{\pi\gamma}}}{h_p \pi\gamma} max\left(1, G_T^e\right) \tag{10}$$

Such that households, whose human capital is h_p, strictly prefer private education if and only if $x > \hat{x}\left(G_T^e, h_p, \pi\right)$.[31] Note that the threshold increases with the expected level of public tertiary spending G_T^e. In addition, for a given level of G_T^e, as non-graduate parents have a higher opportunity cost in investing in private education, their threshold is higher than graduate parents' threshold. We now posit the following assumption:

Assumption 1

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

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

Assumption 1(i) implies that non-graduate parents never enrol their children at a private university, whatever the level of G_T^e might be.[32] In contrast, Assumption 1(ii) allows graduate parents to opt out of the public system.

3.4 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(i), non-graduate parents never opt out. The

[31] If $x = \hat{x}(G_T^e, h_p, \pi)$, we assume that households opt out of the public system.

[32] Assumption 1(i) is introduced to simplify the analysis of the voting game and it is justified by the fact that non-graduate parents have a higher opportunity cost of enroling their children at private universities and a lower average income. Relaxing Assumption 1(i) and allowing some non-graduate parents to enrol their children at private universities would not change qualitative results.

opting out rate of graduate parents, denoted by Ω, is given by the following expression:

$$\Omega\left(G_T^e\right) = \begin{cases} 1 & \hat{x}\left(G_T^e\right) \leq m - \delta \\ 1 - \frac{\hat{x}\left(G_T^e\right) - (m-\delta)}{2\delta} & m - \delta < \hat{x}\left(G_T^e\right) \leq m + \delta \\ 0 & \hat{x}\left(G_T^e\right) > m + \delta \end{cases} \tag{11}$$

It is straightforward to verify that $\Omega\left(G_T^e\right)$ is monotone nonincreasing in G_T^e.[33]

We next define the income threshold level as a function of the opting out rate as follows[34]:

$$\tilde{x} = (m + \delta) - 2\delta\Omega\left(G_T^e\right) \tag{12}$$

The government education budget is then as follows:

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

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.

$$F\left(\tau, G_T^e; \delta, K\right) = \tau\left[M - K\frac{\gamma}{1+\gamma}\left[\Omega\left(G_T^e\right)\left(m + \delta\left(1 - \Omega\left(G_T^e\right)\right)\right)\right]\right] \tag{13}$$

In the following, we discuss how the budget varies with τ, G_T^e, δ and K and in Lemma 2 (Appendix 1), we provide formal proofs. As expected, the budget depends positively on the tax rate and it is also positively related to G_T^e, because the opting out rate decreases with the expected level of tertiary public spending. Therefore, the lower the opting out rate is, the lower the level of private education expenditure deducted from taxpayers' gross income is. As for the relationship between the budget and income inequality, it is possible to prove that an increase in income inequality reduces the budget if $\widehat{x}\left(G_T^e\right)^2 > m^2 - \delta^2$. This condition is clearly satisfied if $\widehat{x}\left(G_T^e\right) > m$ and it is more likely met as inequality increases. Finally, the relationship between the budget and the share of graduate K in the adult pupulation depends on two effects: there is a direct positive effect due to the fact that average income increases with K; the second indirect effect is instead negative, as a higher K implies that a higher share of population opts out of the public system and, due to tax deductibility of private education expenditure, the budget shrinks. Lemma 2 (Appendix 1) states the condition under which the first positive effect dominates the second one.

[33] Note that if the expected outcome of the voting process is such that the equilibrium level of public tertiary spending is not effective ($G_T^e < 1$), children of non-graduates and of those graduates not opting out will not attend university.

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

In what follows, to simplify notation, we indicate the public budget with $F\left(\tau, G_T^e\right)$, thus focusing on the variables whose value is determined in equilibrium.

The public education system operates under a balance-budget rule. Hence, given the budget $F\left(\tau, G_T^e\right)$, a share ϕ is spent on basic education; thus, $G_B = \phi F\left(\tau, G_T^e\right)$. The complementary share $(1-\phi)$ determines the level of public spending on tertiary education; thus, $G_T = (1-\phi)F\left(\tau, G_T^e\right)$. Majority voting decides τ and ϕ.

3.5 Preferred Policies

We distinguish three groups. The first group (A) comprises non-graduate parents *(h_p $=h < 1$)* whose share in the population is $(1-K)$. The second group (B) comprises graduate parents *(h_p =1)* whose income is below $\hat{x}\left(G_T^e\right)$ and their measure is equal to $K\left(1-\Omega\left(G_T^e\right)\right)$. Groups A and B never enrol their children at a private university. The third group (C) comprises graduate parents with income above or equal to $\hat{x}\left(G_T^e\right)$ who opt out of the public system and their measure is equal to $K\Omega\left(G_T^e\right)$.

We now compute each group's preferred tax rate and allocation of public budget between the two education tiers; that is, the pair $\left(\tau^P, \phi^P\right)$ for$P \in \{A, B, C\}$. We preliminarily assume that if the public tertiary education expenditure preferred by group P, for$P \in \{A, B, C\}$, is positive, it is also effective (greater than 1). In other words, we assume that $\forall G_T^e \geq 0$ there is enough fiscal room to guarantee the effectiveness of public tertiary expenditure.[35] The parameters' restriction to support such assumption is derived in Lemma 3 (Appendix1).[36]

3.5.1 Group A's Preferred Policies ($h_p = h$)

Taking $\Omega\left(G_T^e\right)$ as given, group A's preferred tax rate and public budget allocation, τ^A and ϕ^A, are obtained as follows:

$$\tau^A = arg \max_{0\leq\tau\leq1}\left[\ln(1-\tau)hx + \gamma\left(\alpha ln\phi F\left(\tau, G_T^e\right) + \eta ln(1-\phi)F\left(\tau, G_T^e\right)\right)\right] = \frac{\gamma(\alpha+\eta)}{1+\gamma(\alpha+\eta)}$$

$$\phi^A = arg \max_{0\leq\phi\leq1}\left[\ln(1-\tau)hx + \gamma\left(\alpha ln\phi F\left(\tau, G_T^e\right) + \eta ln(1-\phi)F\left(\tau, G_T^e\right)\right)\right] = \frac{\alpha}{\alpha+\eta}$$

Thus, group A's preferred level of public university funding is $G_T^A = (1-\phi^A)F\left(\tau^A, G_T^e\right)$, where $F\left(\tau^A, G_T^e\right)$ is obtained by Eq. (13), substituting $\tau = \tau^A$.

[35] If this were not the case, there would be some values of G_T^e such that the public budget would not be high enough to allow an effective public tertiary investment and therefore agents would maximise an expected utility function obtained from Eq. (6) setting $\mathbf{I} = 0$.

[36] As it will be shown below (see Proposition 1), this parameters' restriction is important to assure the existence of at least one fixed point with an effective level of tertiary education spending for each $P \in \{A, B\}$. The parameter set satisfying this restriction is nonempty, as it is demonstrated in the numerical examples in Sect. 4.

