




Interplay of public and private educational spending: Macroeconomic implications

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ABSTRACT

This paper examines how the composition of education financing shapes economic growth and income inequality. An overlapping-generations model with heterogeneous agents and non-homothetic education preferences shows that lower-income households demand more education relative to income but face tighter financing constraints, making the public–private mix central for distributional outcomes. Shifting toward public provision reduces inequality and promotes growth via human capital accumulation. System GMM estimates for OECD countries support these predictions: a one-unit increase in the public–private spending gap reduces the Gini coefficient by 6.4% and raises GDP per capita by 2.5%. These effects operate through higher tertiary attainment, which compresses income dispersion and enhances productivity. The results highlight that the structure, not just the level, of education financing shapes macroeconomic and distributional outcomes.

1. Introduction

In recent years, many countries have experienced rising income inequality (Alvaredo et al., 2018b) and declining intergenerational mobility (Narayan et al., 2018). These trends have renewed attention to the role of education in shaping economic opportunity and long-run growth. Because education is a key channel through which skills are transmitted across generations, the way it is financed, through public or private sources, can have important implications for both growth and income distribution. This paper examines the macroeconomic consequences of education financing, focusing specifically on the balance between public and private educational expenditures. These questions are highly policy relevant. In the Netherlands, for example, a 2015 reform replaced universal student grants with income-contingent loans, sparking debate over access and inequality (de Gendre and Kabátek, 2021). In Germany, tuition fees were abolished across all federal states by 2014 after a period of reintroductions (Minor, 2023). Such policy shifts illustrate the importance of understanding how the public–private mix of education finance affects both growth and distribution.

A key motivation for studying the composition of education spending is that it shapes access to human capital in ways that total expenditure alone does not capture. When education systems rely heavily on private spending, households face higher out-of-pocket costs, which may discourage investment among students from low-income backgrounds, particularly where credit markets are imperfect (Chetty et al.,

2014). By contrast, a higher public share reduces financial barriers and broadens access to skills. OECD evidence suggests that systems with stronger public cost-sharing tend to exhibit higher intergenerational mobility, smaller skill gaps, and better learning outcomes among disadvantaged groups (OECD, 2018).

The structure of education finance also interacts with long-run growth. In highly privatised systems, wealthier families can invest more in human capital while poorer households underinvest, widening skill gaps and slowing aggregate growth. Public financing can mitigate these disparities by lowering the effective cost of educational investment and expanding participation in skill formation, while private provision may contribute to quality improvements through competition and innovation (Hanushek and Woessmann, 2011). These considerations highlight why the balance between public and private spending, rather than either component alone, is central to understanding the evolution of growth and inequality.

Human capital investments are widely recognised as a key driver of both growth and equality.¹ A large literature studies the role of public and private education in shaping inequality and growth. Glomm and Ravikumar (2003) and Dotti (2019) show that public education can reduce inequality under certain conditions, while De la Croix and Doepke (2009) emphasise how private schooling choices can reinforce stratification and model heterogeneous preferences for education

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¹ For recent reviews of returns to human capital investment see Heckman et al. (2018), Flabbi and Gatti (2018), and Rossi (2020). For links between education and economic growth see Ogbeifun and Shobande (2021).

quality. Cardak (1999) similarly introduces heterogeneous education preferences into an OLG model of public versus private provision. In both frameworks, however, preferences are distributed independently of household income, so neither generates a mechanism by which lower-income households have systematically stronger demand for education as a share of income. Much of this literature relies on borrowing constraints as the primary mechanism limiting private investment in education.

This paper departs from this literature by emphasising a demand-side mechanism based on non-homothetic education preferences. While most existing models rely on borrowing constraints to explain disparities in education investment, I show that inequality can arise even in their absence. Non-homothetic preferences have been used in OLG growth models (Galor and Moav, 2004), but applied to consumption and bequest decisions rather than to the education preference weight, and the necessity-good property is consistent with empirical evidence that education budget shares decline with household income (Hashimoto and Heath, 1995). This preference structure is not merely a theoretical convenience. Microeconomic evidence consistently documents that wealthier households devote a larger absolute amount but a smaller share of income to education-related activities, including tutoring, enrichment programs, and private supplementary schooling (Kornrich and Furstenberg, 2013; Ramey and Ramey, 2010). Introducing this pattern directly into the preference weight, rather than deriving it as a consequence of credit rationing, allows the model to isolate the demand-side channel and generate a tractable closed-form mechanism linking education finance composition to distributional outcomes.

In the model, education functions as a necessity good: lower-income households exhibit a stronger preference weight for education and optimally devote a larger share of their income to it, yet their limited absolute income constrains actual private investment. Because households with the strongest latent demand for education are precisely those least able to fund it privately, the composition of public and private financing becomes decisive for distributional outcomes: public spending disproportionately satisfies the educational demand of lower-income households, compressing the skill distribution in a way that aggregate spending levels alone cannot capture. I show that this preference structure implies the composition of public and private spending matters for distribution independently of the aggregate level, a prediction confirmed with System GMM estimation on a panel of 37 OECD economies. The paper therefore asks: how does the balance between public and private education spending affect growth and inequality when households differ systematically in their ability and willingness to invest in education? In particular, to what extent can public provision offset these disparities, and how does the composition of education finance shape aggregate outcomes?

A critical distinction sets this paper apart from the prior literature on public versus private education. Existing theoretical work, including Glomm and Ravikumar (1992), De la Croix and Doepke (2004), and Glomm and Ravikumar (2003), compares discrete and mutually exclusive regimes: a fully public system against a fully private one. This is a useful theoretical benchmark but it does not correspond to the policy choices available to governments in practice. All OECD economies operate mixed systems in which public and private sources jointly fund education, and the relevant policy question is how shifting the balance within that mix, at the margin, affects macroeconomic outcomes. This paper is the first to model and estimate the effect of the continuous public–private spending gap as a policy instrument, rather than treating public and private provision as alternative regimes. The mechanism through which this gap operates, non-homothetic preferences generating demand-side inequality rather than supply-side credit rationing, is also new to this literature.

To address these questions, the paper combines a theoretical framework with an empirical analysis. The theoretical contribution is an

overlapping-generations (OLG) model in which human capital accumulation depends on both public and private education, and where education investment is non-homothetic. This allows inequality to emerge endogenously even in the absence of credit frictions, providing a transparent mechanism linking education finance to distributional outcomes. This distinguishes the framework from models in which inequality arises primarily from credit market imperfections. To isolate this mechanism, the baseline model abstracts from borrowing constraints. Although borrowing constraints are empirically important, particularly for low-income households, this abstraction is a deliberate scope choice that allows the preference-driven channel to be studied in isolation; robustness to relaxing this assumption is examined in the appendix.

The model shows how the composition of education finance shapes the joint evolution of growth, inequality, and welfare. To ensure that inequality remains meaningful over time, the framework incorporates heterogeneous permanent learning abilities, generating persistent differences in human capital accumulation across households and a non-degenerate stationary distribution of human capital, as in heterogeneous-agent human capital models such as Artige and Cavenaile (2023). Within this framework, greater reliance on public education spending tends to promote growth and reduce inequality by lowering the effective cost of educational investment for households with lower human capital. Among the simulated policy counterfactuals, reforms combining progressive taxation with higher public education spending generate the largest aggregate welfare gains.

The theoretical analysis is complemented by an empirical application using cross-country panel data. Dynamic panel methods are used to address persistence and potential endogeneity, while the limitations of available data on private education spending are discussed. The empirical results broadly support the theoretical predictions: countries with higher public spending relative to private spending tend to exhibit higher GDP growth and lower inequality, although the marginal effects diminish at very high levels of public provision. It is shown that tertiary attainment is the primary channel linking the spending gap to both outcomes, opening the empirical black box that the theoretical mechanism predicts. These findings suggest that the composition of education spending matters as much as its total level, with public financing playing a crucial role in broadening access to skills and supporting inclusive growth. Notably, in the specifications that include both the public–private spending gap and total education expenditure, the latter loses statistical significance while the gap remains significant, suggesting that in this sample and context, the composition of financing carries more explanatory power than its aggregate level once the two are disentangled.

