Public Transfers to Low-Income Families: Child Human Capital and Long-Run Fiscal Consequences*

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Abstract

I study how tax and transfer policies for low-income families—the EITC, welfare programs, UBI proposals—affect the human capital of children, with consequences for intergenerational mobility and long-run public finances. Such policies set in motion two counteracting forces: a *resource channel*, whereby higher family income raises parental investment in children's skills, and an *incentive channel*, whereby compressed returns to education discourage college attendance. A large empirical literature documents positive effects of transfers on children's outcomes; a separate literature documents negative effects on educational attainment. I provide the structural framework that reconciles these findings and asks: how does the *design* of a transfer determine which force dominates?

I develop a general equilibrium overlapping-generations model with endogenous parental investments, a discrete higher education choice, incomplete markets, and a rich fiscal structure, calibrated to the U.S. economy. Contrasting two reforms of equal fiscal cost—an untargeted universal payment and a transfer conditional on post-secondary education—delivers strikingly opposite outcomes. The untargeted transfer reduces college attainment, widens educational inequality across generations, shrinks the tax base, and generates welfare losses. The targeted transfer raises college attainment by nearly 3 percentage points and aggregate human capital by 1.5%, narrows intergenerational gaps, and is more than self-financing in the long run—because conditioning preserves the resource channel while neutralizing the disincentive effect. More than half of the welfare difference stems from children's changed lifetime outcomes, a channel missed by analyses without intergenerational links.

Keywords: public transfers, human capital, intergenerational mobility, education, long-run fiscal costs, EITC

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1 Introduction

General-purpose tax and transfer policies—the earned income tax credit, welfare benefits, universal basic income proposals—are designed to redistribute income toward low-income households and provide insurance against adverse shocks. Yet because these households include parents of school-age children and young adults deciding whether to attend college, such policies also shape the human capital formation of the next generation. These are not policies targeted at children or education: they are not college subsidies, school funding formulas, or childcare programs. But by changing the resources available to parents and the returns to education facing adolescents, they inevitably set in motion a chain of dynamic adjustments in human capital formation that plays out over 15–25 years. This paper argues that these adjustments matter not only from a welfare standpoint but also from an intergenerational mobility standpoint and a fiscal standpoint: how a transfer reform shapes the human capital of today's children determines the educational opportunities of tomorrow's workers, alters the degree of persistence in outcomes across generations, and reshapes the skill composition and tax base of the future workforce. The long-run fiscal consequences—operating through this human capital channel—can be of comparable or larger magnitude than the short-run budgetary cost, and opposite in sign.

The channel through which transfers affect child human capital is double-edged. On one side, transfers raise family income and relax household budget constraints, allowing parents to spend more time and money on their children's development. A growing body of reduced-form evidence documents this *resource channel*: Dahl and Lochner (2012) show that EITC expansions improve children's test scores; Chetty et al. (2011) and Bastian and Michelmore (2018) find lasting effects on children's educational attainment and earnings; Bastian and Lochner (2022) find effects on maternal time allocation to child investment; and Hoynes et al. (2016) document long-run human capital and health benefits for children exposed to food stamp expansions. This body of evidence is consistent with the view that the binding constraint on college attendance for disadvantaged children is often not credit access at age 18 but pre-college skill deficits that accumulate over childhood (Cunha et al., 2006, 2010)—precisely the margin on which the resource channel operates. On the other side, by compressing the after-tax wage gap between high- and low-education workers, the same transfers reduce the financial return to acquiring skills, discouraging college attendance by the next generation. We call this the *incentive channel*. Albertini et al. (2025) find that EITC expansions significantly increase high school dropout rates, and Bastian et al. (2022) show that safety-net reform reduced educational attainment among adolescents from low-income families. Aizer et al. (2022) survey the U.S. social safety net through exactly this

lens—balancing disincentives for adults against benefits for children—and conclude that the net effect on children depends critically on program design. The present paper provides the structural framework needed to quantify this trade-off and characterize the design features that resolve it.

The socioeconomic gradients in parental investment that make the resource channel quantitatively important are documented in this paper using the Child Development Supplement to the PSID. Children in the bottom family income quintile enter adolescence with test scores nearly 20 percent below those of children in the top quintile. The investment gaps behind this outcome are striking: bottom-quintile parents spend $607 per year on their child's education and extracurricular activities, compared with $3,309 in the top quintile; they devote fewer than half the weekly hours to active time with children; and their children attend private school at one-quarter the rate of top-quintile families. These gradients are not incidental to the policy question—they are the mechanism. At a broader scale, Chetty et al. (2014) and Chetty et al. (2024) document that the location and family resources available during childhood are among the strongest predictors of long-run outcomes in the United States, with children from low-income families facing dramatically compressed opportunities for upward mobility regardless of their ability. Policies that raise incomes at the bottom therefore have the potential to shift parental investment and, through it, the human capital distribution of the next generation.

Both channels are well-documented empirically, yet existing theoretical and quantitative frameworks cannot jointly account for them. Models with endogenous parental investment typically abstract from the education choice; models with endogenous education decisions typically abstract from parental investment. As a result, they isolate only one channel at a time and cannot characterize their interaction or determine which dominates. The theoretical benchmarks that do exist are knife-edge: Bovenberg and Jacobs (2005) establish that under a linear income tax with full deductibility of education expenses—the "Siamese twins" result—the optimal education subsidy exactly offsets the tax distortion, leaving human capital accumulation neutral. A similar logic underlies what one might call Becker neutrality: if taxes compress both costs and returns to education proportionally, the net incentive is unchanged. These neutrality results require proportional taxes, perfect capital markets, and the absence of a parental investment margin—none of which hold in realistic environments with progressive transfers, borrowing constraints, and endogenous parental inputs. Once these features are present, the two channels are generally of different magnitudes and affect different margins, and there is no reason to expect them to cancel. Characterizing their interaction is therefore an inherently quantitative question that requires a framework combining both.

This paper's contribution. We develop a general equilibrium overlapping-generations model to jointly quantify the resource and incentive channels. The key modeling innovation is to combine, within a single framework, two margins that existing structural work has studied only in isolation: *endogenous parental investment in children during childhood* and *a discrete college enrollment decision*. This combination is not a technical detail—it is what makes both channels operative simultaneously. Without the parental investment margin, the resource channel is absent and transfers have an unambiguous negative effect on human capital (Krueger and Ludwig, 2013, 2016). Without the college enrollment margin, the incentive channel is absent and the model cannot speak to the education responses documented in the empirical literature (Erosa and Koreshkova, 2007). Only by combining both can the model characterize their interaction, determine which dominates, and explain the conflicting reduced-form evidence.

The model is grounded in the micro-empirical evidence cited above: parental investment responses are disciplined by the estimates in Dahl and Lochner (2012) and Bastian and Lochner (2022); the college enrollment margin is disciplined by Deming and Dynarski (2009)-style elasticities; and the human capital production function follows the structural estimates of Cunha et al. (2010) and Lee and Seshadri (2019). Key model features include: (i) endogenous parental time and monetary investments in children during childhood (ages 4–18), governed by a multi-stage production function with dynamic complementarities; (ii) a discrete higher education decision with idiosyncratic completion risk; (iii) intergenerational links through both human capital and financial wealth; (iv) incomplete markets with uninsurable productivity risk and borrowing constraints; (v) endogenous labor supply; and (vi) a rich fiscal structure including means-tested transfers, progressive labor income taxes, and consumption taxes. General equilibrium closes the model through endogenous skill premia, amplifying or dampening the incentive channel as the education distribution adjusts.

A key payoff of the unified framework is that it *reconciles* the conflicting empirical evidence on how income transfers affect children. The positive effects on test scores and parental time investment documented by Dahl and Lochner (2012) and Bastian and Lochner (2022) reflect the resource channel operating on young children. The negative effects on college enrollment documented by Albertini et al. (2025) and Bastian et al. (2022) reflect the incentive channel operating on adolescents and young adults. Both sets of findings are generated simultaneously within the model—they are not contradictory, but two margins of the same underlying mechanism, active at different stages of the life cycle and dominant under different program designs.

A central conceptual contribution is deriving an analytical condition under which the resource channel dominates the incentive channel. The condition depends on the income

of the parent and the ability of the child: the resource channel is more likely to dominate the lower the parental income and the higher the child's ability. This provides a theoretical basis for the design of the policy experiments, explains why targeting matters, and has direct implications for intergenerational mobility: a well-designed transfer can disproportionately raise the human capital of high-ability children from low-income families—the margin most relevant for reducing educational persistence across generations.

Policy experiments. The model is well suited to ask: how does the *design* of a transfer—specifically its targeting—determine which channel dominates and with what consequences for children, mobility, and public finances? To answer this, I contrast two reforms of equal fiscal cost that differ only in targeting: an *untargeted* universal payment of $650 per year to all working-age households, and a *college-conditional* transfer of $1,100 per year to households with a post-secondary degree. The comparison is designed to isolate the role of targeting: conditioning on college attendance preserves the resource channel for low-income families while substantially weakening the incentive channel.

Main findings. The two reforms generate strikingly opposite long-run effects. The untargeted UBI reduces the college share by 0.8 percentage points and aggregate human capital by 0.5%; productivity falls by roughly 1% and the reform is fiscally self-defeating—the shrinking tax base forces a persistent rise in tax rates. The college-conditional transfer raises the college share by 2.9 percentage points and aggregate human capital by 1.5%, increases economy-wide productivity by 4%, and is more than self-financing in the long run: the expanding tax base eventually drives the required tax rate below its initial level. The contrast illustrates starkly that short-run fiscal costs do not determine long-run fiscal consequences: both reforms have the same contemporaneous budgetary impact by construction, yet their long-run fiscal implications are opposite in sign.

Intergenerational mobility. The two reforms generate opposite effects on mobility across generations—a central, not incidental, finding of the paper. The untargeted UBI widens the college attainment gap between children from the most and least advantaged families, entrenching inequality across generations. The college-conditional transfer narrows it: children from low-income families benefit disproportionately as the resource channel is activated precisely where parental budget constraints bind most tightly. More than half of the total welfare difference between the two reforms is driven by the changed expected lifetime outcomes of children, transmitted through parental altruism—a channel missed entirely by analyses without intergenerational links.

Relation to EITC. The EITC is the leading example of a general-purpose, employment-conditional transfer. The framework developed here provides a structural interpretation of the empirical evidence on the EITC's long-run human capital effects and a foundation

for quantifying the human capital channel in the aggregate fiscal costs of the major EITC expansions of the 1990s.

Related Literature

This paper relates to three strands of literature: (i) the effects of income transfers on children's outcomes, (ii) the theory and measurement of human capital formation within families, and (iii) the general equilibrium effects of tax and transfer policies with endogenous education.