3.5.2 Group B's Preferred Policies (h_p=1 and $x < \hat{x}\left(G_T^e\right)$)

Taking $\Omega(G_T^e)$ as given, group B's preferred tax rate and public expenditure allocation, τ^B and ϕ^B, are obtained as follows:

$$\tau^B = arg \max_{0\le\tau\le1}\left[\ln(1-\tau)x + \gamma\left(\alpha \ln\phi F\left(\tau, G_T^e\right) + ln(1-\phi)F\left(\tau, G_T^e\right)\right)\right] = \frac{\gamma(\alpha+1)}{1+\gamma(\alpha+1)}$$

$$\phi^B = arg \max_{0\le\phi\le1}\left[\ln(1-\tau)x + \gamma\left(\alpha \ln\phi F\left(\tau, G_T^e\right) + ln(1-\phi)F\left(\tau, G_T^e\right)\right)\right] = \frac{\alpha}{\alpha+1}$$

Thus, group B's preferred level of public university funding is $G_T^B = \left(1-\phi^B\right)F\left(\tau^B, G_T^e\right)$, where $F\left(\tau^B, G_T^e\right)$ is obtained by Eq. (13), substituting $\tau = \tau^B$.

3.5.3 Group C's Preferred Policies $\left(h_p = 1 \text{ and } x \ge \hat{x}\left(G_T^e\right)\right)$

Taking $\Omega(G_T^e)$ as given, group C's preferred tax rate and public budget allocation, τ^C and ϕ^C, are obtained as follows:

$$\tau^C = arg \max_{0\le\tau\le1}\left[\ln(1-\tau)\frac{1}{\gamma+1}x + \gamma\left(\alpha \ln\phi F\left(\tau, G_T^e\right) + \ln\frac{\gamma}{\gamma+1}x\right)\right] = \frac{\gamma\alpha}{1+\gamma\alpha}$$

$$\phi^C = \arg \max_{0\le\phi\le1}\left[\ln(1-\tau)\frac{1}{\gamma+1}x + \gamma\left(\alpha \ln\phi F\left(\tau, G_T^e\right) + ln\frac{\gamma}{\gamma+1}x\right)\right] = 1$$

Thus, group C's preferred level of public university funding is $G_T^C = \left(1-\phi^C\right)F\left(\tau^C, G_T^e\right)$=0.[37]

Note that given any ϕ the Bs prefer τ^A to τ^C and the Cs prefer τ^A to τ^B. In addition, given any τ, the Bs prefer ϕ^A to ϕ^C and the Cs prefer ϕ^A to ϕ^B. Hence, we can order the preferred policies of the three groups as follows:

$$\begin{aligned} \tau^B > \tau^A > \tau^C \\ \phi^B < \phi^A < \phi^C = 1 \end{aligned} \tag{14}$$

4 Political Equilibrium

Thus far, we have taken the rate of opting out $\Omega(G_T^e)$ as given and solved for each group's preferred policy-pair $\left(\tau^P, \phi^P\right)$ with $P \in \{A, B, C\}$. We now consider the political process in which parents vote on the policy-pair. If one of the three groups is majoritarian, it is obviously a Condorcet winner and the political equilibrium is the outcome preferred by the group. If none of the groups is majoritarian, it is well

[37] Note that, within groups, τ^P does not depend on income. This is a consequence of having assumed a logarithmic utility function as the elasticity of marginal utility of consumption is equal to 1. Between groups, the redistributive conflict depends on the different expected benefits from public education.

known that, in a bi-dimensional policy space, majority voting might lead to cycles and non-existence of a (Condorcet) winner. In our setting, however, groups' preferences are separable, i.e. τ^P does not depend on ϕ^P and vice versa, and group A is the median in both dimensions (see expression (14)); it follows that if none of the groups is majoritarian, group A is a Condorcet winner and the voting outcome is $\left(\tau^A, \phi^A\right)$.[38]

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

Definition 1: Political equilibrium. A political equilibrium comprises:

i. an income threshold $\widehat{x}$ satisfying Eq. (10);
ii. a private education spending decision for graduate parents ($e^* = 0$ for $x < \hat{x}$, and $e^* = \frac{\gamma}{\gamma+1}x$ for $x \geq \hat{x}$);
iii. aggregate variables $\left(\tau^*, \phi^*, \Omega\left(G_T^e\right)\right)$, where $\Omega\left(G_T^e\right)$ is defined by Eq. (11), and the policy-pair (τ^*, ϕ^*) is the outcome of the majority voting game.
In addition, denoted by $G_T^* = (1-\phi^*)F\left(\tau^*, G_T^e\right)$ the equilibrium public tertiary education spending:
iv. the perfect foresight condition $G_T^* = G_T^e$ must hold;
v. G_T^* must be a focal point and if positive must be greater than 1*(effectiveness).*[39]

We define $z^P = \left(1-\phi^P\right)\tau^P$ and note that $z^B > z^A > z^C$ from the ranking of preferred policies in expression (14). For each $P \in \{A, B, C\}$, we can construct a continuous and nondecreasing function $\Delta^P\left(G_T^e\right)$ mapping expected into actual public tertiary education spending, which is obtained using Eq. (13) as follows:

$$\Delta^P\left(G_T^e\right) = z^P\left[M - K\frac{\gamma}{1+\gamma}\Omega\left(G_T^e\right)\left(m + \delta(1 - \Omega\left(G_T^e\right)\right)\right] \tag{15}$$

Thus, actual public tertiary education spending is $G_T^P = \Delta^P(G_T^e)$ with $G_T^e \in \mathbb{R}_+$.

If group P is the political winner, an equilibrium is characterised by a fixed point of $\Delta^P(G_T^e)$, that is a public tertiary education spending G_T^{P*} that satisfies $G_T^{P*} = \Delta^P(G_T^{P*})$, so that the public tertiary education spending expected by parents is identical to the one actually implemented in the political process.

Proposition 1: Existence of fixed points. Consider $P \in \{A, B\}$.

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

a unique fixed point of $\Delta^P\left(G_T^e\right)$ exists with $G_T^{P*} = G_T^e$, and $1 < G_T^{P*} < z^P M$ (interior fixed point).

---

[38] In fact, since group A is the median in both dimensions, $\left(\tau^A, \phi^A\right)$ wins in pairwise comparisons against $\left(\tau^B, \phi^B\right)$ and against $\left(\tau^C, \phi^C\right)$. Note that also a coalition between groups B and C, proposing a linear combination between the groups' bliss points $\left(\tau^{BC}, \phi^{BC}\right)$, would be defeated by $\left(\tau^A, \phi^A\right)$ because this policy-pair would be preferred to $\left(\tau^{BC}, \phi^{BC}\right)$ by either group B or C. The same voting outcome would have been obtained assuming issue by issue voting as in Shepsle's (1979) structure induced equilibrium (see Persson and Tabellini 2000).

[39] A focal point (or Schelling point) is a solution that economic agents tend to choose by default in the absence of communication (see Shelling 1960).

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

$G_T^{P*} = G_T^e = z^P M$ is always a fixed point of $\Delta^P\left(G_T^e\right)$. Two additional fixed points might exist inside the interval $(1, z^P M)$.

For $P = C$, there exists a unique fixed point of $\Delta^C\left(G_T^e\right)$ with $G_T^{C*} = G_T^e = 0$.

Proof: See Appendix 1. Suppose $z^P M < \frac{\gamma(m+\delta)}{(1+\gamma)^{\frac{1+\gamma}{\gamma}}}$. In this case, Proposition 1 establishes that a unique fixed point exists. Thus, if parents anticipate that group $P \in \{A, B\}$ will be the political winner, their expectations about the public tertiary education spending converge to G_T^{P*} with $1 < G_T^{P*} < z^P M$.