This paper makes three incremental contributions to the literature. Theoretically, it introduces non-homothetic education preferences into an OLG framework in which the preference weight is decreasing in household human capital, generating endogenous inequality through a demand-side channel that does not require credit market frictions. Unlike existing models that compare discrete public and private regimes, the framework is designed to study the marginal effect of shifting the continuous public–private spending mix, which is the empirically and policy-relevant margin for OECD governments operating mixed systems. Empirically, it provides the first cross-country System GMM estimates of the effect of the public–private education spending gap as a continuous treatment on both GDP per capita and income inequality. A mediation analysis further shows that tertiary attainment accounts for a substantial share of the reduced-form effects, linking the aggregate results to the human capital channel the theory predicts. From a policy perspective, the findings identify a specific and actionable lever: shifting the composition of education finance toward greater public provision yields both equity and efficiency gains, with the effect concentrated in countries where private spending already dominates, precisely where income barriers to access are most acute.

The remainder of the paper is organised as follows. Section 2 presents the theoretical model. Section 3 describes the empirical analysis. Section 4 discusses the results and policy implications. Section 5 concludes.

2. Theoretical model

The model examines the policy trade-off between public and private education financing and how their balance affects economic growth and income inequality. Human capital formation relies on both public inputs, such as publicly provided schooling, and private household investments, including tutoring, health, extracurricular activities, and educational technology. The framework follows the OLG structure of De la Croix (2001) but shifts the emphasis from credit frictions to the composition of education financing and its implications for human capital accumulation and income distribution.

A key feature is that education preferences are non-homothetic: the importance households place on investing in their children’s education depends on their level of human capital. Specifically, lower-income households exhibit a stronger preference weight for education (education functions as a necessity good in this framework), while higher-income households, despite their larger absolute spending, devote a smaller income share to private education. The structural tension between preference intensity (highest at low human capital) and ability to pay (lowest at low human capital) is what makes the public–private composition of financing consequential: public spending disproportionately satisfies the educational demand of those households that cannot fund it privately. Human capital is produced using both publicly funded and parentally financed inputs, with intergenerational transmission reinforcing these effects. To prevent the degenerate long-run distribution implied by a fully deterministic concave technology, the model incorporates heterogeneity in learning abilities, generating persistent inequality and a stationary income distribution that can be mapped to empirical measures such as the Gini coefficient.

2.1. Environment

Consider an overlapping-generations economy in which individuals live for three periods and die at the end of the third. Each individual has one parent and one child, so the population size is constant and normalised to one. Individuals share identical preferences but differ in their ability to transform educational inputs into human capital. Differences across households therefore arise from heterogeneity in inherited human capital and permanent ability draws, which translate into differences in income.

In the first period of life, individuals do not work or consume; they only accumulate human capital. In the second period, they supply one unit of labor inelastically, earn wages, consume, and save for retirement. In the third period, they retire and consume their accumulated savings. At $t = 0$, the initial generation is endowed with human capital h_{j0} and a permanent ability draw a_j . Ability scales the productivity of educational investments without changing over the life cycle and follows a log-normal distribution with mean one:

$$\ln(a_i) \sim \mathcal{N}\left(-\frac{\sigma_a^2}{2}, \sigma_a^2\right), \quad \mathbb{E}[a_i] = 1. \tag{1}$$

The initial distribution of human capital $h_{i,0}$ is drawn from a log-normal distribution, with the dispersion parameter jointly calibrated with σ_a to match the empirical Gini coefficient and income distribution targets. To focus on the interaction between public and private education financing, the model abstracts from credit markets. This is a deliberate scope restriction rather than a claim that credit frictions are unimportant in practice; their role is examined separately in the robustness extension of Appendix A.5.

2.1.1. Household optimisation

Agents born in period $t-1$ (generation t) have preferences over three components: consumption in adulthood c_t , consumption in retirement d_{t+1} , and investment in their child’s education e_t . Lifetime utility is given by

$$\max_{c_t, d_{t+1}, e_t} u(c_t, d_{t+1}, e_t) = \ln(c_t) + \beta \ln(d_{t+1}) + \gamma_i \ln(e_t), \tag{2}$$

where β is the discount factor for retirement consumption.

The parameter γ_i captures heterogeneity in education preferences and introduces non-homotheticity into the model:

$$\gamma_i = \frac{\gamma_0}{1 + \phi_{nh} \frac{h_t}{h_0}}, \tag{3}$$

where $\gamma_0 > 0$ is the baseline preference for education and ϕ_{nh} governs the strength of the non-homotheticity mechanism. This specification implies that the marginal utility weight placed on education varies with relative human capital, generating systematic differences in private education spending across households.

Labor income is taxed at a proportional rate τ_t , which applies to earnings from supplying efficient labor units. Adults earn after-tax labor income $(1 - \tau_t)w_t h_t$ and allocate it across current consumption, educational investment, and retirement consumption. The household problem can therefore be written using a present-value budget constraint:

$$c_t + e_t + \frac{d_{t+1}}{R_{t+1}} = (1 - \tau_t)w_t h_t, \tag{4}$$

where $R_{t+1} = 1 + r_{t+1}$ is the gross return on savings.

Equivalently, households save an amount s_t in adulthood such that retirement consumption satisfies

$$d_{t+1} = R_{t+1} s_t. \tag{5}$$

2.1.2. Human capital accumulation

Human capital is accumulated during the first stage of life through both public and private educational inputs. The human capital production function is

$$h_{i,t+1} = a_i \Psi g_i^\lambda e_{i,t}^\theta h_{i,t}^{1-\lambda-\theta}, \tag{6}$$

where $\Psi > 0$ is a productivity parameter and a_i denotes the individual ability draw.

Ability is drawn from a stationary distribution and captures heterogeneity in innate learning capacity across households. The parameter a_i scales the productivity of both public and private educational inputs, implying that individuals with higher ability convert educational investments into human capital more efficiently. Ability is permanent over the life cycle and therefore generates persistent differences in human capital accumulation across households.

Public education spending g_t is provided uniformly by the government, while $e_{i,t}$ represents parental spending on children’s education. The parameters satisfy

$$0 < \lambda < 1, \quad 0 < \theta < 1, \quad \lambda + \theta < 1.$$

The parameter λ captures the elasticity of human capital with respect to public education spending, while θ captures the elasticity with respect to private parental investment. Public education therefore affects all households symmetrically, whereas private education decisions generate heterogeneity in educational investment across families.

The term $h_{i,t}^{1-\lambda-\theta}$ introduces partial intergenerational persistence of human capital, generating dynamic inequality even in the absence of borrowing constraints.

The model employs a single human capital production function rather than a level-specific structure spanning primary, secondary, and tertiary stages. The primary justification is theoretical: the mechanism of interest concerns the composition of financing between public and private sources, not stage-specific differences in pedagogy or production technology. Whether public spending enters at the primary, secondary, or tertiary level does not alter the core logic that public provision disproportionately satisfies the latent demand of lower-income households; what matters is the relative weight of public and private inputs within a given stage, not the number of stages modelled. Introducing level-specific production functions would add parameters without illuminating this mechanism. This approach is also consistent with standard practice: canonical OLG models of education finance,

including Glomm and Ravikumar (1992) and De la Croix (2001), adopt the same single-stage structure. The intergenerational persistence term $h_{i,t}^{1-\lambda-\theta}$ implicitly embeds the stock of human capital accumulated through prior schooling in the household endowment, so earlier education stages enter through initial conditions without requiring explicit modelling.