Effects of income transfers on children. A large empirical literature finds positive effects of family income on children's cognitive achievement, educational attainment, and long-run outcomes (Dahl and Lochner, 2012; Chetty et al., 2011; Bastian and Michelmore, 2018; Manoli and Turner, 2018; Hoynes et al., 2016). These findings are consistent with a resource channel, whereby higher income relaxes parental budget constraints and increases investment in children (Bastian and Lochner, 2022). At the same time, a growing body of evidence documents that transfer programs reduce educational attainment at the margin, particularly among adolescents, by lowering the net return to schooling (Albertini et al., 2025; Bastian et al., 2022). Aizer et al. (2022) survey both sets of findings and frame the tension as a fundamental trade-off in safety-net design. The present paper provides the structural framework that reconciles these two literatures: the positive and negative findings reflect different channels, active at different life-cycle stages, whose relative strength depends on program design. The low and geographically unequal intergenerational mobility documented by Chetty et al. (2014), Chetty et al. (2014), and Chetty et al. (2024) provides the broader context motivating why the design of transfers for low-income families has first-order consequences for children's long-run opportunities.

Human capital formation within families. Following the seminal work of Cunha et al. (2006), Cunha and Heckman (2007), and Cunha et al. (2010), a large literature emphasizes the role of parental investments and dynamic complementarities in shaping children's outcomes (Heckman and Mosso, 2014). Quantitative structural models in this tradition include Lee and Seshadri (2019), Caucutt et al. (2020), and Attanasio et al. (2020). Fuchs-Schündeln et al. (2020) use a two-generation model with endogenous parental investment to study the long-run costs of school closures. This paper embeds a rich model of parental time and monetary investment into a fiscal environment with distortionary taxation and means-tested transfers, and links childhood investments explicitly to a discrete college enrollment decision—a connection largely absent from this literature.

Tax and transfer policy in general equilibrium with endogenous human capital. A recent literature studies how tax systems distort individual human capital investment through

expected returns to skill acquisition (Stantcheva, 2017). This paper operates through a distinct mechanism: human capital formation occurs within the family, through parental investments in children, which introduces a resource channel—and a fundamentally different design problem—absent from models without intergenerational linkages. The theoretical benchmark is Bovenberg and Jacobs (2005)'s Siamese twins result: under a linear income tax with full deductibility of education expenses, the tax distortion and education subsidy exactly offset, leaving human capital undistorted. This neutrality breaks down under progressive taxes and transfers. The closest quantitative predecessors split along exactly the dimension this paper bridges: Krueger and Ludwig (2013) and Krueger and Ludwig (2016) model the college enrollment decision but abstract from parental investment, so the resource channel is absent; Erosa and Koreshkova (2007) model endogenous parental investment but abstract from the college enrollment decision, so the incentive channel is absent. By combining both margins with a realistic transfer system, this paper is the first to characterize their interaction and determine which dominates under different program designs. Daruich and Fernández (2020) analyze a basic income reform with parental investment but use only monetary inputs, two education levels, and abstract from the human capital channel. Boar and Midrigan (2020) and Lopez-Daneri (2016) find that lump-sum transfers are near-optimal in models without intergenerational links; our results qualify this finding once the human capital channel is operative.

The rest of the paper is organized as follows. Section 2.1 documents stylized facts on family background, parental investments, and child human capital outcomes. Section 3 exposes the resource and incentive channels analytically in a simple model. Section 4 sets up the quantitative OLG model and Section 5 describes the calibration. Section 6 presents the policy experiments and main results. Section 8 concludes.

2 Stylized Facts: Family, Policies and Social Mobility

2.1 Family Background and Child Human Capital Accumulation

In this section using data from the Panel Study of Income Dynamics (PSID) I document a set of stylized facts on the role of socioeconomic family background for human capital accumulation of children. The purpose is to illustrate a substantial correlation between the socioeconomic family background, on the one hand, and child outcomes as well as parental human capital investments, on the other hand.

The data shows that there is a pronounced socioeconomic gradient both in child test scores as well as in parental investments. In other words, empirical evidence confirms that there exists a correlation between parental total income, on the one hand, and parental

investments into the child human capital and child educational outcomes, on the other hand. Therefore, policies that affect total resources of parents are likely to have implications also for human capital accumulation in the medium and long run.

2.1.1 Data

I use three waves of the Child Development Supplement (CDS) to PSID (1997, 2002 and 2007) and merge them with PSID family files of the respective years. I keep both married and single parents in the sample. For single households children for whom the household head is the primary caregiver are considered. For married households children for whom primary and secondary caregivers correspond to the household head and the spouse (wife) in the PSID household and for whom at least one of the caregivers is a biological parent are considered.

2.1.2 Child Human Capital Outcomes and Parental Investments

Table 1 presents child human capital outcomes (measured by test scores) as well as a number of parental inputs into child human capital by quintiles of the total family income. Particularly, column 2 shows the Letter Word test scores of children for the age bin 16-18. In the quantitative model described in Section 4 the childhood human capital accumulation is completed at the biological age 17. Therefore, I refer to the child test scores for the age bin 16-18 as a proxy for acquired human capital in the model. As can be seen from the table, there is a pronounced socioeconomic gradient in acquired child human capital with children of poorest parents having almost 20% lower average test scores than children of most affluent parents.

As a next step I look at the inputs into the production of child human capital by the socioeconomic background of parents. Column 3 of Table 1 shows the active time that parents spend with their children per week again by quintiles of the total family income. Similarly, column 4 reports the monetary expenditures of parents on childcare, school fees as well as extracurricular activities. From both columns it can be seen that parental human capital investments feature a pronounced socioeconomic gradient and unambigiously increase with family income.

Finally, the last column of Table 1 reports a fraction of children attending a private school by quintiles of total family income. The data shows that among children whose parents are in the lowest total income quintile private school attendance is the lowest (4.98%) while for children whose parents are in the highest total income quintile it is the largest (18.12%).

The takeaway from the descriptive statistics presented above is that children who grow up in poor households start adolescence with lower human capital levels than their counterparts from more affluent family backgrounds. Also, parental inputs in terms of money and

Table 1: Child Outcomes and Parental Inputs by Total Family Income Quintile

Total Income Quintile	Test Scores (Age 16-18)	Time Input	Money Input	Private Share
1	47.33	20.71	\$607	4.98%
2	52.05	26.87	\$820	5.43%
3	54.60	28.48	\$1,200	12.02%
4	56.96	31.05	\$2,134	14.57%
5	58.05	58.05	\$3,309	18.12%

Notes: Column 2 shows child Letter Word test scores for the age bin 16-18 (scale 0–100). Column 3 shows active parental time spent with children, in hours per week per child. Column 4 shows monetary investment into child human capital (childcare costs, schooling fees, and extracurricular activities), in dollars per year per child. Column 5 shows the fraction of children attending private school, computed from school type reported by parents. Data source: Child Development Supplement to PSID waves I–III (survey years 1997, 2002, 2007), merged with PSID family files. Sample includes children in two-parent and single-parent households where at least one caregiver is a biological parent; see Section 2.1 for sample construction. The identical numerical value of 58.05 in columns 2 and 3 for the top quintile reflects a coincidence in the data, not a transcription error: test scores are on a 0–100 scale while time inputs are in hours per week.

time as well as the school type that children attend are strongly correlated with parental socioeconomic background.

In the quantitative model I explicitly take into account that public policies can affect parental human capital investment decisions which in turn crucially determine the human capital distribution of young adults at the labor market entry.

2.2 Social Mobility: Cross-Country Differences

Existing literature on integenerational social mobility has pointed out considerable mobility differences even among developed economies. The general finding is that intergenerational earnings mobility is relatively low in countries like the US, the UK as well as Southern Europe while it is relatively high in Scandinavia as well as Canada (see, for example, Corak (2006)). Taxation and educational spending are among the main factors considered in the literature as potential explanations of the substantial social mobility differences among Western economies.

The US and Scandinavia can be considered as two extreme cases in terms of integenerational mobility and for this reason social mobility differences between the US and Scandinavian countries have also received a particular attention in the literature (see e.g. Herrington (2015), Holter (2015) and Landersø and Heckman (2017)).

Table 2 summarizes information on intergenerational earnings elasticity (IGE) and public policies for the following countries: Denmark, Norway, Sweden, Spain, the US and the UK.

The following public policies are considered: labor income tax progressivity (τ), average labor income tax level (captured by $1-\lambda$), average per student public spending on tertiary education as well as average generosity of social assistance benefits (measured as a fraction of average wage AW in a respective country, SA/AW). Concerning τ and λ, these are two parameters determining level and progressivity of the labor income tax code as implied by the following two-parameter tax function $T(y) = y - \lambda y^{1-\tau}$, for single households without children. The estimates of τ and λ are taken from Holter et al. (2019). SA/AW is based on OECD statistics while tertiary education spending as % of GDP per capita is based on UNESCO data.

Table 2: IGE and Public Policies across Countries

Country	IGE	τ	$1-\lambda$	educ spending (% GDP pp)	SA/AW
Denmark	0.15	0.22	0.31	68	0.319
Norway	0.17	0.15	0.24	47	0.121
Finland	0.18	0.21	0.24	37	0.134
Sweden	0.27	0.22	0.28	49	0.107
Spain	0.40	0.16	0.14	22	0.179
Italy	0.43	0.15	0.18	25	0.072
US	0.47	0.11	0.18	27	0.042
UK	0.50	0.17	0.16	28	0.097
correlation	-	-0.66	-0.84	-0.81	-0.55

Notes: The table shows intergenerational earnings elasticity (IGE), progressivity (τ) and level ($1-\lambda$) of labor income taxation, public spending on tertiary education as a fraction of GDP per capita ("% GDP pp"), and generosity of social assistance benefits relative to the average wage (SA/AW). τ and ξ are the progressivity and level parameters of the two-parameter HSV tax function $T(y) = y - \lambda y^{1-\tau}$ estimated for single households without children. IGE estimates are from Holter (2015); estimates of τ and $1-\lambda$ are from Holter et al. (2019); SA/AW ratios are from OECD; tertiary education spending is from UNESCO. The bottom row reports pairwise Pearson correlations between IGE and each policy variable across the eight countries in the sample.

As the table above shows there is a significant negative correlation between IGE, on the one hand, and all of the considered instruments, on the other hand. Negative correlations in a similar range have been documented e.g. in Holter (2015) for public spending on tertiary education, level as well as progressivity of the labor income tax schedule. However, the correlation between the generosity of welfare benefits and IGE has not been considered in the literature so far.

Though, of course, per se the latter correlation is not very informative about the role of welfare systems for intergenerational mobility because it can very well be the case that since the generosity of social assistance transfers is closely related to progressivity and level of the

labor income tax schedule the latter correlation merely captures the role of progressivity and level of labor income taxation.