Suppose $z^P M \geq \frac{\gamma(m+\delta)}{(1+\gamma)^{\frac{1+\gamma}{\gamma}}}$. In this case, multiple fixed points might exist. However, the only focal point would be$G_T^{P*} = z^P M$. Indeed, suppose that parents anticipate that the winner of the voting game will be group P. By comparing the fixed points of $\Delta^P\left(G_T^e\right)$, parents'expectations would reasonably converge on the fixed point associated to the highest value of public tertiary spending; that is,$G_T^{P*} = z^P M$. Indeed, all fixed points feature the same level of taxationτ^P; however, the budget is higher when $G_T^e = z^P M$, as the opting out rate is zero. Hence, if agents anticipate that group P will be in power, they will also reasonably expect that public tertiary education expenditure will be set equal to $z^P M$, which guarantees the highest level of utility to group P (focal point).

Proposition 2: Comparative statics. Focusing on focal points, the following inequalities hold:

2.1 $G_T^{B*} > G_T^{A*} > G_T^{C*} = 0$

2.2 $\frac{dG_T^{A*}}{d\eta} > 0$

2.3 If $1 < G_T^{P*} < z^P M$, $\frac{dG_T^{P*}}{d\delta} < 0$ iff $\hat{x}\left(G_T^{P*}\right)^2 > m^2 - \delta^2$. If $G_T^{P*} = z^P M$ then $\frac{dG_T^{P*}}{d\delta} = 0$

2.4 If $1 < G_T^{P*} < z^P M$, $\frac{dG_T^{P*}}{dK}$>0. If $G_T^{P*} = z^P M$ then $\frac{dG_T^{P*}}{dK} = 0$

Proof. See Appendix 1. Proposition 2 (*2.3*) states the conditions under which the value of public tertiary spending decreases with δ. Indeed, as income inequality increases, the share of parents opting out of the public system increases and thus the public budget shrinks because of tax deductibility of private expenditures. This result relies on the fact that we have abstracted from decongestion effects (see on this point the discussion in Sect. 3.1).[40]

Figures 1 and 2 below present a graphical illustration of Proposition 1 showing the

[40] Specifically, this result depends on our assumption about the human capital production function in expression (4). If variable costs were more important than fixed costs in the production of tertiary education, or if adverse selection, due to peer group effects, did not affect negatively the quality of public education, an increase in the share of population opting out of the public system might rise the welfare of public users. Indeed, in De la Croix and Doepke (2009) the result that an increase in inequality improves the welfare of "poor" agents depends on assuming constant return to scale in the human capital production function and on abstracting from adverse selection effects.

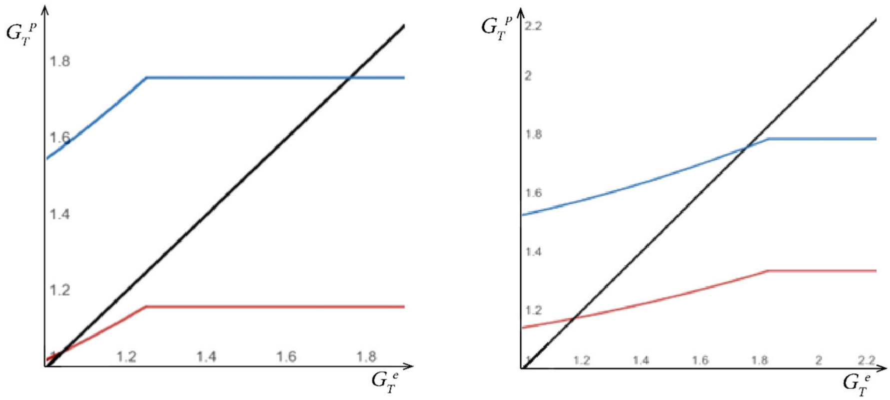

Fig. 1 Groups A (red) and B (blue) fixed point mapping (colour figure online)

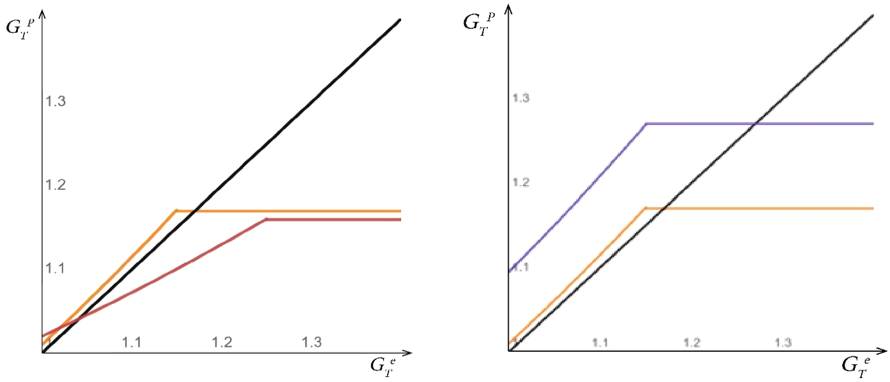

Fig. 2 Group A's fixed point mapping. Left Panel ($\eta = 0.6$): Red $\delta = 2$; Orange $\delta = 1$. Right Panel ($\delta = 1$): Purple $\eta = 0.67$; Orange $\eta = 0.6$ (colour figure online)

fixed points for various values of the model parameters. In Fig. 1, $\Delta^A(G_T^e)$ for group A is in red and $\Delta^B(G_T^e)$ for group B is in blue. In the left panel, the parameters are set to: $\alpha = 0.5; \gamma = 0.33; h = 0.5; \delta = 2; K = 0.6; m = 10; \eta = 0.6$. 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 parameter values are $\alpha = 0.5; \gamma = 0.3; h = 0.3; \delta = 7; K = 0.6; m = 12; \eta = 0.7$. For these parameter values, the fixed points are: $\mathrm{G}_\mathrm{T}^{\mathrm{A}*}$ =1.17 and $\mathrm{G}_\mathrm{T}^{\mathrm{B}*}$ =1.76.

Focusing on group A, Fig. 2 illustrates how the fixed point G_T^{A*} changes with δ and η.[41] Keeping constant the other parameter values, ($\alpha = 0.5; \gamma = 0.33; h = 0.5; K = 0.6; m = 10$), the left panel suggests that decreasing δ the fixed point G_T^{A*}

[41] Analogous graphs can be obtained changing δ for group B.

increases; the right panel shows that increasing η the fixed point G_T^{A*} increases.[42] Note that in our numerical examples when $z^P M > \frac{\gamma(m+\delta)}{(1+\gamma)^{\frac{1+\gamma}{\gamma}}}$ only one fixed point exists.

In the next proposition, we focus on focal points.

Proposition 3: Existence of political equilibria. 3.1 If group A is majoritarian (i.e. $1 - K > \frac{1}{2}$) a unique political equilibrium of the voting game exists.

3.2 If group A is not majoritarian, there might be a multiplicity of political equilibria, and at least one political equilibrium always exists.

Proof. See Appendix 1. If A is majoritarian, the unique equilibrium is $\left[\tau^* = \tau^A, \phi^* = \phi^A\right]$ with $G_T^e = G_T^{A*}$. If A is not majoritarian, either one of the other groups is majoritarian or no group is majoritarian and group A is pivotal. Thus, three possible outcomes can arise as equilibria:

i. $\left[\tau^* = \tau^B, \phi^* = \phi^B\right]$ with $G_T^e = G_T^{B*}$, *if* $1 - \Omega\left(G_T^{B*}\right) > \frac{1}{2K}$;
ii. $\left[\tau^* = \tau^C, \phi^* = \phi^C\right]$ with $G_T^e = G_T^{C*}$, *if* $\Omega\left(G_T^{C*}\right) > \frac{1}{2K}$;
iii. $\left[\tau^* = \tau^A, \phi^* = \phi^A\right]$ with $G_T^e = G_T^{A*}$, *if* $1 - \Omega\left(G_T^{A*}\right) \leq \frac{1}{2K}$ and $\Omega\left(G_T^{A*}\right) \leq \frac{1}{2K}$.