2.1.3. Firms

Production is carried out by competitive firms using physical capital K_t and human capital H_t according to the Cobb–Douglas technology

$$Y_t = K_t^\alpha H_t^{1-\alpha}. \quad (7)$$

Human capital is the aggregate of individual efficiency units:

$$H_t = \int h_{i,t} d\Gamma_t(h). \quad (8)$$

Competitive factor markets imply that labor and capital are paid their marginal products:

$$w_t = (1 - \alpha) \frac{Y_t}{H_t}, \quad r_t = \alpha \frac{Y_t}{K_t}. \quad (9)$$

2.1.4. Government

An infinitely lived government finances public education through a proportional tax on labor income. Total tax revenue is

$$T_t = \tau_t w_t H_t. \quad (10)$$

A fixed share $\phi_g \in (0, 1)$ of this revenue is allocated to public education spending:

$$g_t = \phi_g \tau_t w_t H_t. \quad (11)$$

The remaining share of tax revenue finances other government expenditures that do not directly enter the human capital production function:

$$G_t = (1 - \phi_g) T_t. \quad (12)$$

These expenditures represent public consumption and other government programs treated as exogenous from the perspective of household decisions.² The model abstracts from public debt, explicit transfer programs, and public pensions. These are deliberate scope restrictions rather than claims that such instruments are unimportant. The paper’s focus is on the composition of education expenditure and its consequences for human capital accumulation; incorporating public debt would shift attention to intergenerational burden-sharing, while modelling transfer targeting or pension design would require taking a stand on distributional rules that are orthogonal to the mechanism under study. Retirement consumption is already present in the OLG structure through private savings: households save in adulthood and consume savings in retirement, so the absence of a public pension system is a simplification of the financing arrangement rather than an omission of the retirement stage itself. The treatment of G_t as exogenous follows the same convention as Glomm and Ravikumar (1992) and De la Croix (2001), whose frameworks also abstract from these fiscal dimensions to keep the education composition channel transparent and identifiable.

² This follows Glomm and Ravikumar (1992) and Benhabib and Spiegel (1994). The non-education component captures transfers, public consumption, and administrative spending that are empirically present but do not directly enter the human capital production function. The parameter ϕ_g is calibrated to reproduce the observed public education spending share, ensuring the split is empirically disciplined.

2.2. Equilibrium

A competitive equilibrium consists of sequences

$$\{c_{i,t}, d_{i,t+1}, e_{i,t}, s_{i,t}, h_{i,t}\}, \{w_t, r_t\}, \{g_t\},$$

and distributions Γ_t such that:

1. Households maximise utility subject to their budget constraints, taking prices and government policy as given.
2. Firms maximise profits and satisfy the factor pricing conditions.
3. The government budget constraint holds.
4. Capital and labor markets clear.
5. The distribution of human capital evolves according to the accumulation technology

$$h_{i,t+1} = a_i \Psi g_t^\lambda e_{i,t}^\theta h_{i,t}^{1-\lambda-\theta},$$

which induces the law of motion for the distribution Γ_t .

Aggregate physical capital evolves according to household savings:

$$K_{t+1} = \int s_{i,t} d\Gamma_t, \quad (13)$$

which, together with the law of motion for human capital, fully characterises the aggregate dynamics of the economy. A detailed derivation of the household optimality conditions, the distributions of ability and initial human capital, and the steady-state characterisation are provided in Appendix A.1.

Because public education spending depends on aggregate tax revenue, fiscal policy feeds back into the human capital accumulation process and therefore affects both growth and the evolution of inequality over time.

2.3. Numerical simulation

The numerical simulation quantifies the mechanisms of the model and evaluates policy counterfactuals affecting taxation and education finance. Because the model features heterogeneous households and non-homothetic education preferences, closed-form aggregate dynamics are generally not available, so simulation allows the full distribution of human capital to evolve endogenously across generations.

The structural parameters are calibrated to match empirical counterparts for OECD economies around 2017, with targets summarised in Table 1. Public education expenditure is matched by choosing ϕ_g , the share of government revenue allocated to education, which together with the tax rate τ and labor income share $(1 - \alpha)$ determines the equilibrium ratio of public education spending to GDP,

$$\frac{g_t}{Y_t} = \phi_g \tau (1 - \alpha). \quad (14)$$

Private education spending is disciplined by the preference parameter γ_0 , which governs parental investment in children’s education. On the household side, the discount factor is set to $\beta = 0.8$ (Galor and Weil, 2000), the baseline education preference parameter to $\gamma_0 = 0.08$, and the non-homotheticity parameter to $\phi_{nh} = 0.28$. The human capital production elasticities are $\lambda = 0.25$ and $\theta = 0.25$ (Glomm and Ravikumar, 1992). The three parameters γ_0 , ϕ_{nh} , and $\sigma_a = 0.28$ are jointly calibrated to match private education spending as a share of GDP (0.73%), the 90/10 income ratio (5.0), and the bottom-50% income share (0.25) (World Inequality Database, 2022). On the production side, the capital share is $\alpha = 0.30$ (King and Rebelo, 1999), the tax parameter $\tau = 0.34$ (OECD, 2023), and the government allocates $\phi_g = 0.198$ of revenue to education, reproducing the observed public education spending ratio.

The calibration reproduces key empirical patterns of OECD economies. Public education spending matches its empirical counterpart by construction, while private education spending and inequality measures are close to their benchmarks. The simulated saving rate is

Table 1
Calibration targets.

	Model	Data
Public education (% of GDP)	4.71	4.71
Private education (% of GDP)	0.78	0.73
Saving rate (% of GDP)	28.35	22.00
Gini coefficient	0.34	0.30
90/10 income ratio	5.22	5.00
Bottom 50% income share	0.25	0.25

Table 2
Policy counterfactuals: Baseline vs. Alternative policies.
Source: Author’s calculations.

	Baseline	CF1	CF2	CF3	CF4
Panel A: Policy variables (levels)					
Public education (% GDP)	4.71	4.76	4.71	4.76	4.66
Private education (% GDP)	0.78	0.78	0.81	0.81	0.80
Eff. tax rate: Top 10% (%)	34.00	34.00	39.58	39.57	34.00
Eff. tax rate: Bottom 50% (%)	34.00	34.00	25.57	25.60	34.00
Panel B: Economic outcomes (percent change relative to baseline)					
Aggregate welfare (CEV %)	–	+2.12	+10.12	+12.43	–2.11
GDP (short-run change)	–	+0.17%	–0.09%	+0.08%	–0.18%
Gini coefficient	0.34	–0.25%	–8.98%	–9.20%	+0.25%
Top 10% income share	0.23	–0.20%	–6.32%	–6.48%	+0.20%
Bottom 50% income share	0.26	+0.23%	+8.39%	+8.59%	–0.23%

Notes: Panel A reports levels of policy variables under the baseline and each counterfactual scenario. Panel B reports percentage changes in economic outcomes relative to the baseline steady state. Welfare changes are measured as consumption-equivalent variation (CEV).

somewhat higher than in the data, reflecting the model’s abstraction from government transfers, pension systems, and capital depreciation. Given these parameters, the model is simulated forward across generations until the distribution of human capital converges to a stationary equilibrium, after which policy experiments are conducted by perturbing fiscal parameters and recomputing transition dynamics and steady-state outcomes.

Figure A.2.1 summarises the baseline transition dynamics. Panel (a) shows the evolution of the Gini coefficient as the economy converges toward its steady-state equilibrium, while Panel (b) reports the corresponding shares of public and private education spending as a percentage of GDP. Public spending is distributed uniformly across households while private spending depends on household income and human capital, so households with higher human capital invest more in private education for their children. Through this interaction, the public–private composition of education finance shapes both the distribution of skills and aggregate economic outcomes over time.

2.3.1. Policy counterfactuals

To quantify the mechanisms described above, I conduct a set of policy counterfactuals using the calibrated model. The objective of these simulations is not to generate precise forecasts but to evaluate how alternative fiscal policies affect the long-run distribution of income, aggregate output, and welfare. Welfare effects are measured using consumption-equivalent variation (CEV), which allows the model to assess how different groups gain or lose relative to the baseline steady state.