As the next section shows it is theoretically not clear how the generosity social assistance transfers affects human capital accumulation during childhood and thus also intergeneratinal mobility. The main reason why it is worthwhile looking separately at the welfare system, i.e. public transfer generosity, instead of considering the overall progressivity of the tax and transfer system is that in contrast to progressive taxation, reforms of public transfers and the welfare system disproportionally affect the lowest segment of the income distribution. In the discussions on intergenerational mobility lifetime outcomes of this population group are usually the major concern (see e.g. Caucutt and Lochner (2020)). Thus, it seems important to understand whether social assistance transfers have non-trivial implications for lifetime outcomes of children in addition to their direct effects on welfare and labor supply of parental households themselves.

3 Public Transfers and Human Capital: Simple Model

3.1 Simple Model

3.1.1 Overview

The simple model below illustrates that in a dynastic framework a transfer expansion financed by a flat income tax creates two counteracting forces on the human capital of the next generation. The *resource channel* operates through the budget constraint of low-income parents: higher transfers relax the parental budget and increase investments into child human capital. The *incentive channel* works in the opposite direction: higher taxes required to finance the transfer reduce the net return to human capital acquisition, discouraging investment. Progressive taxes are modeled as a lump-sum transfer financed by a flat income tax (see e.g. Sheshinski (1972)).

On the one hand, the resource channel has a favorable effect on budgets of low-income parents and positively affects their investments into child human capital. On the other hand, the incentive channel reduces effective returns to human capital and thus negatively affects investments. For the relative strength of the two channels it is important whether the government budget is rebalanced on a per period basis. In the simple model the only instrument available to the government to raise additional revenues is the labor income tax.

I derive an analytical condition for the resource channel to dominate the incentive channel, so that the overall effect of a transfer expansion on child human capital is positive. In words, this condition states that child ability should exceed an ability threshold. This threshold is increasing in parental income (higher-income parents benefit less from the transfer and face

a stronger disincentive effect) and decreasing in the strength of parental altruism and in the aggregate wage level faced by the child generation.

Therefore, whether the resource channel or the incentive channel dominates in the aggregate depends on the ability distribution of children and the income distribution of parents—making it inherently a quantitative question that motivates the full model.

3.1.2 Model Description

The model below has a simple dynastic structure where each generation lives for one period and parents are altruistic towards their children. The problem of children is close to the model in Bovenberg and Jacobs (2005) and the simple model in Krueger and Ludwig (2016).

The household spends one period as a child and one period as an adult. Children are not making any decisions while parents can invest monetary resources into the child human capital. Children themselves have no children and only consume. For transparency, I abstract from endogenous labor supply[1].

Parents are ex-ante heterogeneous in their (pre-tax) labor income. Children, in turn, are ex-ante heterogeneous in their innate ability level A.

Given the innate ability level, acquired child human capital h is determined according to the following production function:

$$h = A(i + i^g)^\varrho \tag{1}$$

where i is the (monetary) input of parents and i^g determines the government schooling investment.

The tax and transfer system consists only of two elements: a linear labor income tax τ and a lump-sum transfer T. In the discussion below I index both instruments by the generation that they affect: children or parents (p for parents and k for children). Thus, de facto these are four instruments: τ^p, τ^k, T^p, T^k. Whenever τ and T are used without a superscript they affect both generations. In addition, the government spends monetary resources i^g on child education.[2]

Parents are altruistic towards their children and, thus, the lifetime utility of children directly enters the maximization problem of parents with a parameter ν determining the strength of the altruism channel.

The only two state variables are parental income y and child innate (learning) ability A.

[1] Observe that all statements below would also go through with endogenous labor supply under Greenwood-Hercowitz-Huffmann preferences.

[2] In the simple model education expenditures i^g proxy for both pre-tertiary and tertiary education spending because the model because the model does not have a dynamic dimension.

The child value function is denoted by $\hat{V}(\cdot)$ and can be written as

$$\begin{aligned} &\hat{V}(A,i) = \log(w^k h(1-\tau^k) + T^k) \\ \Leftrightarrow\ &\hat{V}(A,i) = \log(w^k A(i+i^g)^{\varrho}(1-\tau^k) + T^k) \end{aligned} \tag{2}$$

where I restrict $\tau^k \geq 0$ and $T^k \geq 0$.

Parents maximize their lifetime utility given by:

$$V(y,A) = \max_i \Big\{ \log(y(1-\tau^p) + T^p - i) + \nu \hat{V}(A,i) \Big\}$$

subject to the non-negativity constraint:

$$i \geq 0.$$

Thus, using eq. (2) the parental maximization problem can be written as

$$V(y,A) = \max_{i \geq 0} \Big\{ \log(y(1-\tau^p) + T^p - i) + \nu \log(w^k A(i+i^g)^{\varrho}(1-\tau^k) + T^k) \Big\}. \tag{3}$$

3.2 Optimal Parental Investment i

Take the first order condition with respect to i to get:

$$\frac{1}{y(1-\tau^p) + T^p - i} = \frac{\nu \varrho w^k A(i+i^g)^{\varrho-1}(1-\tau^k)}{w^k A(i+i^g)^{\varrho}(1-\tau^k) + T^k}.$$

Throughout I focus on a marginal reform of T^k, T^p and i^g, assuming that in the baseline $T^k = T^p = i^g = 0$ (and, thus, also $\tau^k = \tau^p = 0$).

For later use, observe that under $T^k = T^p = i^g = \tau^p = \tau^k = 0$ (i.e. setting all policy parameters to zero) optimal i can be obtained in closed form:

$$i = \frac{\nu \varrho y}{1 + \nu \varrho}. \tag{4}$$

Note that under this restriction on policy parameters for any $\nu > 0$ optimal i is given by an interior solution. And since a marginal reform implies a variation around this solution, the corner solution $i = 0$ never becomes relevant unless ν is very small.

3.3 Child Human Capital and Public Policies

As a next step, using the framework described above I analyze how a marginal transfer reform (financed by labor income taxes) affects parental human capital investment decisions

and, thus, child human capital. The sign of this effect matters for the overall welfare implications of the considered transfer reform, but also for understanding an interplay of tax and transfer reforms with education policies. While at the current stage the quantitative analysis in Section 4 does not consider an optimal mix of the two instruments, an explicit consideration of the effect of tax and transfer reforms on parental incentives to invest into child human capital is of central importance for the interplay of progressive taxation and education subsidies.

First I introduce the following two definitions:

1. T and i^g are defined as *policy substitutes* concerning their effect on human capital accumulation if $\frac{\partial h}{\partial T}$ and $\frac{\partial h}{\partial i^g}$ have the same sign;

2. T and i^g are defined as *policy complements* concerning their effect on human capital accumulation if $\frac{\partial h}{\partial T}$ and $\frac{\partial h}{\partial i^g}$ have opposite signs.

Bovenberg and Jacobs (2005) use a setting without intergenerational links and argue that progressive taxation and education spending are *policy complements* regarding their effect on human capital accumulation. Below I show that in a setting with intergenerational linkages the sign of $\frac{\partial h}{\partial T}$ can be positive and therefore progressive taxation and education spending can be *policy substitutes* regarding their effect on human capital.

Using the implicit function theorem (see Appendix B for details) and given the properties of the human capital production function, the following holds:

$$\frac{\partial h}{\partial T^p} > 0, \ \frac{\partial h}{\partial T^k} < 0, \ \frac{\partial h}{\partial i^g} > 0. \tag{5}$$

The object of interest is the effect of a joint marginal reform of T^p and T^k on child human capital h:

$$\frac{\partial h}{\partial T} = \frac{\partial h}{\partial T^p} + \frac{\partial h}{\partial T^k}. \tag{6}$$

In other words, $\frac{\partial h}{\partial T}$ captures the response of the child human capital stock h to a change in the generosity of public transfers to both parents and children.

No Government Budget Balancing. First, I consider a scenario when a marginal reform of T is not accompanied by an increase of the tax rate τ and, thus, the government budget is not rebalanced on a per period basis.

Proposition 1. *Consider a marginal reform of T. There exists a unique child ability threshold $\bar{A}$ such that*

- *for children with $A \geq \bar{A}$ public transfers T positively affect parental human capital investments and, thus, child human capital (i.e. $\frac{\partial h}{\partial T} \geq 0$);*
- *for children with $A < \bar{A}$ public transfers T negatively affect parental human capital investments and, thus, child human capital (i.e. $\frac{\partial h}{\partial T} < 0$),*

where

$$\bar{A} = \frac{1}{(\nu\varrho)^{\varrho}(1+\nu\varrho)^{1-\varrho}} \frac{y^{1-\varrho}}{w^k}. \tag{7}$$

The ability threshold $\bar{A}$ is

1. *Increasing in parental income y*
2. *Decreasing in the degree of parental altruism ν*
3. *Decreasing in the aggregate child wage level w^k.*

Proof 1. *See Appendix B.*

Thus, a marginal reform of T, not accompanied by the government budget rebalancing, positively affects human capital of children with a high enough ability. Whether the child ability is below or above the threshold $\bar{A}$ determines whether parents invest additional resources into the child human capital or rather increase own consumption. The probability of the ability threshold being reached is higher if the aggregate wage level for the child generation is high as well as if the parental generation has low incomes and features a high degree of altruism towards their children.

It can be seen directly from the parental maximization problem stated in eq. (3) that the returns to parental investment i are increasing in the child wage level w^k and the strength of parental altruism ν. Therefore, the higher w^k and ν are, the lower is the child ability threshold $\bar{A}$. At the same time, human capital investment decisions of low-income parents are ceteris paribus more responsive to changes in the amount of taxes that have to be paid, i.e. the strength of the *current generation* effect is decreasing in parental income.

Balanced Government Budget As a next step, assume that the government budget is balanced on a per generation basis.

For the parental generation the government budget can be written as

$$T^p + i^g = \tau^p \int (y) d\Phi_y$$

where Φ_y denotes the parental income distribution.

Therefore, under a balanced government budget, the effect of T^p on the child human capital h is given by (superscript *bal* refers to *bal*anced government budget)

$$\Big(\frac{\partial h}{\partial T^p}\Big)^{bal} = \frac{\partial h}{\partial T^p} + \frac{\partial h}{\partial \tau^p}\frac{\partial \tau^p}{\partial T^p}.$$

For the child generation the government budget is

$$T^k = \tau^k w^k \int\int A(i(y,A)+i^g)^{\varrho} d\Phi_A d\Phi_y$$

where Φ_A denotes the child ability distribution.