If group C is the political winner (case *(ii)*), in equilibrium tertiary education is fully privately funded. Differently, if one of the two other groups is the political winner, tertiary education can be either fully publicly funded (if $z^P M \geq \frac{\gamma(m+\delta)}{(1+\gamma)^{\frac{1+\gamma}{\gamma}}}$) or a mix of private/public funding can emerge. Note that the fully public regime is more likely if income inequality is sufficiently low, so that the preferred tertiary education level varies little in the population, and if the political winner is group B (in fact, $z^B > z^A$).

4.1 Discussion of Political Outcomes

We have demonstrated that if group A is majoritarian, the unique political equilibrium features a lower level of public education expenditure relative to what group B prefers. Therefore, in countries where the intergenerational persistence in education is high, and consequently the share of the population with tertiary education is low, our model predicts low investments in public education, particularly at the tertiary level.This policy choice is self-reinforcing insofar as it prevents the 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.[43] However, even when graduate households are the majority, our model indicates that the economy could present 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

42 Note that the condition $\widehat{x}(G_T^{*P})^2 > m^2 - \delta^2$ is always satisfied in our numerical examples. Thus, the budget decreases as income inequality increases.

43 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 lagging countries and a faster expected progress for high-performing countries.

consistent with low public education budget expectations. This scenario could describe the circumstances observed in countries, such as Anglo-Saxon countries, characterised by low public spending but high private education expenditure concentrated in tertiary education.

The potential for multiple equilibria suggests that policymakers could establish the conditions to switch to a higher public spending equilibrium by affecting expectations about public education expenditure. Specifically, by announcing policies directed at increasing the investment in public education, particularly at the tertiary level, a higher share of households would opt for the public system, which would make the increase in public spending feasible**.** The likelihood of a high public spending equilibrium would also increase if the education system were reformed in order to increase intergenerational educational mobility. The interests of low-socioeconomic status households would become closer to those of the educated middle class and political support to public education spending would increase.

As for income inequality, if the conditions stated in Proposition 2 are satisfied, a reduction in income inequality increases the likelihood of the emergence of an equilibrium supported by group B. Indeed, as public education budget increases, the condition for group B to be majoritarian, $1 - \Omega\left(G_T^{B*}\right) > \frac{1}{2K}$, is more likely satisfied.

Finally, if the share of graduate parents in the population (K) increases, and if condition *(iv)* in Lemma 2 (Appendix 1) holds, the public education budget increases (as average income increases) and, unless group C becomes majoritarian, the condition for Group B to be majoritarian, $1 - \Omega\left(G_T^{B*}\right) > \frac{1}{2K}$, would be more likely satisfied.

Building on our theoretical results, in Appendix 2 we perform a multivariate correlation analysis on 43 middle-high income countries and regress education expenditures on income inequality and intergenerational persistence in education. The results are broadly consistent with our model's predictions. Specifically, intergenerational persistence in education is negatively correlated to all education spending variables (public, private, and public tertiary); income inequality is negatively correlated with (both levels of) public expenditures and positively correlated with private education expenditure.

4.2 Different Political Processes

In solving the model, we have assumed a majority-voting framework, keeping with most of the literature on the topic. Nevertheless, it is interesting to discuss robustness of our results to different specifications of the political process.[44] The following discussion is meant to sketch the intuitive arguments. A formal derivation of the results is beyond the scope of this paper.

Let us consider a political system with office-motivated politicians and probabilistic voting, as in De la Croix and Doepke's (2009). In this setting, without assuming ad hoc groups' ideological bias, the politicians' preferred policy pair (τ^*, ϕ^*) is obtained by maximizing a weighted average of the interest groups' utility with weights equal to the groups' numerosity.[45] Note that, in our model the numerosity of group B and group C depends on expectations, therefore their weights would be endogenous. Differently

[44] We thank an anonymous referee for the suggestion.

[45] See Persson and Tabellini (2000) and references therein.

from what stated in Proposition 1, with probabilistic voting there would be just one function $\Delta(G_T^e)$ mapping the expected public tertiary education expenditure into actual expenditure and not one for each interest group. Such function $\Delta(G_T^e)$ would be a linear combination (with endogenous weights) of the mappings associated to each interest group. Therefore, the comparative statics properties of the equilibrium (Proposition 2) would continue to hold. As for the multiplicity-of-equilibria result, this would be preserved only if the function $\Delta(G_T^e)$ had more than one fixed point.

Another alternative would be to consider policy-motivated politicians and coalitions among them, as for example in Levy (2004). In our model, one could imagine three politicians, each representing an interest group. The politicians are organized in coalitions/parties. These coalitions choose platforms for the electorate to vote on. The platform that receives the highest number of votes is implemented. A coalition is stable if it is "deviation-proof", that is if no politician (or a group of politicians) wishes to induce a finer coalition or wants to run alone. Applying this "deviation-proof" condition, and considering the fact that in our model the median voter is the same for both policy dimensions, it would be possible to confirm the results of Proposition 3. In other words, each possible coalition of two or three politicians would be broken by the deviation of the politician whose proposed platform represents the interest of the median voter, confirming the majority-voting result. In other words, coalition structures are stable only if they yield the median voter's outcome. Thus, the same political outcome arises in the presence of parties and in the absence of parties (see Levy 2004).

5 Conclusion and Policy Implications

In this study, following a political economy approach, we investigate the determinants of public education expenditure and its allocation between different education tiers. To analyse this issue, we propose a model wherein the public education budget and its allocation are endogenously determined through majority voting. Our model predicts that in countries characterised by high intergenerational persistence in education and 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. This policy choice is self-reinforcing, as it prevents aggregate human capital accumulation and could lock countries into "low education" equilibria (e.g. Italy). In contrast, in countries where aggregate human capital is high, our model engenders the possibility of multiple equilibria. In these countries, we may either observe a strong public system in which many or all affluent households participate (for example, Nordic European countries), or a system characterised by low public education expenditure (unbalanced towards basic education), where affluent families use private education providers, particularly at the tertiary level (e.g. Anglo-Saxon countries). The divide between the two education regimes appears to be related to the level of income inequality, as it is confirmed by cross-country data collected for 43 high- and middle-income countries (see Appendix 2).

The main policy message of our analysis is that to escape a "low education" political equilibrium, rather than a generic increase in public education spending (that might be politically unsustainable in democratic contexts, if the majority of the population is low-educated), reforms of the education system directed to reduce the importance of inherited human capital in educational attainments are needed. Concerning this point, a number of analysts have emphasised that the observed difference in the probability of college graduating between students of different social backgrounds can be, at least partially, country-specific. Namely, admission criteria, flexibility of curricula, organization of counselling, mentoring, and tutoring activities, are all factors that can affect at least partially academic performance.[46] Thus, by introducing reforms directed at improving intergenerational educational mobility, a policy-maker can affect political support for public education spending, particularly at tertiary level, since the interests of low-socioeconomic status households would become closer to those of the educated middle class. In this way, a virtuous circle could be triggered that could lead to an increase in the political support for public education spending and in turn to an increase in the share of university graduates in the adult population over time.