Four counterfactual experiments are considered. The first increases public education spending relative to the baseline while leaving the tax schedule unchanged. The second introduces progressive labor-income taxation while maintaining overall government revenue constant. The third combines both reforms, while the fourth reduces public education spending, representing a shift toward greater reliance on private education financing. Table 2 summarises the steady-state outcomes of these experiments relative to the baseline equilibrium.

Figs. 1 and 2 illustrate the transition dynamics of inequality and output under the alternative policy scenarios. The first counterfactual

isolates the education-spending channel. Increasing public education spending raises the public education share of GDP from 4.71 percent to 4.76 percent. Private education spending declines slightly as households partially substitute public provision for private investment. The resulting reduction in inequality is modest: the Gini coefficient falls by approximately 0.25 percent relative to the baseline. At the same time, output increases slightly as higher public spending strengthens human capital accumulation. Welfare gains are positive but relatively small, with aggregate welfare increasing by roughly 2 percent in CEV terms.

The second counterfactual introduces progressive labor-income taxation while keeping total tax revenue constant. Following Heathcote et al. (2017) (HSV), after-tax labor income follows

$$\ell_{i,t}^a = \lambda_t^{\text{HSV}} \ell_{i,t}^{1-\tau_p}, \tag{15}$$

where $\ell_{i,t} = w_t h_{i,t}$ denotes pre-tax labor income, τ_p governs the degree of tax progressivity, and λ_t^{HSV} is a scaling parameter chosen each period to keep total tax revenue equal to the baseline level $T_t = \tau w_t H_t$, distinct from the public education elasticity λ in Eq. (6). In counterfactuals CF2 and CF3, the flat-tax labor income term $(1 - \tau_t)w_t h_{i,t}$ in the household budget constraint (Eq. (4)) is replaced by the progressive after-tax income $\ell_{i,t}^a$ defined above. In this counterfactual, the progressivity parameter is set to $\tau_p = 0.15$.

This reform increases effective tax rates for higher-income households while reducing them for lower-income households. In particular, the effective tax rate faced by the top decile rises from 34 percent to approximately 39.6 percent, while the rate for the bottom half declines to about 25.6 percent. Because the reform is revenue neutral, total public education spending remains unchanged. The redistribution of disposable income generates a substantial decline in inequality, with the Gini coefficient falling by roughly 9 percent relative to the baseline. Output declines slightly as higher tax progressivity weakens incentives for saving and investment. From a welfare perspective, however, the reform generates large gains for lower-income households, while higher-income households experience welfare losses.

The third counterfactual combines progressive taxation with higher public education spending. This reform produces the largest reduction in inequality, with the Gini coefficient declining by about 9.2 percent relative to the baseline. The additional public education spending strengthens human capital accumulation and largely offsets the negative output effects of progressive taxation, leaving GDP close to its baseline level. The combined reform also produces the largest welfare gains in the model, with aggregate welfare increasing by more than 12 percent in CEV terms.

The final counterfactual examines the effects of reducing public education spending. Public education expenditure falls to 4.66 percent of GDP, increasing reliance on private educational investment. As a result, inequality rises slightly relative to the baseline and output declines modestly. Welfare also falls across the income distribution, with aggregate welfare declining by about 2 percent in CEV terms.

Fig. 3 summarises the welfare implications of these policy experiments. Panel (a) reports welfare changes for key income groups, while Panel (b) illustrates how welfare gains and losses vary across the full income distribution. The results highlight the strongly progressive nature of the tax reform, with welfare gains concentrated among lower-income households and welfare losses among higher-income households. The magnitude of these distributional effects is substantial. Under the progressive tax reform (CF2), households in the bottom half of the income distribution experience welfare gains of roughly 25 percent in consumption-equivalent terms, while the top decile experiences a welfare loss of about 13.8 percent. The combined policy reform (CF3) further amplifies these gains, with bottom 50% households gaining nearly 28 percent in CEV terms. Detailed welfare results are reported in Table A.4.1 in Appendix A.4.

The counterfactual experiments illustrate two distinct channels through which fiscal policy affects economic outcomes. Changes in the composition of education finance influence inequality primarily

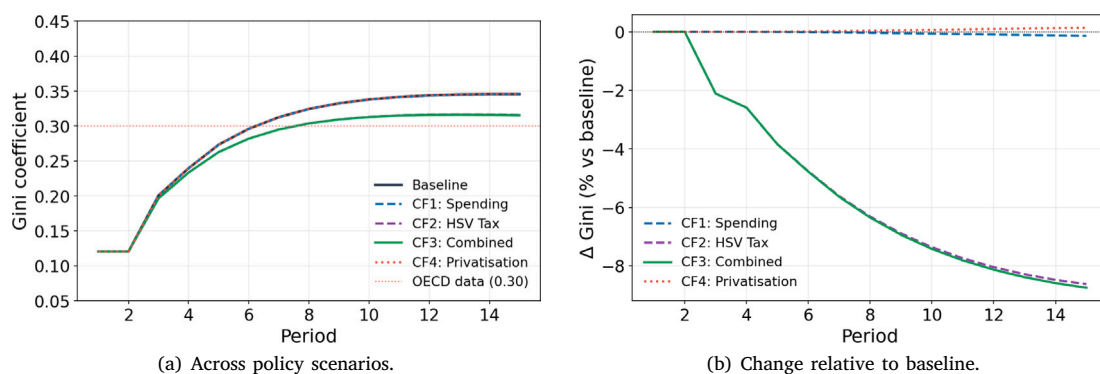


Fig. 1. Inequality dynamics across model scenarios.

Notes: Panel (a) shows the evolution of the Gini coefficient under alternative model scenarios: higher public education spending (CF1), progressive taxation (CF2), a combined policy (CF3), and reduced public education spending (CF4). Panel (b) reports the percentage deviation of the Gini coefficient relative to the baseline equilibrium.

Source: Author's calculations.

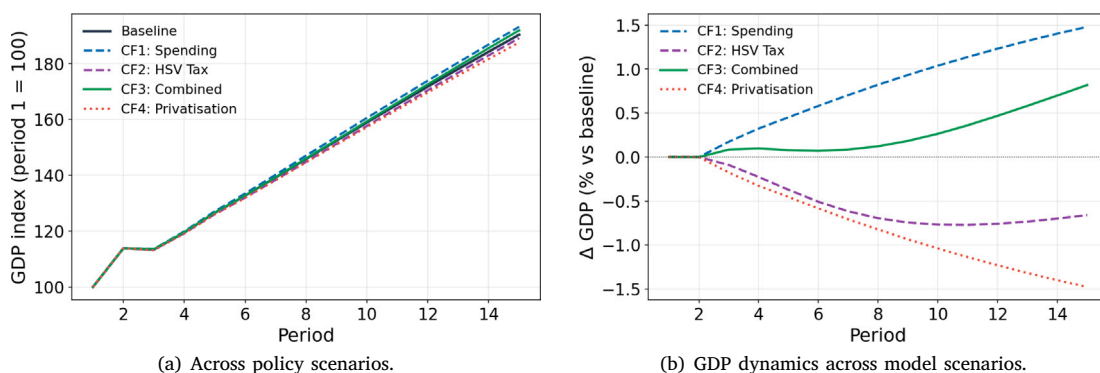


Fig. 2. GDP dynamics across model scenarios.

Notes: Panel (a) shows the evolution of GDP under alternative model scenarios: higher public education spending (CF1), progressive taxation (CF2), a combined policy (CF3), and reduced public education spending (CF4). Panel (b) reports the percentage deviation of GDP relative to the baseline equilibrium for each scenario.

Source: Author's calculations.