Under a balanced government budget the effect of a marginal reform of T^k on child human capital h is given by

$$\Big(\frac{\partial h}{\partial T^k}\Big)^{bal} = \frac{\partial h}{\partial T^k} + \frac{\partial h}{\partial \tau^k}\frac{\partial \tau^k}{\partial T^k}.$$

Observe that as before the following holds (see Appendix B for details):

$$\Big(\frac{\partial h}{\partial T^p}\Big)^{bal} > 0,\ \Big(\frac{\partial h}{\partial T^k}\Big)^{bal} < 0,\ \Big(\frac{\partial h}{\partial i^g}\Big)^{bal} > 0. \tag{8}$$

Finally, the net effect of a joint reform of T^p and T^k on the child human capital h is given by:

$$\Big(\frac{\partial h}{\partial T}\Big)^{bal} = \Big(\frac{\partial h}{\partial T^p}\Big)^{bal} + \Big(\frac{\partial h}{\partial T^k}\Big)^{bal}.$$

Proposition 2. *Consider a marginal reform of T under a balanced government budget. There exists a unique child ability threshold $\bar{A}$ such that*

- *for children with $A \geq \bar{A}$ public transfers T positively affect parental human capital investments and, thus, child human capital (i.e. $\Big(\frac{\partial h}{\partial T}\Big)^{bal} \geq 0$);*
- *for children with $A < \bar{A}$ public transfers T negatively affect parental human capital investments and, thus, child human capital (i.e. $\Big(\frac{\partial h}{\partial T}\Big)^{bal} < 0$),*

where

$$\bar{A} = \frac{1}{(\nu\varrho)^{\varrho}(1+\nu\varrho)^{1-\varrho}} \frac{y^{1-\varrho}}{w^k} \frac{1}{\left(1 - \frac{y}{\int (y) d\Phi_y} - \frac{2y(1+\nu\varrho)^{\varrho}}{w^k(\nu\varrho)^{\varrho}\int\int A y^{\varrho} d\Phi_A d\Phi_y}\right)}. \tag{9}$$

The dependence of the ability threshold $\bar{A}$ on parental income y, parental altruism ν and aggregate child wage w^k as stated in ***Proposition 1*** *holds. However, the elasticity of the ability threshold $\bar{A}$ with respect to y, ν and w^k is higher than without the government budget being balanced.*

Proof 2. *See Appendix B.*

Thus, also when a marginal reform of public transfers T is financed by adjusting the linear labor income tax τ it is still the case that its effect on the child human capital is positive for high ability children. However, the restrictions on parental income and parental altruism for the ability threshold to be reached become stricter as compared to the case when τ is not adjusted. In addition, the ability threshold is now more sensitive to the aggregate wage level w^k of the child generation. The intuition for the latter result is that under a balanced government budget a higher w^k increases the return to child human capital not only directly but also indirectly via a smaller required increase in τ^k.

3.4 Simple Model: Summary

Using the simple two generations model I have shown that the following factors are of central importance for the sign of the effect of a marginal public transfer reform on the child human capital accumulation:

1. The status quo position of parents in the current generation income distribution;
2. The status quo position of children in the next generation income distribution;
3. The strength of the altruism motive.

The *current generation* effect refers to the implications of the change only of the first factor; the *future generation* effect refers to the implications of the change only in the second factor.

In the quantitative model introduced in the next section it is also possible to disentangle the two effects. Particularly, as a decomposition exercise in the transition analysis I will assume that either only the currently alive adult population is subject to a reform or that only future generations are subject to a reform.

4 Quantitative Model

4.1 Overview

The model is a general equilibrium overlapping generations framework with intergenerational links. Parents are altruistic towards their children and can invest their time and monetary

resources into the human capital of children while the latter are in the household as well as transfer wealth to them directly when they leave the household. Innate ability (initial human capital) of children is correlated with parental education. Thus, the model captures both nature and nurture dimensions of the intergenerational transmission of skills.

The complete human capital accumulation process during childhood and adolescence is explicitly modelled - both pre-tertiary education decisions (by parents) and tertiary education decisions (by young adults themselves) are endogenous and adjust in response to public policy reforms. To isolate the role of endogenous human capital accumulation, the model abstracts from the quality-quantity trade-off (see Becker and Lewis (1973) and thus fertility is assumed to be exogenous and policy invariant with the number of children being homogeneous across all parental household types.

Given the focus on tax and transfer reform the model features a rich fiscal side with the tax and transfer system as well as the social security system being explicitly modelled and calibrated in line with the US institutions.

The model shares some similarities with the general equilibrium model employed in Krueger and Ludwig (2016) which however considers only the college education decision while ignoring the pre-college human capital accumulation. In terms of modeling of parental human capital investments during childhood several modeling assumptions are similar to those made in Fuchs-Schündeln et al. (2020). In fact, the quantitative model that I build in this paper nests both the general equilibrium model of Krueger and Ludwig (2016) and the partial equilibrium two generation setting employed in Fuchs-Schündeln et al. (2020) as special cases.

4.2 Individual State Variables

At the beginning of economic life young households are ex-ante heterogeneous along the following two dimensions: acquired human capital and initial assets. After the higher education decision is taken, also education level becomes a state variable. Next, after the education stage is completed acquired human capital h seizes to be a state variable and is stochastically mapped into a fixed productivity component $\gamma(s)$ which allows to reduce the dimensionality of the state space. When children are born into the household their human capital is also a state variable for parents. Therefore, during the parenthood phase of the lifecycle there are two endogenous continuous state variables - assets and child human capital. Additionally, since labor income is subject to idiosyncratic productivity shocks the transitory and persistent shock realizations - ϵ and η, respectively - also enter the state space. Table 3 summarizes the individual state variables and defines the range of values they can take.

Table 3: State Variables

State Var.	Values	Interpretation
j	$j \in \{0, 1, \ldots, J\}$	Model Age
a	$a \geq -\underline{a}(j, s)$	Assets
h	$h > 0$	Own Human Capital (during education phase)
$\gamma(s, h)$	$\gamma(s, h) \in \{\gamma^l(s), \gamma^h(s)\}$	Fixed Productivity Component (after labor market entry)
s	$s \in \{hi, sco, co\}$	Education Level
$\hat{h}$	$\hat{h} > 0$	Child Human Capital
η	$\eta \in \{\eta_l, \eta_h\}$	Persistent Productivity Shock
ϵ	$\epsilon \in \{\epsilon_l, \epsilon_h\}$	Transitory Productivity Shock

Notes: List of state variables of the economic model.

4.3 Demographics, Timing and Economic Decisions

Time is discrete, indexed by t and goes forever. One model period is equal to four years. In every period t the economy is populated by J overlapping generations indexed by j. Individuals survive from age j to age $j+1$ with probability ϕ_{j+1}. Before retirement survival is certain while from the retirement age j_r onwards survival risk becomes relevant.

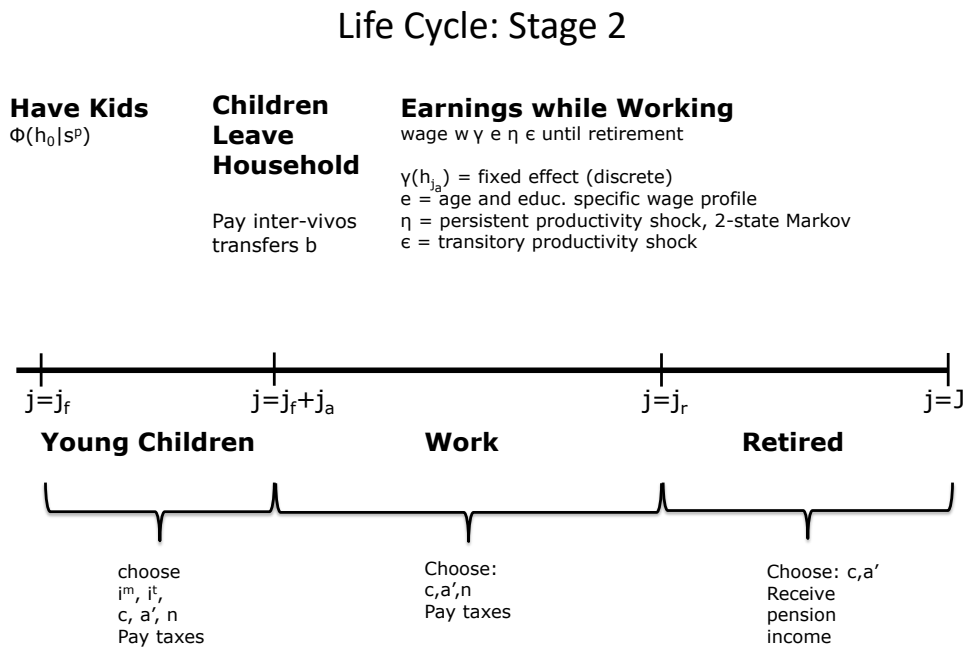
Children stay in the parental household until biological age 18 (model age j_a), i.e. for four model periods. The first two years of the child lifecycle are ignored and thus children are "born" at biological age 2. At this age parents draw an initial child human capital level from a distribution that depends on their education level[3]. While children are in the household parents invest their time and monetary resources into child human capital. These parental investments are referred to as private human capital investments. When children leave the parental household parents give them (non-negative) inter-vivos transfers b which can be used for consumption financing and/or for covering college expenses. The lifecycle of households starting from the point in time when children are born is summarized in the upper panel of Figure 1.

At model age j_a the college education decision takes place. Those children who choose college spend one model period for education, the other group starts working directly at age j_a. Dropping out of college takes place stochastically with the dropout shock being realized directly before the college education starts[4]. College dropouts are assumed to have to pay two times smaller tuition costs than college graduates, and also to face a tighter borrowing limit.

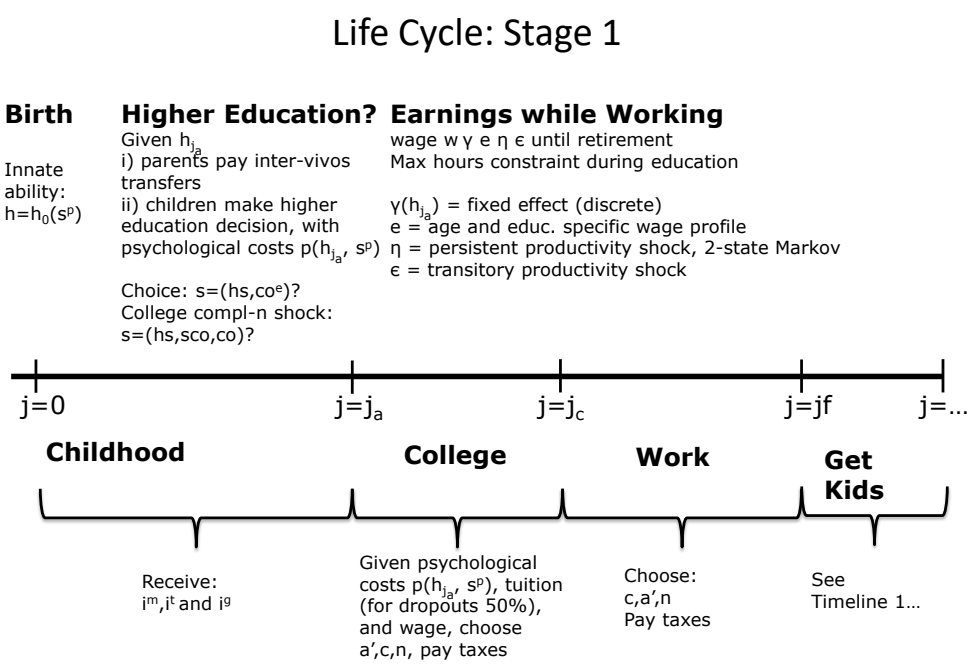
[3] Bolt et al. (2018) also assume that the initial child human capital depends only on parental education.