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Data availability The dataset generated during the current study are available at Feenstra et al. (2015), OECD (2023b, c, d, 2004, 2005, 2006, 2007, 2008, 2009, 2010), UNESCO (2023), World Bank, Gini Index, World Bank (2023a).

Declarations

Conflict of Interest The authors have no competing interests to declare that are relevant to the content of this article.

Appendix 1

Lemma 1. There exists a threshold:

$$\hat{x}\left(G_T^e, h_p, \pi\right) = \frac{1 + \pi\gamma^{\frac{1+\pi\gamma}{\pi\gamma}}}{h_p \pi\gamma} max\left(1, G_T^e\right)$$

such that households, whose human capital is h_p, strictly prefer private education if and only if $x > \widehat{x}\left(G_T^e, h_p, \pi\right)$.

Proof. If the household is planning to choose public tertiary education, the expected utility is given by Eq. (6) substituting $h_T = G_T^e$

$$EU\left(c, h_B, G_T^e\right) = ln\left((1-\tau)h_p x\right) + \gamma \ln(h_B) + \boldsymbol{I}\gamma\pi \ln\left(G_T^e\right)$$

with $\mathbf{I} = 0$ for $G_T^e < 1$ and $\mathbf{I} = 1$ for $G_T^e \geq 1$.

The expected utility of the opting out decision is instead given by Eq. (6) setting $h_T = e^*$

[46] See for example Di Pietro and Cutillo (2008) for a discussion of the effect on drop-out rates of the 2001 Italian reform of tertiary education.

$$EU\left(c, h_B, e^*\right) = \ln\left((1-\tau)\left(h_p x - e^*\right)\right) + \gamma\left[\ln\left(h_B\right) + \pi\ln\left(e^*\right)\right]$$
$$= ln(1-\tau) + ln\left(\frac{1}{\gamma+1}h_p x\right) + \gamma ln\left(h_B\right) + \gamma\pi ln\left(\frac{\gamma}{\gamma+1}h_p x\right)$$

Imposing$EU\left(c, h_B, G_T^e\right) = EU(c, h_B, e^*)$, we obtain the threshold in Eq. (10).

Lemma 2. The public budget $\mathrm{F}\left(\tau, \mathrm{G}_{\mathrm{T}}^{\mathrm{e}}; \delta, \mathrm{K}\right)$ satisfies the following:

(i) $\frac{\partial F}{\partial \tau} > 0$

(ii) $\frac{\partial F}{\partial G_T^e} \geq 0$.

(iii) $\frac{\partial F}{\partial \delta} \leq 0\ if\ \hat{x}\left(G_T^e\right)^2 > m^2 - \delta^2$.

(iv) $\frac{\partial F}{\partial K} > 0\ if h < \frac{1}{(1+\gamma)}$.

Proof. Substituting Eq. (11) into Eq. (13), we obtain the following expression for the budget for $G_T^e \geq 0$:

$$F\left(\tau, G_T^e; \delta, K\right) = \begin{cases} \tau\left[M - K\frac{\gamma}{(1+\gamma)}m\right] & \hat{x}\left(G_T^e\right) \leq m - \delta \\ \tau\left[M - K\frac{\gamma}{4\delta(1+\gamma)}\left((m+\delta)^2 - \left(\hat{x}\left(G_T^e\right)\right)^2\right)\right] & m - \delta < \hat{x}\left(G_T^e\right) < m + \delta \\ \tau M & \hat{x}\left(G_T^e\right) \geq m + \delta \end{cases} \tag{A.1}$$

(i) It is straightforward. (ii) The rate of opting out decreases with G_T^e ($\frac{\partial \widehat{x}}{\partial G_T^e} \geq 0$). This implies that the level of private expenditures in tertiary education (which are tax deductible) decreases with G_T^e. (iii) Taking the first derivative of the budget in eq. (A.1) with respect to δ, when $m - \delta < \widehat{x}\left(G_T^e\right) < m + \delta$, it is easy to show that it if $\widehat{x}\left(G_T^e\right)^2 > m^2 - \delta^2$ the derivative is negative. In the other cases, $\frac{\partial F}{\partial \delta} = 0$. (iv) The average income $M = (1-K)hm + Km$ is positively related to *K*, thus, from A.1 we obtain:

$$\frac{\partial F}{\partial K} = \begin{cases} \tau m\left[1 - h - \frac{\gamma}{(1+\gamma)}\right] & \widehat{x}\left(G_T^e\right) \leq m - \delta \\ \tau\left[m(1-h) - \frac{\gamma}{4\delta(1+\gamma)}\left((m+\delta)^2 - \left(\widehat{x}\left(G_T^e\right)\right)^2\right)\right] & m - \delta < \widehat{x}\left(G_T^e\right) < m + \delta \\ \tau m(1-h) & \widehat{x}\left(G_T^e\right) \geq m + \delta \end{cases}$$

Noting that $\tau\left[m(1-h) - \frac{\gamma}{4\delta(1+\gamma)}\left((m+\delta)^2 - \left(\widehat{x}\left(G_T^e\right)\right)^2\right)\right] < \tau m\left[1 - h - \frac{\gamma}{(1+\gamma)}\right], \forall G_T^e \geq 0$, a sufficient condition for $\frac{\partial F}{\partial K} > 0$ is $h < \frac{1}{(1+\gamma)}$<1.

Lemma 3. For $P \in \{A, B\}$ and $\forall\ \mathrm{G_T^e} \geq 0$, the fiscal room is enough to guarantee that $\mathrm{G_T^P} > 1$ if

$$M - \frac{1+\gamma(\alpha+\eta)}{\eta\gamma} > K\frac{\gamma}{4\delta(1+\gamma)}\left((m+\delta)^2 - max\left(m-\delta; \frac{(1+\gamma)^{\frac{1+\gamma}{\gamma}}}{\gamma}\right)^2\right)$$

Proof. The above condition is obtained from A.1 by considering its minimum value and τ preferred by group A.[47] Consequently, it holds *a fortiori* when the budget increases, and, given the ranking of the preferred policies in expression (14), it is satisfied *a fortiori* for $P = B$.

Proof of Proposition 1. For $P \in \{A, B\}$, given parameters' restriction in Lemma 3, $\Delta^P\left(G_T^e\right) > 1$ and it is continuous monotone nondecreasing in G_T^e (see Lemma 2), with $G_T^e \in \mathbb{R}_+$.[48] Its minimum value is obtained for $0 \leq G_T^e \leq 1$

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

The maximum value is obtained when $\widehat{x}\left(G_T^e\right) \geq m+\delta$. In this case, public tertiary education spending is equal to its maximum

$$\max\Delta^P\left(G_T^e\right) = z^P M$$

There are two possibilities:

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

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

First, we must show that the function $\Delta^P(G_T^e)$ crosses the 45-degree line exactly once when $z^P M < \frac{\gamma(m+\delta)}{(1+\gamma)^{\frac{1+\gamma}{\gamma}}}$. In this case, $\Delta^P(G_T^e) < G_T^e$ when$G_T^e = \frac{\gamma(m+\delta)}{(1+\gamma)^{\frac{1+\gamma}{\gamma}}}$, while $\Delta^P\ (G_T^e) > G_T^e$ when$0 \leq G_T^e \leq 1$. We can exclude that $\Delta^P(G_T^e)$ crosses more than once, as the relationship between the budget and G_T^e is quadratic, and it is easy to verify that the first derivative of the function $\Delta^P(G_T^e)$ with respect to G_T^e is monotone nondecreasing. Therefore, $\Delta^P(G_T^e)$ crosses the 45-degree line only once and the fixed point G_T^{P*} lies in the interval $1 < G_T^{P*} < z^P M$.