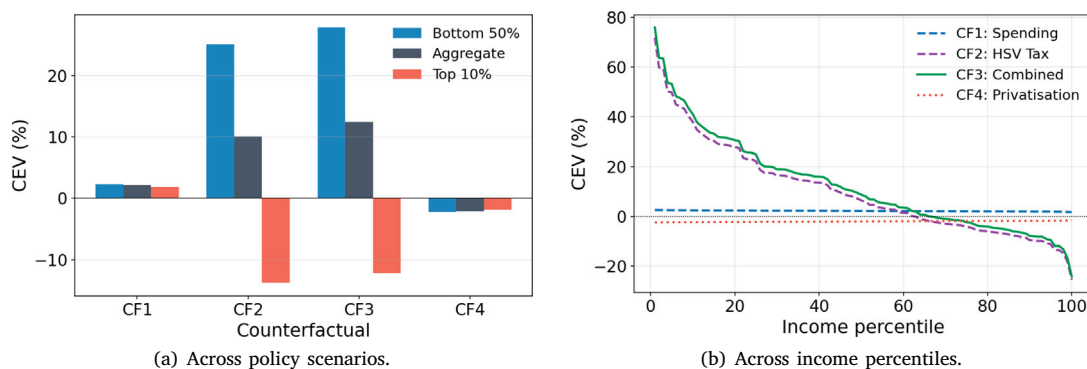


Fig. 3. Welfare effects of policy counterfactuals.

Notes: Panel (a) reports consumption-equivalent variation (CEV) for different income groups under the policy counterfactuals: increased public education spending (CF1), progressive taxation (CF2), the combined reform (CF3), and reduced public education spending (CF4). Panel (b) shows the distribution of welfare effects across the income distribution, where the horizontal axis represents income percentiles and the vertical axis reports the CEV relative to the baseline steady state. Positive values indicate welfare gains, while negative values indicate welfare losses.

Source: Author's calculations.

through human capital accumulation, while tax progressivity affects inequality directly through redistribution of disposable income. Policies combining both mechanisms reduce inequality while maintaining strong economic performance, as the output gains from broader human capital formation largely offset the investment disincentives of progressive taxation.

The model delivers three predictions that guide the empirical analysis. A larger public share of education financing raises long-run GDP per capita by lowering the effective cost of educational investment and expanding the aggregate stock of skills. Heavier reliance on private education spending amplifies inequality because higher-income households invest more in their children's education. And these effects should be detectable in cross-country data as systematic differences in growth and inequality associated with differences in the composition of education finance. Section 3 examines whether the data support these predictions.

2.4. Extensions: Credit constraints and input substitution

The baseline model abstracts from credit market imperfections and assumes a Cobb–Douglas aggregation of public and private education inputs. This subsection briefly assesses the robustness of the mechanism to relaxing these assumptions. Full details are reported in Appendix A.5 and A.6.

Introducing borrowing constraints does not alter the core mechanism but affects both the level of inequality and the strength of policy responses (Table A.5.2). When constraints bind for a substantial fraction of households, inequality increases markedly, reflecting the inability of lower-income households to translate their high demand for education into actual investment. In this environment, the equalising effect of public education is amplified: increases in public spending generate larger reductions in inequality because public provision partially substitutes for constrained private investment. By contrast, when borrowing constraints are weak, the model converges back to the baseline, with both inequality and policy effects closely replicating the unconstrained case. These results indicate that while credit constraints are not necessary for the mechanism to operate, they reinforce its quantitative importance when binding.

The results are also robust to alternative assumptions about the substitutability between public and private education inputs (Table A.6.3). Under near-Cobb–Douglas aggregation, the model closely reproduces the baseline results. When inputs are complementary, the equalising effect of public spending is weaker, as unequal private investment limits the effectiveness of public provision. When inputs are substitutable, the reduction in inequality is also attenuated, but for a different reason: households substitute away from private education toward other uses of income, weakening the education investment channel through which public spending operates. At the same time, this reallocation increases capital accumulation and leads to stronger output growth.

Overall, the qualitative relationship between education financing, inequality, and growth is robust across these extensions. However, the magnitude and transmission channels of the effects depend on the presence of credit constraints and on the degree of substitutability between public and private education inputs.

3. Empirical analysis

The analysis examines the relationship between the public–private composition of education spending and two outcomes: disposable income inequality and GDP per capita. To address the persistence and potential endogeneity inherent in these relationships, the empirical strategy relies on the System GMM estimator of [Arellano and Bover \(1995\)](#) and [Blundell and Bond \(1998\)](#), which combines equations in differences and levels and instruments endogenous variables using their own lagged differences and levels. Instrument validity is assessed using the Hansen test for overidentifying restrictions and the AR(2) test for second-order serial correlation in the differenced residuals. To avoid

overfitting, the number of instruments is kept below the number of countries in each specification. All specifications are estimated with one to two lag periods, country fixed effects to account for the substantial cross-country heterogeneity documented in Figures B.0.7 and B.0.8, and Windmeijer-corrected standard errors.

3.1. Empirical framework

3.1.1. Income inequality

The first dependent variable is the Gini coefficient of disposable income. The baseline specification is:

$$\log \text{GINI}_{it} = \beta \text{PP}_{it} + \alpha_1 \log \text{GINI}_{i,t-1} + \alpha_2 \log \text{GDP}_{it} + \alpha_3 X_{it}^{\text{gini}} + \gamma_i + \epsilon_{it}, \quad (16)$$

where PP_{it} is the public–private tertiary education spending gap, $\log \text{GINI}_{i,t-1}$ captures inequality persistence, $\log \text{GDP}_{it}$ controls for income levels, X_{it}^{gini} includes government consumption, employment in agriculture, adolescent fertility, years of compulsory education, and governance, γ_i denotes country fixed effects, and ϵ_{it} is the error term. The coefficient on PP_{it} captures the marginal effect of shifting the public–private balance rather than assuming equal productivity of both inputs.

The controls in X_{it}^{gini} follow the literature on the determinants of inequality. Government consumption affects income distribution through public sector compensation ([De Mello and Tiongson, 2006](#); [Anderson et al., 2017](#)). Employment in agriculture proxies sector dualism, since the shift toward non-agricultural employment generates between-sector inequality ([Alderson and Nielsen, 2002](#)). Adolescent fertility affects the human capital accumulation of young individuals and their labor market entry ([Kearney and Levine, 2012](#)). Governance captures the unequal political influence of high-income households ([Chong and Gradstein, 2007](#)), while employment conditions for unskilled workers directly affect the low-income share of the distribution ([Glyn, 1995](#)).

3.1.2. GDP per capita

The second dependent variable is GDP per capita. The baseline specification follows:

$$\log \text{GDP}_{it} = \psi \text{PP}_{it} + \theta_1 \log \text{GDP}_{i,t-1} + \theta_2 \log \text{GINI}_{it} + \theta_3 X_{it}^{\text{gdp}} + \gamma_i + v_{it} \quad (17)$$

where PP_{it} is the public–private education spending gap, $\log \text{GDP}_{i,t-1}$ captures output persistence, $\log \text{GINI}_{it}$ controls for inequality, and X_{it}^{gdp} includes tertiary enrollment, governance, FDI, gross fixed capital formation, trade, inflation, employment in agriculture, employment rate, and government education expenditure.

The controls follow the standard growth literature. Tertiary enrollment proxies human capital, which facilitates technology adoption and innovation ([Benhabib and Spiegel, 1994](#)). Governance supports political stability and growth ([Islam and McGillivray, 2020](#)). FDI ([Li and Liu, 2005](#)), gross fixed capital formation ([Meyer and Sanusi, 2019](#)), agriculture ([Tiffin and Irz, 2006](#)), and employment ([Eriksson, 1997](#)) are standard engines of output growth. Trade openness ([Dollar and Kraay, 2003](#)) and inflation ([Barro et al., 1996](#)) are included to control for external and monetary conditions respectively. In addition to the education spending gap, GDP per capita and income inequality are treated as endogenous and instrumented using their own lags within the System GMM framework.

3.2. Data and descriptive evidence

The analysis uses a balanced panel of 37 OECD countries spanning 2008 to 2019.³ Income inequality is measured by the disposable income Gini coefficient and GDP per capita is sourced from the World Bank. Private and public expenditures on tertiary education are drawn from

³ The list of countries is detailed in Table B.0.4 in the Appendix.