[4] Given the four year frequency of the model this is the most parsimonious way of modeling college dropout risk.

Figure 1: Two Stages of Household Life-Cycle: Before and After Children are Born



(a) Lifecycle Description Stage 2: After Children are Born



(b) Lifecycle Description Stage 1: Before Children are Born

At model age j_a all education groups draw a fixed productivity component which has only two realizations - high and low. The probability of drawing a high realization of the fixed effect is an increasing function of acquired human capital. College students (both those who will graduate and those who will drop out) are assumed to work at high school wages[5].

After education is completed all households enter the labor market. When the labor market entry happens acquired human capital seizes to be a state variable for all education groups. College graduates and college dropouts redraw their fixed productivity component based on a newly obtained higher education level. The lifecycle of households starting from the beginning of their economic life up to the point in time when they become parents is summarized in the lower panel of Figure 1.

During the working life households endogenously choose hours worked subject to a time endowment constraint. Retirement takes place exogenously at the model age j_r. The maximum possible lifespan is J. There is no population growth.

4.4 Human Capital

Human Capital Accumulation during Childhood. In every period during childhood human capital accumulation takes places according to the following production function:

$$h' = g\left(j, h, i^m, i^t, i^g\right), \tag{10}$$

where i^t and i^m denote parental time and monetary investment while i^g denotes public investment. Some of the parameters of the human capital production function are age-dependent for calibration purposes to capture differences in the relative importance of inputs at different stages of childhood.

4.5 Higher Education Decision

After leaving the parental household the first economic decision of children is a discrete choice whether to attend college. During the college phase students can work at non-college wages. Students have to pay tuition fees, but are also allowed to borrow.

At the beginning of the college period the college completion shock is realized which determines household wages for the rest of the lifcycle, as well as the cost of education and borrowing conditions.

[5]This means that both the aggregate wage level as well as the fixed productivity component are the same as for high school graduate workers.

4.6 Labor Productivity

The wage of a household at age j with education level s and with a fixed productivity component realization $\gamma(s)$ is given by:

$$w(s,h,j) = w_s \cdot \gamma(s) \cdot \epsilon(s,j) \cdot \eta \cdot \varepsilon \tag{11}$$

where w_s is the aggregate wage component, $\gamma(s)$ is a fixed household productivity component, $\epsilon(s,j)$ is a deterministic education-specific productivity profile, and η and ε denote persistent and transitory productivity shocks, respectively.

4.7 Decision Problems

Below household decision problems are stated using a recursive formulation.

4.7.1 The Education Choice

At age j_a, given their initial asset position a, the stock of acquired human capital h as well the education level of their parents s_p young households make a higher education choice $s \in \{hs, co^e\}$ where hs denotes high school and co^e denotes college enrollment. Children who decide not to enroll in college and choose $s = hs$, enter directly the labor market and their labor productivity is determined by the realizations of the fixed effect $\gamma(s = hs)$, the stochastic persistent income shock η and the stochastic transitory income shock ε.

Children who decide to enroll in college become college graduates or college dropouts with a probability $\pi^c(h)$ and $1-\pi^c(h)$, respectively. The college completion probability $\pi^c(h)$ depends on the level of acquired human capital h.

During the college period all households work at high school wages and their permanent productivity level $\gamma(s = hs)$ is also determined in the same way as for high school graduates. Also, during the college period students can work only part time. Additionally, college students experience utility (or psychological) costs that depend on their acquired human capital h and on the education of their parents s_p.

The post-education decision skill state is determined as follows

$$s = \begin{cases} hs & \text{if } V(j_a, s = hs; a, h) \geq V(j_a, s = co^e; s_p, a, h) \\ co^e & \text{if } V(j_a, s = co^e; s_p, a, h) \geq V(j_a, s = hs, s_p; a, h), \end{cases} \tag{12}$$

where $V(j_a, s = co^e; s_p, a, h)$ is the pre-dropout/graduation value function given by:

$$V(j_a, s = co^e; s_p, a, h) = \pi^c(h) \cdot V(j_a, s = co; s_p, a, h) + (1 - \pi^c(h)) \cdot V(j_a, s = sco; s_p, a, h). \tag{13}$$

Therefore, the pre-education choice value function can be written as

$$V(j_a, s_p; a, h) = \max_{s \in \{hs, co^e\}} \{V(j_a, s = hs; a, h), V(j_a, s = co^e, s_p; a, h)\}. \quad (14)$$

In the computational implementation, to achieve a faster convergence of the model solution I apply Extreme Value Type I (Gumbel) i.i.d. taste shocks to smooth the decision problem stated in eq. (14).

4.7.2 Working Life

Before children are born into the household and after they leave the parental household parents solve a standard consumption-savings problem with endogenous labor supply. Thus, the decision problem can be written as

$$V(j, s, \gamma, \eta, \varepsilon, a) = \max_{c, a', \ell} \left\{ u(c) - v(\ell) + \beta \sum_{\eta'} \pi(\eta'|\eta) \sum_{\varepsilon'} \psi(\varepsilon') V(j+1, s, \gamma, \eta', \varepsilon', a') \right\}$$

subject to

$$\begin{aligned} a' + c(1+\tau^c) &= (a + Tr_{t,j})(1 + r(1-\tau^k)) + y(1-\tau^p) - T(y(1-\tau^p)) \\ y &= w\epsilon(s,j)\eta\varepsilon n(\ell) \\ a' &\geq -\underline{a}(s,j) \\ \ell &\leq \Gamma. \end{aligned}$$

where the function $n(\ell)$ defines a mapping of supplied hours worked ℓ into effective hours worked, and $\underline{a}(s,j)$ is an age- and education-specific borrowing limit. Γ denotes the per period time endowoment.

4.7.3 Parenthood

Children are born into the household at model age j_f. Initial human capital of children h_0 depends on the education level of parents s^p. Since the dependence on parental education is deterministic, in the model period $j_f - 1$ no expectation over the child innate human capital has to be formed[6]. While children are in the household parents optimally choose monetary and time investments into child human capital as well as continue choosing hours worked and making a consumption-savings decision. Thus, the decision problem during this stage

[6]However, in the computational implementation given that the continuous child human capital is discretized on a grid parental households technically still form an expectation over the human capital gridpoints on which their children will land.

of the lifecycle can be written as

$$V(j,s,\gamma,\eta,\varepsilon;a,h) = \max_{c,i^m,i^t,a',h',\ell} \Big\{ u\left(c\right) - v(\ell) - v^t(\varsigma \cdot i^t) \\ +\beta \sum_{\eta'} \pi(\eta'|\eta) \sum_{\varepsilon'} \psi(\varepsilon') V(j,s,\gamma,\eta',\varepsilon';a',h') \Big\}$$

subject to

$$\begin{aligned} a' + c(1+\tau^c) + \varsigma \cdot i^m &= (a + Tr_{t,j})(1 + r(1-\tau^k)) + y(1-\tau^p) - T(y(1-0.5\tau^p)) \\ y &= w\epsilon(s,j)\eta\varepsilon n(\ell) \\ a' &\geq -\underline{a}(j,s) \\ \ell + \varsigma \cdot i^t &\leq \Gamma \\ h' &= g(j,h,i(i^m,i^t,i^g)). \end{aligned}$$

4.7.4 Children leave the Household

At parental age $j_f + j_a$ children leave the household of parents and form own adult households. In this period a one time inter-vivos transfer decision b is made. These transfers become assets of children within the same model period, and thus also generate utility for their parents. The dynamic program then reads as

$$V(j_a + j_f, s, \gamma, \eta, \epsilon; a, h) = \max_{c,b,a',\ell} \{ u\left(c\right) - v\left(\ell\right) \\ +\beta \sum_{\eta'} \pi(\eta'|\eta) \sum_{\varepsilon'} \pi(\varepsilon') V(j_a + j_f + 1, s, \gamma, \eta', \varepsilon'; a') + \nu V\left(j_a, s_p; \frac{b}{1 + r(1-\tau^k)}, h\right) \Big\},$$

where $V\left(j_a, s_p; \frac{b}{1+r(1-\tau^k)}, h\right)$ denotes the pre-education decision value function of children. Maximization is subject to

$$\begin{aligned} a' + c(1+\tau^c) + \varsigma \cdot b &= (a + Tr_{t,j})(1 + r(1-\tau^k)) + y(1-\tau^p) - T(y(1-\tau^p)) \\ y &= w\epsilon(s,j)\eta\varepsilon n(\ell) \\ a' &\geq -\underline{\mathrm{a}}(s,j) \\ \ell &\leq \Gamma. \end{aligned}$$

After children have left the household, parental households continue solving a consumption-savings problem and choose hours worked until they reach retirement:

$$V(j,s,\gamma,\eta,\varepsilon,a) = \max_{c,a',\ell} \left\{ u\left(c\right) - v\left(\ell\right) + \beta \sum_{\eta'} \pi(\eta'|\eta) \sum_{\varepsilon'} \psi(\varepsilon') V(j+1,s,\gamma,\eta',\varepsilon',a') \right\}$$

subject to

$$\begin{aligned} a' + c(1+\tau^c) &= (a + Tr_{t,j})(1 + r(1-\tau^k)) + y(1-\tau^p) - T(y(1-\tau^p)) \\ y &= w\gamma\epsilon(s,j)\eta\varepsilon n(\ell) \\ a' &\geq -\underline{a}(s,j) \\ \ell &\leq \Gamma. \end{aligned}$$

4.7.5 Retirement

During retirement, i.e. after reaching the model age j_r, households solve a standard consumption-saving problem given by:

$$V(j,s,\gamma,\eta;a) = \max_{c,a'} \left\{ u\left(c\right) + \beta\phi(j) V(j+1,s,\gamma,\eta;a') \right\}$$

subject to

$$\begin{aligned} a' + c(1+\tau^c) &= (a + Tr_{t,j})(1 + r(1-\tau^k)) + y - T(y) \\ y &= pen(s,\gamma,\eta_{j_r-1}) \\ a' &\geq 0 \\ \eta &= \eta(j_r - 1), \end{aligned}$$

where $pen(s,\gamma,\eta(j_r-1))$ is retirement income which depends on education-specific wages $w(s)$, persistent shock realization in the last working period before retirement $\eta(j_r-1)$, skill level s and the fixed productivity component γ. This allows to capture the actual degree of progressivity embedded in the US social security system which is important when varying the progressivity of the rest of the tax and transfer system.