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47 Note that, $\widehat{x}\left(G_T^e\right) = \max\left(m-\delta; \frac{(1+\gamma)^{\frac{1+\gamma}{\gamma}}}{\gamma}\right)$ when $0 \leq G_T^e \leq 1$.

48 Being $\Delta^P(G_T^e)$ a monotone transformation of the budget function F, its continuity and monotonicity follows from continuity and monotonicity of F (see eq. A.1).

In case (ii), there is instead the possibility of triple crossing.[49] $\Delta^P(G_T^e)$ certainly crosses the 45-degree line at $G_T^e = z^P M$ and therefore the fixed point $G_T^{P*} = z^P M$ always exists. The function might double cross below $z^P M$ and in this case, we might have two additional interior fixed points with $1 < G_T^{P*} < z^P M$.

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

Proof of Proposition 2. 2.1 To prove that $G_T^{B*} > G_T^{A*}$ recall that $z^B > z^A$. When $G_T^{P*} = z^P M$ the result is obvious. Suppose that G_T^{P*} is an interior fixed point and consider the following implicit function Z:

$$Z\left(G_T^P, \Delta^P\left(G_T^P\right)\right) = G_T^P - z^P\left[\left[M - K\frac{\gamma}{1+\gamma}\Omega\left(G_T^P\right)\left(m + \delta\left(1 - \Omega\left(G_T^P\right)\right)\right)\right]\right] = 0 \quad \text{(A.2)}$$

As G_T^{P*} is a solution of (A.2), by the implicit function theorem, we can write

$$\frac{dG_T^{P*}}{dz^P} = -\frac{\frac{\partial Z}{\partial z^P}}{\frac{\partial Z}{\partial G_T^{P*}}} < 0$$

Indeed, the numerator ($\frac{\partial Z}{\partial z^P}$) has negative sign. The denominator ($\frac{\partial Z}{\partial G_T^{P*}}$) has positive sign because, when G_T^{P*} is an interior solution and a focal point, the function $\Delta^P(G_T^e)$ has a positive slope smaller than 1 in G_T^{P*}.

2.2 To prove that for $P = A$ $\frac{dG_T^{A*}}{d\eta} > 0$, we first note that $\frac{dz^A}{d\eta}$>0. Hence, the result is obvious when $G_T^{A*} = z^A M$. Suppose that G_T^{A*} is an interior solution and consider the function (A.2). By the implicit function theorem, we can write:

$$\frac{dG_T^{A*}}{d\eta} = -\frac{\frac{\partial Z}{\partial \eta}}{\frac{\partial Z}{\partial G_T^{P*}}}$$

The numerator ($\frac{\partial Z}{\partial \eta}$) has negative sign for $P = A$. The denominator ($\frac{\partial Z}{\partial G_T^{P*}}$) has positive sign because, when G_T^{P*} is an interior solution and a focal point, the function $\Delta^P(G_T^e)$ has a positive slope smaller than 1 in G_T^{P*}; thus, $\frac{dG_T^{A*}}{d\eta} > 0$.

2.3 Firstly, note that when $G_T^{P*} = z^P M$, $\frac{dG_T^{P*}}{d\delta} = 0$. Focusing on interior solutions, to prove that $\frac{dG_T^{P*}}{d\delta} \le 0$, iff $\widehat{x}\left(G_T^{P*}\right)^2 \ge m^2 - \delta^2$, consider the function (A.2). By the implicit function theorem, we can write

$$\frac{dG_T^{P*}}{d\delta} = -\frac{\frac{\partial Z}{\partial \delta}}{\frac{\partial Z}{\partial G_T^{P*}}}$$

[49] By utilizing the same argument as in the case (i), we can exclude the existence of more than three fixed points.

The numerator sign depends on the sign of the public budget derivative with respect to inequality. Therefore, from Lemma 2 $\frac{\partial Z}{\partial \delta} > 0$ iff $\widehat{x}\left(G_T^{P*}\right)^2 > m^2 - \delta^2$. The denominator ($\frac{\partial Z}{\partial G_T^{P*}}$) has positive sign because, when G_T^{P*} is an interior solution and a focal point the function $\Delta^P(G_T^e)$ has a positive slope smaller than 1; thus, $\frac{dG_T^{P*}}{d\delta} < 0$ iff $\widehat{x}\left(G_T^{P*}\right)^2 > m^2 - \delta^2$

2.4 Firstly, note that when $G_T^{P*} = z^P M$, $\frac{dG_T^{P*}}{dK} = 0$. Focusing on interior solutions, to prove that $\frac{dG_T^{P*}}{dK} > 0$ if $h < \frac{1}{(1+\gamma)}$ we have to consider the implicit function in A.2, the conditions stated in Lemma 2, and follow the same logical steps of the previous proofs.

Proof of Proposition 3. Consider only focal fixed points.

3.1 For $\left[\tau^* = \tau^A, \phi^* = \phi^A\right]$ to be a political equilibrium of the voting game, with $G_T^e = G_T^{A*}$, it must be $\Omega\left(G_T^{A*}\right) \leq \frac{1}{2K}$ (group C is not majoritarian), and $1-\Omega\left(G_T^{A*}\right) \leq \frac{1}{2K}$ (group B is not majoritarian). Recalling that the measure of group A does not depend on the opting out rate, if A is majoritarian ($1 - K > \frac{1}{2}$), these two conditions are always satisfied for any $1 < G_T^{A*} \leq z^A M$; thus, $\left[\tau^* = \tau^A, \phi^* = \phi^A\right]$ is the unique political equilibrium.

3.2 From Proposition 1 and Proposition 2, $G_T^{C*} < G_T^{A*} < G_T^{B*}$ and $\Omega\left(G_T^{C*}\right) > \Omega\left(G_T^{A*}\right) > \Omega\left(G_T^{B*}\right)$. To show that at least one political equilibrium exists, note that if neither $\left[\tau^* = \tau^C, \phi^* = \phi^C\right]$ nor $\left[\tau^* = \tau^B, \phi^* = \phi^B\right]$ are political equilibria, that is if $1-\Omega\left(G_T^{B*}\right) \leq \frac{1}{2K}$ and $\Omega\left(G_T^{C*}\right) \leq \frac{1}{2K}$, then $\left[\tau^* = \tau^A, \phi^* = \phi^A\right]$ is certainly a political equilibrium with $G_T^e = G_T^{A*}$. In fact, $1-\Omega\left(G_T^{B*}\right) \leq \frac{1}{2K}$ implies $1-\Omega\left(G_T^{A*}\right) < \frac{1}{2K}$ (group B is not majoritarian); whereas $\Omega\left(G_T^{C*}\right) \leq \frac{1}{2K}$ implies $\Omega\left(G_T^{A*}\right) < \frac{1}{2K}$ (group C is not majoritarian). In this political equilibrium, group A is pivotal, although not majoritarian (see preferred policies ranking in expression (14) in the text).