Table 3
Dynamic regression: Income inequality.

	Log Disposable Income Gini	
	(1)	(2)
L.Log D. Income Gini	0.921*** (0.056)	
L2.Log D. Income Gini		0.703*** (0.131)
Public–Private Gap	–0.064*** (0.021)	–0.131*** (0.039)
Observations	226	202
Hansen p -value	0.291	0.171
AR(2) p -value	0.887	0.064
No. instruments	20	22
No. countries	23	25

Note: The table reports the effects of education investment on the Log Disposable Income Gini. Standard errors are Windmeijer-corrected and robust to heteroscedasticity. Constant, country effects, and control variables are included but not reported for brevity. Significance levels are: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

the OECD Education Statistics database. The main independent variable PP_{it} represents the difference between public and private spending on tertiary education as a share of GDP, with positive values indicating that public spending exceeds private.⁴ In the theoretical model, private education spending encompasses the full range of household investments in a child's human capital; in the empirical analysis, it is proxied by institutional expenditure at the tertiary level, primarily tuition fees and related charges paid to universities. The private education expenditure variable is drawn from OECD institutional accounts and captures spending reported by educational institutions, but excludes household outlays on private tutoring, extracurricular activities, and educational materials. Since these unmeasured private inputs are disproportionately concentrated among higher-income households, their omission likely understates the true private spending of affluent families. The estimated equalising effect of public relative to private spending should therefore be interpreted as a conservative lower bound on the true effect. Summary statistics and variable definitions are provided in Tables B.0.5 and B.0.6 in the Appendix. Figures B.0.7 and B.0.8 document substantial cross-country heterogeneity in inequality and GDP per capita, which motivates the use of country fixed effects throughout the analysis.

3.3. Empirical results

3.3.1. Income inequality

Table 3 reports the baseline dynamic specification in column (1), estimated following Eq. (16). The dependent variable is the log of the disposable income Gini. Consistent with the persistence typically observed in inequality dynamics, the coefficient on the lagged dependent variable is large and highly significant (0.92). The public–private education expenditure differential is negative and statistically significant, indicating that a widening gap, reflecting higher public relative to private education investment, is associated with lower income inequality. A one percentage point increase in the public–private spending gap (as a share of GDP) is associated with a 6.4 percent reduction in the disposable income Gini.

All regressions treat the disposable income Gini, GDP per capita, and the public–private expenditure differential as endogenous. Their lags serve as internal instruments, while all remaining controls enter as external instruments. The full list of instruments is provided in Section B of the Appendix. The specification passes standard diagnostic tests: the Hansen test does not reject instrument validity, and the AR(2) test fails to detect second-order serial correlation.

Column (2) presents a specification that replaces the first lag of the Gini with its second lag, allowing for a slower adjustment process.

Table 4
Dynamic regression: Income distribution shares.

	Shares of income distribution		
	Top 1%	Top 10%	Bottom 50%
L.Log top 1%	0.920*** (0.043)		
L.Log top 10%		0.968*** (0.032)	
L.Log bottom 50%			0.945*** (0.036)
Public–Private gap	–0.023* (0.013)	–0.033* (0.019)	0.024* (0.013)
Observations	226	217	215
Hansen p -value	0.346	0.854	0.258
AR(2) p -value	0.183	0.414	0.443
No. instruments	26	24	24
No. countries	29	25	24

Note: The table reports the effects of education investment on Column (1), the log of the top 1%, (2) the log of the top 10%, and (3) the bottom 50% of the income distribution. Standard errors are Windmeijer-corrected and robust to heteroscedasticity. Constant, country effects, and control variables are included but not reported for brevity. Significance levels are: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Including a second lag of inequality is an important robustness check because inequality is a slow-moving variable and its persistence can absorb substantial variation in dynamic GMM models. The equalising effect of public–private education expenditure remains negative and significant under this alternative dynamic structure, demonstrating that the main finding does not depend on the specific lag order and is robust to slower adjustment processes. Countries with relatively higher public education spending experience lower levels of income inequality. The two dynamic specifications demonstrate that the main result, the equalising effect of higher public relative to private education investment, is robust to alternative assumptions about the persistence of income inequality and the structure of the dynamic model.

Table 4 presents an alternative set of dependent variables, income shares for the top 1%, top 10%, and bottom 50%, to assess whether the baseline findings are robust across different dimensions of the income distribution. These measures, drawn from the World Inequality Database (Alvaredo et al., 2018a), provide a complementary view of inequality by focusing directly on distributional shares rather than a summary index. The specification follows the same dynamic structure as the baseline model, with appropriately adjusted controls.

Across all three columns, the lagged dependent variable remains large and highly persistent, as expected for distributional shares. More importantly, the coefficient on the public–private education expenditure gap retains its sign and significance in each specification. For the top 1% and top 10%, a larger public–private expenditure differential is associated with reductions of 2.3% and 3.3% in their income shares, respectively. These results indicate that greater public investment relative to private investment tends to compress the upper end of the distribution.

For the bottom 50%, the effect is reversed: the same differential increases their income share by 2.4%. This pattern is consistent with the mechanism proposed in the main analysis: public educational spending disproportionately raises the human capital of lower-income groups, who rely primarily on wage income.

Empirical evidence shows that the bottom half of the income distribution derives the vast majority of its income from wages, whereas top income groups rely more heavily on capital, business income, and financial returns (Piketty et al., 2018). This structural asymmetry helps explain why educational investment generates stronger distributional effects toward the lower tail. Taken together, these results corroborate the baseline findings: the public–private education expenditure gap reduces inequality not only through a summary measure like the Gini coefficient, but also through a direct reallocation of income shares from the top quantiles to the bottom half of the distribution.

⁴ A cross-country overview is provided in Figure B.0.6 in the Appendix.

Table 5
Dynamic regression: Log GDP per capita.

	Log GDP per capita	
	(1)	(2)
L.Log GDP p.c.	0.990*** (0.013)	
L2.Log GDP p.c.		0.972*** (0.017)
Public–Private gap	0.025** (0.011)	0.030* (0.016)
Observations	233	221
Hansen <i>p</i> -value	0.077	0.054
AR(2) <i>p</i> -value	0.155	0.043
No. instruments	27	27
No. countries	32	32

Note: The table reports the effects of education investment on the Log GDP per capita. Standard errors are Windmeijer-corrected and robust to heteroscedasticity. Constant, country effects, and control variables are included but not reported for brevity. Significance levels are: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 6
Dynamic regression: Log GDP per hour.

	GDP pc	GDP ph	GDP ph
L.Log GDP p.c.	0.990*** (0.013)		
L.Log GDP p.h.		0.967*** (0.029)	
L2.Log GDP p.h.			0.996*** (0.060)
Public–Private gap	0.025** (0.011)	0.040* (0.020)	0.065* (0.038)
Observations	233	246	226
Hansen <i>p</i> -value	0.077	0.102	0.285
AR(2) <i>p</i> -value	0.155	0.353	0.132
No. instruments	27	26	26
No. countries	32	35	35

Note: The table reports the effects of education investment on the log of GDP per hour. Standard errors are Windmeijer-corrected and robust to heteroscedasticity. Constant, country effects, and additional controls are included but not reported for brevity. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

3.3.2. GDP per capita

The results of the dynamic output specification in Eq. (17) and the corresponding robustness checks are presented in Table 5. As with the inequality regressions, GDP per capita, the education spending gap, and the remaining endogenous covariates are instrumented using their own lags within the System GMM framework, while additional variables serve as external instruments. A detailed list of all instruments used across specifications is provided in Section B of the Appendix.

Column (1) reports the baseline specification using the first lag of log GDP per capita. The coefficient on the lagged dependent variable is very close to unity (0.99), reflecting the high persistence typical of macroeconomic output series. The main variable of interest, i.e., the gap between public and private education expenditure, remains positive and statistically significant, with an estimated elasticity of 2.5 percent. This confirms the core finding that a greater relative commitment to public education is associated with higher levels of economic output.