4.8 Production

The final output is produced according to a standard Cobb-Douglas production function:

$$Y_t = F(K_t, L_t) = A K_t^{\alpha} L_t^{1-\alpha} \tag{15}$$

where A is the total factor productivity, and α determines the elasticity of output with respect to capital.

Non-college labor (i.e. high school graduates and college dropouts) and college labor (college graduates) inputs are modelled as imperfectly substitutable in production. Within the non-college workers group labor inputs of high school graduates and college dropout workers are assumed to be perfect substitutes.

Thus, total efficiency units at time t are given by:

$$L_t = ([L_{t,hs} + L_{t,sco}]^{\rho} + L_{t,co}^{\rho})^{\frac{1}{\rho}} \tag{16}$$

where $\frac{1}{1-\rho}$ is the elasticity of substitution between college and non-college labor.

4.9 Government

The government administers a progressive labor income tax code and pays transfers to households as well as collects linear taxes on consumption and capital income. For tractability I abstract from the fact that according to legislation transfers paid in the scope of existing social assistance programs are conditioned on income, assets and family composition and instead approximate all transfer programs by a lump-sum component. This simplification is also introduced, for example, in Boar and Midrigan (2020) as well as Daruich and Fernández (2020).

Let T^{LS} denote the aggregate lump-sum transfer payments while T refers to the aggregate income-dependent tax (and transfer) payments. Thus, while abstracting from institutional details of the public transfers design, I explicitly distinguish between the tax progressivity driven by average tax rates and the tax progressivity driven by marginal tax rates.

Regarding the education financing policies, the government spends $i^g \alpha_j$ per child on primary and secondary school education with the aggregate spending being denoted by E. In addition, it also subsidizes tertiary education at a subsidy rate ϱ, with the aggregate amount of subsidy being denoted by E^{CL}. Thus, there are two policy parameters governing the generosity of the education system, i^g and ϱ[7].

The government budget constraint is therefore given by:

$$\underbrace{T_t^{LS}}_{\text{transfer payments}} + \underbrace{E_t + E_t^{CL}}_{\text{education spending}} + G_t = T_t + \tau_{c,t} C_t + \tau_{k,t} r_t K_t \tag{17}$$

[7]It would also be interesting to model the degree of progressivity embedded in educational spending but at the current stage I abstract from it.

where G_t denotes government consumption (net of education spending). Thus, the government has to finance an exogenous stream of expenditures G_t and endogenous streams of pre-college and college education expenditures E_t and $E^C L$, respectively. For these purposes the government can use the revenues obtained by collecting labor income, capital income and consumption taxes. The government budget has to be rebalanced on a per period basis and thus the model abstracts from the government debt.

Finally, the government also runs a pay-as-you-go social security system.

4.10 Social Welfare

I use a Utilitarian welfare function as a baseline welfare criterion. The social welfare function is defined as follows

$$SWF(\mathcal{T}) = \sum_j N_j \int V(j, \cdot, \mathcal{T}) d\Phi_j(\cdot, \mathcal{T}), \tag{18}$$

where $V(j, \cdot, \mathcal{T})$ is the value function of households of age j given the tax system ($\mathcal{T}$) and $\Phi_j(\cdot, \mathcal{T})$ is the respective cross-sectional distribution given the policy ($\mathcal{T}$). To simplify notation I omit the time subscript t which becomes relevant in the transition analysis.

Observe that the overall change in welfare is determined jointly by a change in the household value function $V(j, \cdot, \mathcal{T})$ and the change in the cross-sectional distribution $\Phi_j(\cdot, \mathcal{T})$.

5 Calibration

In this section I introduce functional form specifications and explain how model parameters are calibrated. There are two subsets of parameters: those exogenously calibrated outside of the model and those endogenously calibrated within the model.

The calibration is based on an average household in the data where average is taken across all demographic characteristics including the marital status.

5.1 Age Brackets

One model period is equal to four years. The first two years of child lifecycle are discarded and thus children are "born" at biological age 2, which is model age $j = 0$. Parental age when children are "born" is denoted by j_f which is equal to 7 and corresponds to biological age 30. Children stay in the parental household for four model periods and at biological age 18 (model age $j_a = 4$) child households start their independent economic life. Young households who decide to pursue college education spend one model period for education and thereafter at model age j_c which is equal to 5 and corresponds to biological age 22 enter the labor market.

Table 4: First Stage Calibration Parameters

Parameter	Interpretation	Value	Source (data/lit)
	Population		
$j = 0$	Age at economic birth (age 2)	0	
j_a	Age at beginning of econ life (age 18)	4	
j_c	Age at finishing CL (age 24)	5	
j_f	Fertility Age (age 32)	7	
j_r	Retirement Age (age 66)	16	
J	Max. Lifetime (age bin 98-101)	24	
$\{\phi_j\}$	Survival Probabilities	see main text	Life Tables SSA
	Preferences		
σ	Relative risk aversion parameter	1	
φ	Frish elasticity	0.6	
	Labor Productivity		
$\{\epsilon(j,s\}$	Age Profile	see main text	PSID 1968-2012
$[\varepsilon_l, \varepsilon_h]$	Realizations of Transitory Shock	$[0.881, 1.119]$	PSID 1968-2012
$[\eta_l, \eta_h]$	States of Markov process	[0.8226, 1.1774]	PSID 1968-2012
π_{hl}	Transition probability of Markov process	0.0431	PSID 1968-2012
	Ability/Human Capital and Education		
ι	College tuition costs (annual, net of grans and subsidies)	14756\$	Krueger and Ludwig (2016)
$\underline{a}(j \in [j_h, j_c - 1], co, ch)$	College borrowing limit	45000\$	Krueger and Ludwig (2016)
σ^h	Elast of subst b/w human capital and CES inv. aggr.	1	Cunha et al. (2010)
σ^g	Elast of subst b/w public inv. and CES aggr. of private inv.	2.43	Kotera and Seshadri (2017)
σ^m	Elast of subst b/w monetary and time inv.	1	Lee and Seshadri (2019)
κ_3^m	CES share parameter of monetary and time inv. (age bin 10-14)	0.5	normalization
$\kappa_j^g = \bar{\kappa}^g, j > 0$	Share of government input for ages 6 and older	0.676	Kotera and Seshadri (2017)
$\Phi(h(j=0)\|s_p)$	Innate ability dist-n of children by parental education	see main text	PSID CDS I
$\underline{h}_0$	Normalization parameter of initial dist-n of initial ability	0.1248	PSID CDS I-III
	Baseline Government policy		
ϱ	Public CL education subsidy	38.8%	Krueger and Ludwig (2016)
ϱ^{pr}	Private CL education subsidy	16.6%	Krueger and Ludwig (2016)
i_j^g	Public early education spending by age	$\approx$ 5000\$	UNESCO (1999-2005)
τ_c	Consumption Tax Rate	5.0%	legislation
τ_k	Capital Income Tax Rate	20%	legislation
τ^p	Soc Sec Payroll Tax	12.4%	legislation
G/Y	Government consumption to GDP	13.8%	current value

Notes: First-stage parameters set exogenously prior to solving the model, either calibrated directly from external data sources or taken from prior literature as indicated in the "Source" column. All dollar values are in 2005 dollars unless otherwise noted.

Table 5: Second Stage Calibration Parameters

Parameter	Interpretation	Value
	Preferences	
β	Time discount rate (target: capital output ratio)	0.9735
ν	Altruism parameter (target: average IVT transfer per child)	0.5058
ϕ	Weight on hours disutility (target: average hours per hh)	10.32
	Labor Productivity	
$\rho_0(s)$	Normalization parameter (target: $\mathbb{E}\gamma(s,h)=1$)	$[0.1890, 0.0034, -0.2015]$
	Human Capital and Education	
κ	Utility weight on time inv. (target: average time inv.)	0.3032
κ_j^h	Share of human capital (target: average monetary inv. & slope of time inv.)	cf. Figure 2
κ_j^m	Share of monetary input (target: slope of money inv.)	cf. Figure 2
κ_0^g	Share of government input for age bin 4-6 (target: average time inv. age bin 2-6)	0.4437
$\bar{A}$	Investment scale parameter (target: average HK at age j_a)	1.1989
$\varrho(s^p < co)$	utility costs $s = co, s^p < co$ (target: fraction of group $s = co$)	-0.4301
$\varrho(s^p = co)$	utility costs $s = co, s^p = co$ (target: conditional fraction of group $s = co$)	-0.4929
	Government policy	
τ	Level parameter of HSV tax function (balance gvt budget)	0.27
ρ^p	Pension replacement rate (balance socsec budget)	0.1893

Notes: Second-stage parameters calibrated jointly to match the indicated data targets (underlined). The level parameter τ of the tax function is solved to balance the government budget in the baseline steady state. The altruism parameter ν targets the average inter-vivos wealth transfer from parents to adult children in PSID. Utility costs $\varrho(s^p)$ govern the non-pecuniary cost of college attendance and are differentiated by parental education to match overall and conditional college completion rates.

At the point in time when children leave the parental household parental age is denoted $j_t = j_a + j_f$ which is equal to 11 and corresponds to biological age 46. Retirement is exogenous and takes places at model age $j_r = 16$ (biological age 66). The maximum lifespan is denoted by $J = 24$ (biological age 99).

5.2 Prices

The baseline model is cast in a general equilibrium framework and, therefore, wages and interest rate are determined endogenously such that first order conditions of the firm's problem are satisfied.

5.3 Preferences

The per period utility function takes the following functional form

$$u(c,n) = \frac{c^{1-\sigma}}{1-\sigma} - \phi \frac{\ell^{1+\frac{1}{\psi}}}{1+\frac{1}{\psi}} \tag{19}$$

where $\sigma = 1$ (i.e. assume logarithmic utility) which makes the above utility function also balanced growth path consistent. Parameter ψ governs directly the Frisch elasticity of labor

supply and is set to 0.6 following Kindermann and Krueger (2014)[8]. In turn, parameter ϕ is calibrated endogenously to match average hours worked of 1/3 of their time endowment.

During parenthood also time spent with children affects parental utility. Particularly, I assume that the disutility from time with children enters the utility function in an additively separable manner[9]:

$$u(c,n) = \frac{c^{1-\theta}}{1-\theta} - \phi\frac{\ell^{1+\frac{1}{\psi}}}{1+\frac{1}{\psi}} - \kappa\frac{\varsigma \cdot i^{t\,1+\frac{1}{\psi}}}{1+\frac{1}{\psi}} \tag{20}$$

where κ is calibrated to match average time investment into children (per week per child). ς denotes the average number of children per household.