To show that a multiplicity of political equilibria might arise, note that for the fixed points $G_T^{A*}, G_T^{B*}, G_T^{C*}$ to be associated with political equilibria the following conditions must be satisfied:

$(i) 1 - \Omega\left(G_T^{A*}\right) \leq \frac{1}{2K}$ and $\Omega\left(G_T^{A*}\right) \leq \frac{1}{2K}$ for G_T^{A*};

$(ii) 1 - \Omega\left(G_T^{B*}\right) > \frac{1}{2K}$ for G_T^{B*}.

(iii) $\Omega\left(G_T^{C*}\right) > \frac{1}{2K}$ for G_T^{C*}.

These conditions might be simultaneously satisfied.

Appendix 2: Descriptive evidence and multivariate correlation analysis

Figure 3 presents education expenditure as a share of GDP in 2019 and its private and public funding composition for a sample of 43 high-middle income countries. It demonstrates the substantial variability in education expenditure and the significant

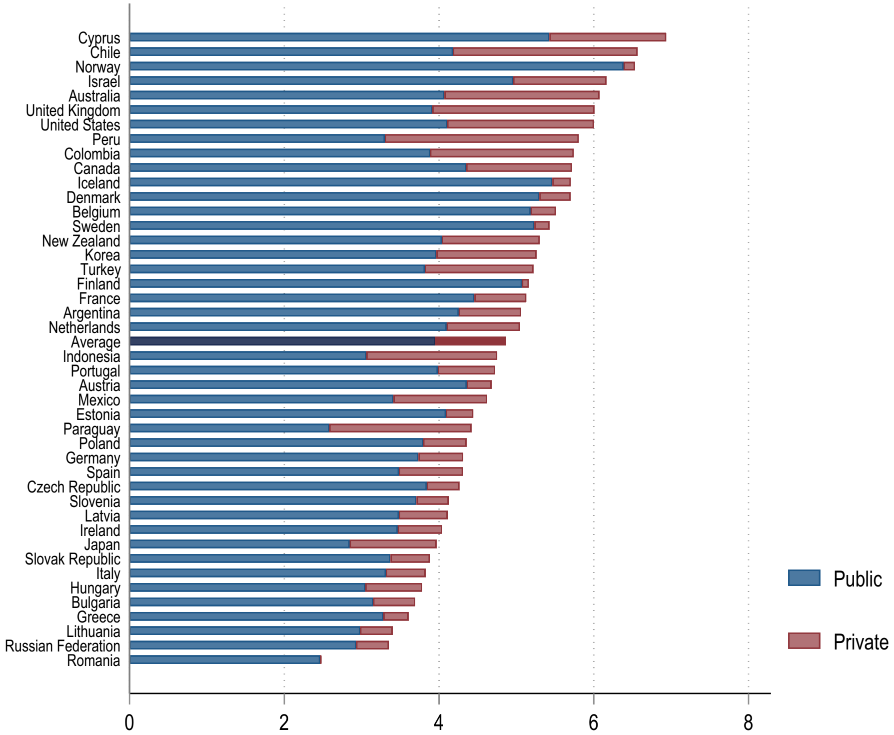

Fig. 3 Public and private education expenditure, % of GDP, year 2019 or latest available

differences in the source of funding among countries.[50] On average, the share of GDP devoted to education was about 5%, ranging from the lowest value in Romania (2.5%) up to the highest in Cyprus (6.9%). In terms of composition, on average 18% of education expenditure was from private funding, with the highest value in Peru (43%) and the lowest in Romania (0.1%).

Figure 4 presents the allocation of public expenditure on basic and tertiary education as shares of GDP. It shows a positive relationship between the two education tiers, but also a great variability: countries with the same share of public basic education might have very different expenditures on tertiary education.

Building on our theoretical results, we endeavour to analyse countries' differences in education expenditures by relating these differences to the variations in income inequality and intergenerational persistence in education. To characterise these relationships, we perform multiple regression correlations. This analysis has only a descriptive purpose as the limited number of observations and endogeneity issues, due to reverse causality and omitted variables, pose major challenges for identifying causal effects. We have collected data on three education-spending variables (public basic, public tertiary and total private) and the proportion of public basic education

[50] In the case of Ireland, expenditures are computed as a share of gross national income (GNI) as GDP is not a satisfactory measure of country's income due to large income outflow.

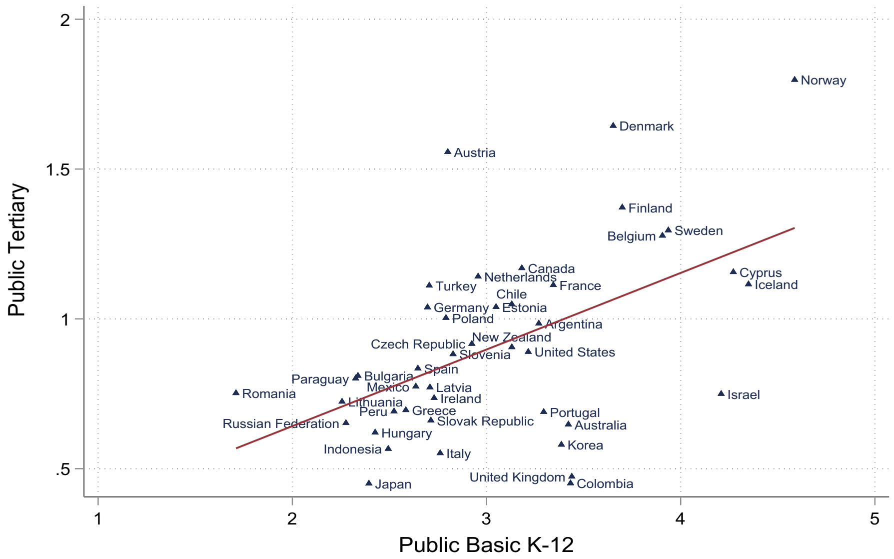

Fig. 4 Public spending on basic vs tertiary education, %GDP, year 2019 or latest available

expenditure on total public education expenditure (public basic/total public) for 43 high and middle income countries covering two time periods.[51] In the first period, expenditures are computed as averages over the years 2000 to 2009; in the second period, averages are computed over the years 2010 to 2019.[52] To mitigate the issue of a potential reverse causality link, whereby low public expenditure in education leads to more inequality and higher education persistence, we have considered the values of income inequality and intergenerational education persistence that precede the observed values of education expenditure.[53] Income inequality is measured by the variable GINI, which is the Gini index of disposable income for the years 2000 and 2010.[54] To assess intergenerational education persistence, we use the variable COR, which measures the correlation between the years spent on education by parent and

[51] Based on ISCED 2011, public basic K-12 refers to educational levels 1 up to 4; public tertiary refers to levels 5 up to 8; total private and total public refer to educational levels 1 up to 8.

[52] For OECD countries and Russian Federation data on public and private spending on education are taken from OECD (2023a, 2023b), and OECD Education at a Glance Publications from 2003 to 2010. Private spending is not available in at least one of the two decades for Luxembourg, Switzerland, and Costa Rica, therefore they are not included in the sample. For non-OECD countries data on education spending are taken from UNESCO, UIS database. As regard to private spending, data are taken from the Sustainable Development Goal 4.5.4. We derive the share of private spending on GDP from the expenditure per student in PPP dollars.