Column (2) extends the dynamic structure by replacing the first lag with the second lag of log GDP per capita. The persistence remains extremely strong (0.97), consistent with slow-moving convergence dynamics. The coefficient on the public–private spending gap remains positive and significant, with an elasticity of roughly 3 percent, slightly larger than in the baseline model. The stability of this estimate across alternative lag structures indicates that the relationship between education expenditure composition and GDP per capita is not driven by short-term fluctuations in output dynamics.

Table 6 assesses whether the main findings for GDP per capita extend to an alternative measure of economic performance: GDP per

hour worked, a standard indicator of labor productivity. Given the known strong correlation between GDP per capita and GDP per hour, this provides a meaningful validation of the baseline results. Column (1) reproduces the GDP-per-capita specification for reference. Columns (2) and (3) replace the dependent variable with the log of GDP per hour, first using a specification with one lag and then with two lags to capture slower productivity adjustment. Across both models, the lagged dependent variable remains highly persistent, with coefficients close to unity, consistent with the slow-moving dynamics of productivity.

Crucially, the coefficient on the public–private education expenditure gap remains positive and statistically significant in all specifications. The estimated magnitudes range from 4.0 percent in column (2) to 6.5 percent in column (3), slightly larger than the corresponding effect on GDP per capita (2.5 percent). This suggests that the relative strength of public education investment may influence productivity even more directly than overall economic output. Overall, the GDP-per-hour results reinforce the main conclusion: countries allocating relatively more resources to public education tend to experience stronger economic performance, whether measured through income per person or labor productivity.

While the dynamic panel approach and the use of internal instruments mitigate concerns related to endogeneity and reverse causality, the empirical results should be interpreted primarily as conditional associations rather than definitive causal estimates. Differences in education financing structures may themselves reflect deeper institutional, political, or economic characteristics across countries. The analysis therefore identifies systematic correlations consistent with the theoretical mechanism rather than establishing a fully causal effect of education spending composition.

3.3.3. Specification and functional form robustness

Tables C.0.9 and C.0.10 evaluate whether the baseline results are sensitive to alternative functional forms of the public–private education expenditure measure. Columns (1) and (2) introduce a squared term to test for nonlinearities. For GDP per capita, the quadratic term is small and insignificant, indicating no detectable curvature. For inequality, the squared term is positive and significant, suggesting diminishing marginal reductions as the gap becomes very large, though the linear term retains its expected sign and significance throughout. Column (3) incorporates total education spending to test whether baseline results are driven by overall expenditure levels rather than composition. Total spending is insignificant in both tables while the public–private gap remains strongly significant and increases in magnitude, confirming that composition rather than scale drives the observed effects. Column (4) replaces the gap with the ratio of public to private spending as an alternative measure. The ratio is negative and significant for inequality and positive and significant for GDP per capita, providing functional-form validation that the relationship holds regardless of how composition is expressed.

Tables C.0.11 and C.0.12 examine whether baseline results hold when accounting for intergenerational mobility and initial country conditions. Columns (1) and (2) introduce measures of absolute and relative intergenerational mobility, both of which are statistically insignificant, while the public–private gap remains stable in sign and significance across both outcome variables. Columns (3) and (4) incorporate interactions with initial income inequality or initial GDP levels. Interaction terms are small and insignificant throughout, and in the inequality regressions the gap remains negative and significant while in the GDP regressions it remains positive and significant, with the magnitude in Column (3) increasing relative to baseline, suggesting that accounting for initial conditions sharpens rather than weakens the underlying relationship.

Tables C.0.7 and C.0.8 assess stability across three identification challenges: alternative dynamic structures, regional and income-group heterogeneity, and reverse causality. Column (1) introduces deeper lags in the GMM instrument set, and the public–private gap retains

its expected sign, significance, and magnitude across both outcomes. Column (2) adds region and income-group controls, after which the coefficient remains significant and of similar magnitude, ruling out the possibility that results merely reflect structural differences across country clusters. Column (3) replaces the contemporaneous spending gap with its lagged value to address reverse causality. The lagged gap remains statistically significant with the expected sign, suggesting that historical differences in education financing predict current inequality and economic performance rather than the reverse.

Across all specifications, a larger public share of education spending is associated with lower disposable income inequality and higher GDP per capita, with the direction, magnitude, and significance of the effect remaining stable throughout. This consistency across functional forms, mobility measures, initial conditions, dynamic structures, and reverse-causality tests confirms that the relationship is not an artefact of model parametrisation or omitted heterogeneity.

3.3.4. Identification, falsification, and alternative measures

Tables C.1.13 and C.1.14 in the Appendix report additional sample and identification robustness checks. Excluding the crisis years 2008–2009 leaves the spending gap coefficient virtually unchanged for both outcomes, ruling out the possibility that results are driven by the acute financing shifts of the global financial crisis. Replacing the disposable income Gini with the market (pre-redistribution) Gini in Table C.1.13 shows that the equalising effect operates on market inequality, not only through redistribution, which is consistent with the model's human capital channel. Winsorizing the Public–Private Gap variable at the first and ninety-ninth percentiles confirms that the findings are not driven by outlying values of the spending gap. Column (5) uses the Palma ratio (the ratio of the income share of the top 10% to that of the bottom 40%, from the UNU-WIDER World Income Inequality Database) as an alternative inequality measure. Unlike the Gini, which summarises the entire distribution through a single area-based statistic, the Palma concentrates explicitly on the tails and is therefore sensitive to a different dimension of distributional change. The coefficient on Public–Private Gap remains negative and highly significant, and the larger magnitude relative to the Gini baseline is consistent with the model's prediction that the equalising mechanism operates primarily through the lower tail of the human capital distribution. The results are therefore robust to the choice of inequality measure and are not an artefact of the Gini's particular weighting of the income distribution.

Table C.2.15 provides a sector-specific falsification test. Replacing the education spending gap with the public–private health spending gap yields a coefficient close to zero and statistically negligible, confirming that the equalising effect identified in the baseline is specific to education finance rather than reflecting a generic public-provision channel. Table C.3.16 examines heterogeneity by system type: the interaction between the spending gap and a dummy for countries with above-median private tertiary enrollment is negative, indicating that the equalising effect is stronger in privately dominated systems where income constraints on access are most acute, a pattern consistent with the theoretical mechanism, even though the interaction term falls short of conventional significance levels in the full sample.

Table C.4.17 provides a level-specific falsification. When the primary to post-secondary and non-tertiary spending gap replaces the tertiary gap, the coefficient turns positive and significant, reflecting that higher primary public spending is associated with more equal access at that stage but does not compress the income distribution through the same channel as tertiary financing. When both gaps enter simultaneously, the tertiary gap dominates and the primary gap becomes statistically insignificant, confirming that the equalising mechanism identified in the baseline operates specifically through tertiary education, where voluntary attendance and income constraints generate the identifying variation. Finally, Table C.5.18 collapses the panel into non-overlapping 2-year averages to smooth high-frequency variation and assess sensitivity to the annual frequency. The sign, magnitude, and significance of the spending gap coefficient are preserved under this alternative time aggregation for both outcomes.

Table 7
Mediation analysis: Tertiary attainment.