As stated in the dynamic programs description I explicitly model a time endowment constraint assuming that $\ell + i^t$ cannot exceed the maximum time endowment Γ which is w.l.o.g. normalized to one[10]. For college students the assumption is that the maximum possible hours worked equal 50% of full-time.

During the college stage students also experience psychological costs determined by the following cost function

$$p(s, s_p; h) = \varrho(s_p) + \frac{1}{h}$$

where $\varrho(s_p)$ is a calibration parameter which depends on parental education. Particularly, $\varrho(s_p < co)$ is calibrated to match the average college share while $\varrho(s_p = co)$ is calibrated to match the college share conditional on parents being college graduates themselves.

5.4 Human Capital Accumulation

5.4.1 Initial Child Human Capital

Innate human capital (at biological age 2) is drawn from a distribution the mean of which depends on parental education. For given parental education the initial human capital distribution is defined exogenously based on child test score data from the Child Development Supplement (CDS) to PSID. Particularly, both the mean of the initial human capital and its dependence on parental education are defined based on child test score data.

[8] As Kindermann and Krueger (2014) point out this value is based on average estimates for both men and women.

[9] Empirically there appears to be only weak correlation between hours worked and time with children. Also, Bastian and Lochner (2022) point out that mothers increase their time with children not at the cost of hours worked but rather via reallocating their leisure time.

[10] This is similar to e.g. Holter et al. (2019)

5.4.2 Human Capital Production Function

At birth at model age $j = 0$, the innate ability (initial human capital) $h = h_0$ of children is determined conditional on parental education level s_p. The dependence of initial human capital on parental education is defined as follows. The initial human capital of children of college dropouts $s = sco$ is assumed to be equal to $\underline{h}_0$ which is the average initial human capital in the Child Development Supplement (CDS) to PSID based on the child Letter Word test score data. For the two other education groups the initial human capital of children is given by:

$$h_0^{s^p=hs} = \underline{h}_0 - \Delta$$
$$h_0^{s^p=co} = \underline{h}_0 + \Delta$$

where Δ is calibrated endogenously to match the intergenerational persistence of earnings.

At ages $j_0, \ldots, j_a - 1$, children then receive parents' human capital investments through money and time $i^m(j), i^t(j)$ and governmental input i^g, respectively. Human capital is accumulated according to a multi-layer human capital production function with imperfectly substitutable inputs

$$h'(j) = \left(\kappa_j^h h^{1-\frac{1}{\sigma^h}} + (1-\kappa_j^h) i(j)^{1-\frac{1}{\sigma^h}}\right)^{\frac{1}{1-\frac{1}{\sigma^h}}} \tag{21a}$$

$$i(j) = \bar{A}\left(\kappa_j^g \left(\frac{i^g}{\bar{i^g}}\right)^{1-\frac{1}{\sigma^g}} + (1-\kappa_j^g)\left(\frac{i^p(j)}{\bar{i^p}}\right)^{1-\frac{1}{\sigma^g}}\right)^{\frac{1}{1-\frac{1}{\sigma^g}}} \tag{21b}$$

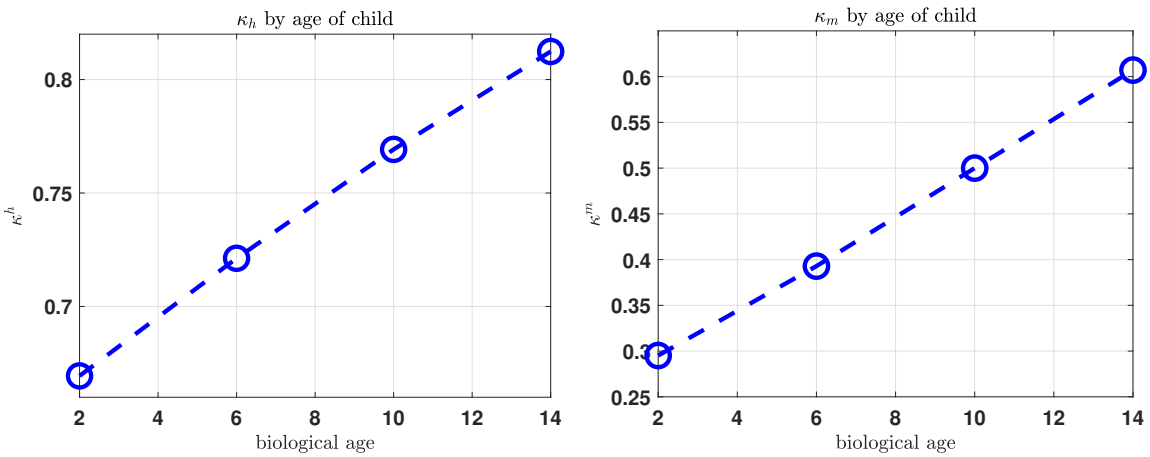
$$i^p(j) = \left(\kappa_j^m \left(\frac{i^m(j)}{\bar{i}^{m,d}}\right)^{1-\frac{1}{\sigma^m}} + (1-\kappa_j^m)\left(\frac{i^t(j)}{\bar{i}^{t,d}}\right)^{1-\frac{1}{\sigma^m}}\right)^{\frac{1}{1-\frac{1}{\sigma^m}}}. \tag{21c}$$

The production function features partially age dependent parameters for calibration purposes - to reflect relative differences in importance of different inputs at different stages of childhood. All inputs are divided by their respective unconditional means through which I achieve unit independence (see Cantore and Levine (2012)).

In the outermost (first) nest human capital at age j is combined with aggregate investment at age j. The substitution elasticity σ^h is fixed exogenously at 1 for all ages (implying a Cobb-Douglas specification) while the age-specific weight parameter $\kappa^j(j)$ is calibrated to match the age profile of (per child) parental time investment. Panel (a) of Figure 2 shows the resulting age profile.

In the inner (second) nest public and private inputs are combined with the substitution elasticity being denoted by σ^g and the age-specific weight parameter $\kappa^g(j)$. The substitu-

Figure 2: Age-Dependent Weight Parameters κ_j^h and κ_j^m of the Human Capital Production Function



(a) Weight on existing human capital: κ_j^h (b) Weight on monetary input: κ_j^m

Notes: Age-specific weight parameters of the human capital production function, plotted against child age (2–18). κ_j^h governs the relative importance of existing human capital versus new investment; κ_j^m governs the split between monetary and time inputs within private investment. Both parameters are calibrated endogenously to match the age profiles of parental time and monetary investments.

tion elasticity is set exogenously to 2.43 using the estimate provided in Kotera and Seshadri (2017). The weight parameter is also fixed exogenously for all ages apart from the kindergarten age, i.e. age bin 2-6. Thus, for school aged children the parameter κ^g is set to 0.676 while for the age bin 2-6 it is calibrated endogenously to match average parental time investment at that age. The resulting $\kappa^g(j_0)$ is equal to 0.558. $\bar{A}$ is a computational normalization parameter which is chosen such that average acquired human capital at age 18 is equal to 1 which gives $\bar{A} = 1.20$.

Finally, in the innermost (third) nest parental time and money inputs are combined with the substitution elasticity being denoted by σ^m and the age-dependent weight parameter $\kappa^m(j)$. The substitution elasticity σ^m is fixed exogenously at the value of 1 using the estimate provided in Lee and Seshadri (2019) while the weight parameter $\kappa^m(j)$ is calibrated endogenously to match the age profile of the parental monetary input. Panel (b) of Figure 2 shows the resulting age profile.

5.5 College Dropout

The probability of finishing college takes the following functional form:

$$\pi^c(h) = 1 - \exp(-\lambda^c h) \tag{22}$$

where λ^c is a parameter calibrated endogenously to match the average share of college dropouts in PSID data[11]. Thus, the probability of finishing college is increasing in acquired human capital.

5.6 Labor Productivity

5.6.1 Productivity Process

To estimate the labor productivity process I use PSID 1967-2013. Particularly, for each education level[12] I regress log household wages on a cubic in age of the household head, time dummies, family size and individual fixed effects. The age wage profile $\epsilon(s, j)$ is obtained by predicting the age polynomial.

As a second step, to obtain estimates of the stochastic productivity component I compute log wage residuals and estimate moments of the wage process by the Generalized Method of Moments (GMM) assuming a standard specification with a persistent and a transitory components:

$$\ln(\mathrm{y}_t) = \ln(\mathrm{z}_t) + \ln(\varepsilon_t)$$
$$\ln(\mathrm{z}_t) = \rho \ln(\mathrm{z}_{t-1}) + \ln(\nu_t)$$

where $\varepsilon_t \sim_{i.i.d} \mathcal{D}_\varepsilon(0, \sigma_\varepsilon^2)$, $\nu_t \sim_{i.i.d} \mathcal{D}_\nu(0, \sigma_\nu^2)$ for density functions $\mathcal{D}$.

5.6.2 Acquired Human Capital and Wages

The mapping of human capital into a fixed productivity component is probabilistic. The fixed effect $\gamma(s)$ can take two values - high and low ($\gamma^h(s)$ and $\gamma^l(s)$, respectively) - for each education group. The probability of drawing a high realization $\gamma^h(s)$ is given by

$$\pi^h(s, h) = \min\left\{1, \frac{h}{\bar{h}}\right\} \tag{23}$$

where h is the child acquired human capital (at age 18) and $\bar{h}$ is a (computational) scaling parameter fixed exogenously for all education groups.

$\gamma^h(s)$ and $\gamma^l(s)$ are calibrated endogenously to ensure that for each education group the average $\gamma(s)$ is equal to one[13], i.e.

$$\int \left(\pi^h(s, h)\gamma^h(s) + \left(1 - \pi^h(s, h)\right)\gamma^l(s)\right)\Phi(dh, s) = 1.$$

[11] Education shares are based on the four recent waves of PSID: 2011, 2013, 2015 and 2017.
[12] Education level of the household is determined by the education level of the household head.
[13] This ensures that the skill premia are matched.

.

The education-specific spreads between $\gamma^h(s)$ and $\gamma^l(s)$ are calibrated to match education-specific ability gradients of (lifetime) wages estimated using NLSY79 data. Particularly, estimates of ability gradients $\hat{\rho}(s)$ are obtained by running the following regressions:

$$\ln\left(\omega(s)\right) = \rho(s) \cdot \frac{e}{\bar{e}} + \upsilon(s),$$

where $\omega(s)$ denotes age-free education-specific wages and e measures test scores of the Armed Forces Qualification Test (AFQT) which are normalized by their mean $\bar{e}$. Finally, $\upsilon(s)$ is an education group specific error term.