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

[54] As discussed in Sect. 3, in our model, income inequality only affects the public budget through the tax deductibility of private expenses, which are decided based on perfectly foresighted public expenses. For this reason, in the correlations, we use the Gini index computed for disposable income. For OECD countries, except for Colombia, the source is the Income Distribution Database available at https://stats.oecd.org/. For non-OECD countries the reference is the Gini Index of the World Bank available at https://databank.worldbank.org/reports.aspx?source=2&series=SI.POV.GINI

Table 1 Summary statistics

Variable	Mean	Standard deviation	Min	Max
Public Basic K-12 Spending %GDP	3.195	0.722	1.643	4.942
Public Tertiary Spending %GDP	0.95	0.311	0.311	1.664
Total Private Spending %GDP	0.85	0.671	0.026	2.839
Public Basic K-12/Total Public	0.77	0.049	0.647	0.9
Cor	0.423	0.1	0.171	0.66
Gini	0.341	0.081	0.227	0.587
Real GDP per capita (log)	10.061	0.594	8.571	11.099

child. We obtain data from the 2023 Global Database on Intergenerational Mobility from the World Bank (WB 2023) for the 1970s and 1980s cohort.[55] Moreover, as different standard of living may affect government spending on education, we include the real GDP per capita as a control variable.[56] Table 1 contains the descriptive statistics.

Table 2 presents the outcome of a pooled linear regression between the four education 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.

In line with the model, public expenditure on education (as percentage of GDP) is negatively correlated with COR and GINI.[57] COR is significant in the relationship with public basic education (Table 2, column 1), while GINI is relevant in the relationship with public tertiary education (Table 2, column 2). In column 3, we again consider public tertiary education and add an interaction term between COR and GINI. Consistent with the model's results, the coefficients of COR and GINI are both significant and negative. The coefficient of the interaction term is positive and significant, implying that the negative relationship between intergenerational persistence in education and public tertiary spending declines as inequality increases. To clarify this relationship, we compute marginal effects (Fig. 5).

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 of income inequality. To explain why the negative correlation between COR and tertiary public expenditure becomes weaker as income inequality increases, note that private expenditures,

[55] COR measures intergenerational persistence in education using Pearson's correlation coefficient between parents' and children's years of education. In the GDIM (WB 2023a, 2023b), 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.

[56] We derive it from the Penn World Tables and take the log of the average over the years 1990 to 1999 and 2000 to 2009 for the first and the second period, respectively (Feenstra et al. 2015, https://doi.org/10.34894/QT5BCC).

[57] For brevity, we do not report results for total public expenditure, since we focus on its composition. They are available upon request from authors.

Table 2 Regression results

	(1) Public basic K-12_spending	(2) Public tertiary spending	(3) Public tertiary spending	(4) Total private spending	(5) Public basic K-12/total public
Cor	– 1.35*	– 0.007	– 4.347***	– 2.018***	– 0.086
	(0.731)	(0.327)	(1.638)	(0.689)	(0.06)
Gini	0.936	– 0.775*	– 7.229***	4.921***	0.189**
	(1)	(0.447)	(2.429)	(0.942)	(0.082)
d2010	– 0.361***	– 0.045	– 0.052	0.13	– 0.006
	(0.129)	(0.058)	(0.056)	(0.122)	(0.011)
real GDP per capita (log)	0.703***	0.236***	0.228***	– 0.146	– 0.009
	(0.145)	(0.065)	(0.062)	(0.136)	(0.012)
Cor#Gini			13.377***		
			(4.954)		
_cons	– 3.441*	– 1.135	1.016	1.429	0.833***
	(1.747)	(0.781)	(1.095)	(1.647)	(0.143)
Observations	86	86	86	86	86
R-squared	0.388	0.342	0.397	0.37	0.12

Standard errors are in parentheses *** p < 0.01, ** p < 0.05, * p < 0.1
Source: authors' elaboration based on OECD, UNESCO (2023) UIS, Penn World Tables, World Bank (World Development Indicators), and WB (2023)

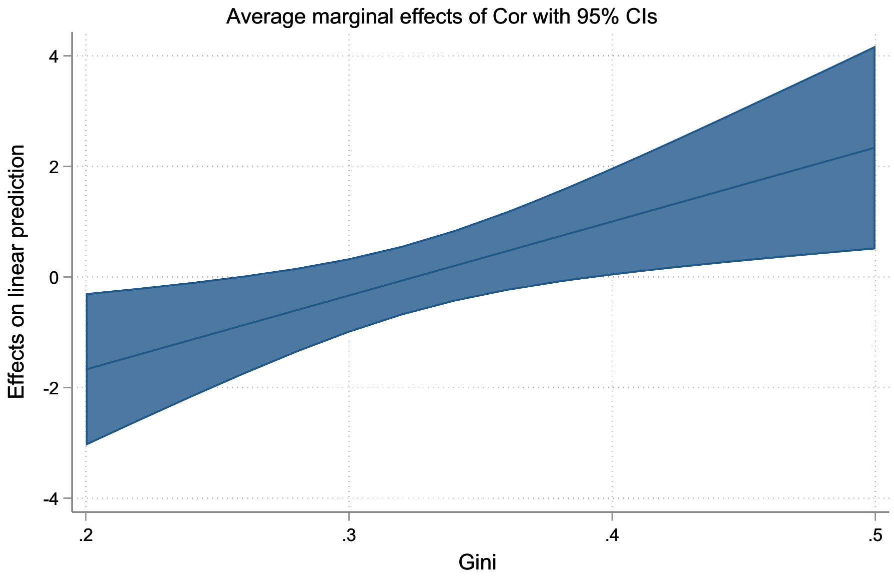

Fig. 5 Average marginal effects of COR on Public Tertiary for increasing values of GINI

which are mainly concentrated on tertiary education, are strongly and negatively correlated to GINI (see Table 2, column 4). Indeed, if providers of tertiary education are mainly private (e.g. in Anglo-Saxon countries), we observe a strong negative relationship between COR and tertiary education spending when considering private (tertiary) expenditure (see Table 2, column 4). As income inequality increases further, the marginal effect of COR on tertiary public education spending becomes positive. Indeed, at odds with our theoretical conjectures, in some countries where both income inequality and intergenerational persistence in education are remarkably high (e.g., Mexico, Turkey, Argentina and Chile), we observe that the allocation of public education expenditure is biased towards tertiary public education. This scenario might describe a situation where the private sector is not sufficiently developed and the political power is in the hands of well-educated minorities, who would benefit most from an increase in public tertiary education spending (see Su (2006)).[58] This circumstance is not captured by our model, whose assumptions about the political process are more apt to describe an environment where power is equally distributed.

In the last column of Table 2, we examine the share of public education spending devoted to basic education. We do not find any significant correlation between COR and the share of public basic education spending on total public expenditure. However, this share is significantly and positively correlated with GINI. This might be consistent with our model; as income inequality increases the weight of the middle class decreases and it is more likely the emergence of an equilibrium *ends against the middle,* as described by Epple and Romano (1996), where the interests of the well-educated elite who opts out of the public system—mainly at the tertiary level- become closer to the interests of poor, less educated agents who are not interested in tertiary public education. Finally, as expected, log real GDP per capita is positively and significantly correlated with public expenditure in both education tiers.

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[58] One objection would be that the rich may send their children overseas for private education. Looking at the outbound mobility ratio, which is the 'number of students from a given country studying abroad, expressed as a percentage of total tertiary enrolment in that country', in 2019 Mexico, Argentina, Chile and Turkey had very low mobility in comparison to the other countries in our sample (UNESCO Institute for Statistics (http://data.uis.unesco.org/)).

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