	(1) Stage 1	Stage 2	
	Log Attainment	(2) Log Gini	(3) Log GDP p.c.
L.Log Attainment	1.011*** (0.070)		
Public–Private E.E.	0.061** (0.029)	–0.020** (0.010)	0.033* (0.019)
Log Attainment		–0.024** (0.010)	0.052* (0.026)
L.Log D. income Gini		0.984*** (0.035)	
L.Log GDP p.c.			0.970*** (0.011)
Observations	200	212	228
Hansen <i>p</i> -value	0.573	0.602	0.267
AR(2) <i>p</i> -value	0.320	0.721	0.123
No. instruments	25	21	22
No. countries	26	22	31

Note: Column (1) Stage 1: dependent variable is Log Attainment (share of population aged 25+ with at least a Bachelor's degree). Columns (2) and (3) Stage 2: log tertiary attainment enters as the mediator alongside Public–Private Gap as a control. Windmeijer-corrected standard errors in parentheses. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

3.4. Mechanism: Human capital accumulation

Table 7 investigates the channel through which the public–private spending gap affects inequality and growth. The analysis follows a two-stage mediation design in which tertiary attainment (the share of the population aged 25 and above holding at least a bachelor's degree) proxies the aggregate human capital stock in the model. This stock variable captures the cumulative effect of past education financing decisions and directly connects the theoretical mechanism to an observable macroeconomic outcome.

Column (1) establishes the first stage: a larger public–private spending gap is associated with a significantly higher stock of tertiary-educated adults, consistent with the model prediction that public provision raises the equilibrium level of human capital accumulation by lowering the effective cost of tertiary education for lower-income households. Columns (2) and (3) report the second stage: tertiary attainment enters negatively and significantly in the Gini regression and positively and significantly in the GDP per capita regression. Crucially, the direct coefficient on Public–Private Gap attenuates substantially once attainment is controlled for: by around 69 percent in the inequality equation and by 86 percent in the GDP equation, indicating that human capital accumulation accounts for a large share of both reduced-form effects. The persistence of a significant direct effect of Public–Private Gap in both stage-two equations confirms partial rather than full mediation, implying that additional channels operate alongside the human capital route.

The downstream links from tertiary attainment to inequality reduction and to aggregate output growth are well established in the literature and do not require re-estimation here. A higher stock of tertiary-educated workers compresses the wage distribution by increasing the relative supply of skilled labor, directly reducing labor income inequality (Mankiw et al., 1992; Hanushek and Woessmann, 2011). Broader tertiary access also weakens the intergenerational transmission of educational advantage, increasing social mobility and reducing the persistence of inequality across cohorts (Heckman et al., 2006, 2018). On the output side, the positive relationship between educational attainment and GDP per capita is among the most replicated findings in the growth literature, operating through technology adoption, productivity growth, and innovation (Mankiw et al., 1992; Barro and Lee, 2013; Benhabib and Spiegel, 1994). The present analysis therefore focuses on the first step of the chain, the effect of financing composition on attainment, where the identifying variation is cleanest and where the novel contribution of this paper lies.

4. Discussion

This study shows that the composition of education finance, specifically the balance between public and private spending, plays an important role in shaping long-run growth and income inequality. Because the public–private education spending gap is expressed in levels, the coefficients in the baseline regressions can be interpreted as semi-elasticities. The inequality specification indicates that a one-unit increase in the public–private gap is associated with a 6.4 percent decrease in the disposable income Gini, corresponding to a reduction of roughly 0.019 Gini points for a country with a Gini of 0.30. The estimated semi-elasticity for GDP per capita of 0.025 implies a 2.5 percent increase per unit increase in the gap, suggesting that reallocating even modest resources toward public education can generate meaningful improvements in both equality and aggregate income. It should be noted that the empirical estimates and model counterfactuals operate on different margins, since the empirical specification measures changes in the overall spending gap across countries while the model simulations examine specific fiscal reforms, so the quantitative effects are not directly comparable but point to consistent qualitative mechanisms.

The mechanisms linking education financing to growth and inequality operate through two complementary channels. Private education spending tends to amplify inequality because it depends directly on parental income, widening skill gaps and strengthening intergenerational transmission of advantage. Public spending, by contrast, lowers the effective cost of skill investment and broadens access to human capital accumulation, compressing the skill distribution and raising the share of the population able to acquire productive skills. This broader participation in human capital formation raises aggregate productivity and supports long-run growth. Public spending may also display diminishing returns, which helps explain why the theoretical simulations show that combining progressive taxation with increased public education spending generates the largest welfare gains, a pattern consistent with the empirical finding that human capital accumulation is the primary operative link between the spending gap and both distributional and aggregate outcomes (Section 3.4).

The broader implications are consistent with evidence documented by Lindert (2004), showing that expansions of social spending have often reduced inequality without undermining growth. From a policy perspective, countries where private spending represents a large share of education finance may benefit from strengthening public subsidies, reducing private cost burdens, and ensuring that tertiary tuition policies do not make access dependent on family resources or student debt. This policy implication is reinforced by the heterogeneity analysis in Table C.3.16, which shows that the equalising effect of the spending gap is stronger in countries with above-median private tertiary enrollment, precisely the systems where income constraints on access are most acute and where a shift toward public provision would generate the largest distributional gains. Future research could enrich this framework by incorporating credit markets, wealth accumulation, or heterogeneous returns to education on the theoretical side, and by using microdata on household expenditures and student loans to uncover the mechanisms behind the aggregate patterns documented here.

Several scope conditions of the analysis deserve acknowledgement. The sample is restricted to OECD countries for the period 2008–2019, reflecting the availability of harmonised data on tertiary education expenditure. Extending the analysis to developing economies, where basic education dominates and institutional frameworks differ substantially, is a natural but distinct research question that would require different data and likely a modified theoretical framework. The focus on tertiary education is theoretically motivated and constitutes a meaningful setting for at least two reasons. First, across OECD countries secondary school enrollment is near-universal and the financing

structure is predominantly public with limited cross-country variation, leaving insufficient identifying variation at that stage. Second, and more importantly, tertiary education feeds directly into the labor market: graduates enter employment immediately, so changes in the financing structure translate into wage and productivity effects within a few years rather than the two to three decades required for effects to propagate through the full educational pipeline. This makes the 12-year sample window appropriate for detecting medium-run effects of tertiary financing on GDP and inequality. The results are therefore best understood as capturing the medium-run labor market consequences of tertiary education financing structures in advanced economies, a channel that is empirically detectable in the available data and that the theoretical model is designed to represent.

5. Conclusion

This paper examines how the composition of education financing, specifically the balance between public and private spending, shapes long-run growth and inequality. An overlapping-generations model shows that while public and private investment are complementary, a larger public share promotes both growth and equity by lowering the effective cost of human capital accumulation and broadening access to skill formation. Policy simulations confirm that modest increases in public spending raise GDP per capita and reduce inequality, with the largest welfare gains arising from reforms combining progressive taxation with higher public education expenditure.

The empirical analysis corroborates these predictions. System GMM estimates on a multi-country panel show that a larger public–private spending gap is associated with significantly lower disposable income inequality and higher GDP per capita, with a one-unit increase corresponding to a 6.4 percent reduction in the Gini coefficient and a 2.5 percent increase in GDP per capita. Human capital accumulation is the primary operative channel: controlling for the stock of tertiary-educated adults attenuates the direct effect of the spending gap in the inequality equation and in the GDP per capita equation.

These findings show that spending composition, not just spending levels, is central to distributional and growth outcomes. The analysis contributes a preference-driven mechanism, specifically non-homothetic education preferences in which the expenditure share decreases with household human capital, that generates endogenous inequality even in the absence of credit market frictions. This mechanism implies that the public–private mix matters not because of access constraints but because public provision disproportionately satisfies the latent educational demand of lower-income households, a prediction that the empirical evidence supports. Policies that strengthen public investment, reduce financial barriers, or shift tuition systems toward greater cost-sharing can yield both equity and efficiency gains, particularly for countries seeking to promote social mobility and sustain long-run growth.

Declaration of generative AI and AI-assisted technologies

During the preparation of this work the author used Claude (Anthropic) to assist with language editing, prose refinement, and structural revisions of selected passages. The author performed all conceptual development, theoretical modelling, empirical analysis, and interpretation of results independently. After using this tool, the author reviewed and edited all AI-assisted content and takes full responsibility for the content of the published article.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at <https://doi.org/10.1016/j.strueco.2026.06.016>.

Data availability

Data will be made available on request.

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