Table 6 shows the resulting estimates $\hat{\rho}(s)$. The estimated ability (human capital) gradient is strictly increasing in education reflecting a pronounced complementarity between ability (human capital) and education.

Table 6: Ability Gradient by Education Level

Education Level	Ability Gradient
HS dropout / HS graduate	0.4248 (0.0481)
College dropout	0.5786 (0.0245)
College graduate	0.7298 (0.0670)

Notes: Estimated ability gradient $\hat{\rho}(s)$ from OLS regression of log age-free wages on AFQT scores normalized by their mean, estimated separately for each education group. The coefficient measures the proportional increase in age-free wages per unit increase in normalized AFQT scores. The gradient is strictly increasing in education, reflecting complementarity between ability and education. Data: NLSY79, replication files of Abbott et al. (2019). Standard errors in parentheses.

5.6.3 Marginal Premium and Complementarity between Human capital and Education

Using the functional form in eq. 23 observe that the average college wage premium is proportional to the following ratio:

$$\begin{aligned} \bar{wp} &= \frac{\gamma^l(s=cl) + [\gamma^h(s=cl) - \gamma^l(s=cl)] \cdot \bar{h}(s=cl)}{\gamma^l(s<cl) + [\gamma_h(s<cl) - \gamma_l(s<cl)] \cdot \bar{h}(s<cl)} \\ \bar{wp} &= \frac{\gamma^l(s=cl) + \Delta(s=cl) \cdot \bar{h}(s=cl)}{\gamma^l(s<cl) + \Delta(s<cl) \cdot \bar{h}(s<cl)}, \end{aligned} \tag{24}$$

where $\Delta(s)$ denotes education specific spreads between low and high $\gamma(s)$ realization, and $\bar{h}(s<cl)$ and $\bar{h}(s=cl)$ denote average acquired human capital of non-college and college educated households, respectively.

Denote by h^* the average human capital level of marginal households - i.e. those households for whom the probability of choosing college is non-zero but smaller than one. For these types the college wage premium can be written as

$$\bar{wp}(h^*) = \frac{\gamma^l(s = cl) + \Delta(s = cl) \cdot h^*}{\gamma^l(s < cl) + \Delta(s < cl) \cdot h^*}. \tag{25}$$

Based on a comparison of eq. (24) and eq. (25) observe that the condition that the marginal premium is smaller than the average one, i.e. $\bar{wp}(h^*) < \bar{wp}$, always holds whenever $h(s < cl) < h^* < h(s = cl)$, i.e. as long as the threshold property of the discrete college decision is preserved (technically, due to the presence of Gumbel shocks as a smoothing device this is equivalent to saying that the college choice probability should be monotonically increasing in human capital).

The ratio between the marginal and the average premium $\frac{\bar{wp}(h^*)}{\bar{wp}}$ is increasing in the ratio of education specific spreads $\frac{\Delta(s=cl)}{\Delta(s<cl)}$. Also observe that the complementarity between human capital and education mentioned above requires that $\frac{\Delta(s=cl)}{\Delta(s<cl)} > 1$. Qualitatively the two properties - first, marginal premium is smaller than the average premium; second, complementarity between ability and education - are consistent with each other.

Quantitatively, only one of the two can be exactly matched (because both are driven by the ratio of education specific spreads of the fixed productivity component). My current strategy is to calibrate explicitly the complementarity between ability and education based on NLSY79 data and leave the marginal college wage premium as a non-targeted moment.

5.6.4 Hours Worked and Efficiency Units

The mapping from hours worked to labor services is assumed to be non-linear, as in French (2005), Rogerson and Wallenius (2009) and Erosa et al. (2016). Particularly, n hours of work translate into n^θ efficiency units (with $\theta > 1$). Following Aaronson and French (2004) and Erosa et al. (2016) I set exogenously $\theta = 1.4$.

5.7 College Costs and Borrowing Constraints

As in Krueger and Ludwig (2016) the net tuition cost ι (tuition, fees, room and board net of grants and education subsidies) for one year of college in constant 2005 dollars is 13,213\$. In 2008 dollars, the maximum amount of publicly provided students loans per year is given by $11,250$\$, which is the borrowing limit for college students in the model. For college dropouts I assume that the borrowing limit is 50% of the borrowing limit for college gradu-

ates. For all ages after the college period (i.e. for all $j > j_a$) I let

$$\underline{a}(j, s > hs) = \underline{a}(j-1, s > hs)(1+r) - rp$$

and compute rp such that the terminal condition $\underline{a}(j_r, s) = 0$ is met.

5.8 Government

The government has to balance the budget of the general tax and transfer system as well as the budget of the pension system. The revenue side of the general tax and transfer system consists of taxes on consumption, capital and labor income. The consumption tax rate is set to 5% (see Mendoza et al. (1994)) while the capital income tax rate is fixed at 20% as implied by the current statutory tax rates.

The labor income tax schedule is approximated using a two-parameter tax function as in Heathcote et al. (2017) which is additionally augmented with an intercept. The intercept approximates existing transfer programs and allows to better capture the actual degree of progressivity embedded into the US tax and transfer system. Thus, the resulting tax and transfer function writes as:

$$T(y) = -\omega + y - (1-\tau)y^{1-\xi} \tag{26}$$

where τ is the level parameter, ξ is the progressivity parameter[14] and ω is the additional lump-sum component. Such a specification is also used in Boar and Midrigan (2020) as well as Daruich and Fernández (2020). To parameterize this tax function I rely on estimates provided in Boar and Midrigan (2020) and set ξ equal to 0.049 and ω to 0.167 of the mean household income.[15] Finally, the level parameter τ is calibrated endogenously to match the average marginal tax rate of 28%.

Regarding the education financing policies, the government spends $i^g \alpha_j$ per child on primary and secondary school education where both the level parameter i^g and the age profile α_j are set exogenously based on OECD data. Additionally, the government subsidizes the college education at a rate ϱ which is set to 38.8% following Krueger and Ludwig (2016). The private subsidy rate ϱ^{pr} is calibrated to be 16.6% also following Krueger and Ludwig (2016).

Finally, as for the the pension system, the payroll tax τ^p is set to the current legislative level of 12.4% and the actual progressivity of the pension system is taken into account.

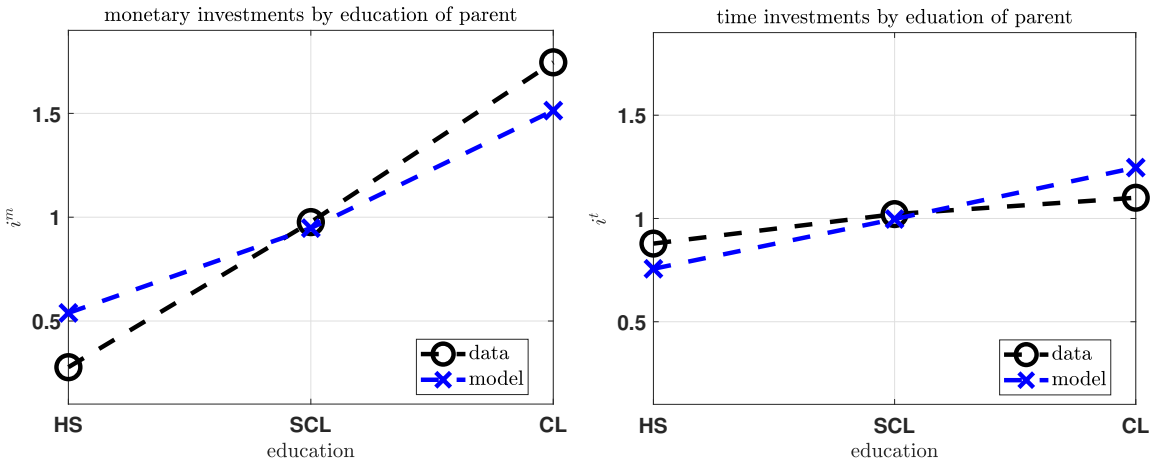
[14] ξ determines the slope of marginal tax schedule, i.e. the progressivity of marginal tax rates.
[15] This is approximately \$14,000.

5.9 Model Validation

Before proceeding to policy experiments I discuss several non-targeted moments as well as selected model implied elasticities.

While age profiles of parental human capital investments are largely explicitly targeted in the calibration the gradients of parental investments by parental education are not calibrated and are an endogenous outcome of the model. Figure 3 shows time and money investments by parental education level. The model matches well the positive slope of both types of investment in parental education. More educated parents invest more both in terms of time and money into the human capital of their children because income and accumulated wealth of the household are increasing in the household education.

Figure 3: Money and Time Investments by Education of Parents



(a) Money Investments

(b) Time Investments

Notes: Average money investments (dollars per year per child) and time investments (hours per week per child) by parents' education level (hsd = high school dropout, hs = high school, cod = college dropout, co = college). Data (black circles) versus model (blue crosses). Education gradients are non-targeted model outcomes.

Next, given the special focus of the paper on the effects of public policies on educational attainment I compute a model implied elasticity of college enrollment decision with respect to an increase in tertiary education subsidies. Deming and Dynarski (2009) summarize existing empirical evidence on the responsiveness of the college enrollment margin to increases in the generosity of college subsidies. According to their estimates, a $\$1,000$ increase in college subsidies results into an increase in college enrollment in the range of 3-6 pp. To obtain a model equivalent of this number I consider an increase in tertiary education subsidies in the model also by $\$1,000$ in a parital equilibrium setting, i.e. holding the interest rate and

wages at the initial steady state level. The model implied increase in college enrollment is 3.5% which is within the range implied by the empirical estimates.

6 Thought Experiments and Results

The analysis in this section uses the calibrated model to quantify the resource and incentive channels of redistributive transfers and evaluate their aggregate, distributional, and welfare implications. All policy experiments are one-time, unanticipated, and permanent changes to the tax and transfer schedule, starting from the steady state calibrated to the U.S. economy in the 2000s–2010s. Each reform requires the joint computation of the full transition path and the new steady state.

6.1 Design of the Experiments

I contrast two transfer reforms of equal fiscal cost, chosen to have the same present discounted value of additional government expenditure.

Untargeted UBI: An additional $650 per year is paid to all working-age households, financed through labor income taxes (benchmark) or consumption taxes. This reform raises family income unconditionally, activating the resource channel for all families but simultaneously compressing returns to education for all young adults (strong incentive channel).

College-conditional UBI ("College UBI"): An additional $1,100 per year is paid to all working-age households with post-secondary education ($s > hs$). The higher per-recipient amount and narrower eligibility preserve the same aggregate fiscal cost (in PDV terms) as the untargeted UBI. By conditioning on college attendance, this reform targets the resource channel toward households whose human capital investment decisions are directly relevant for intergenerational transmission, while substantially weakening the disincentive effects on the college enrollment margin.

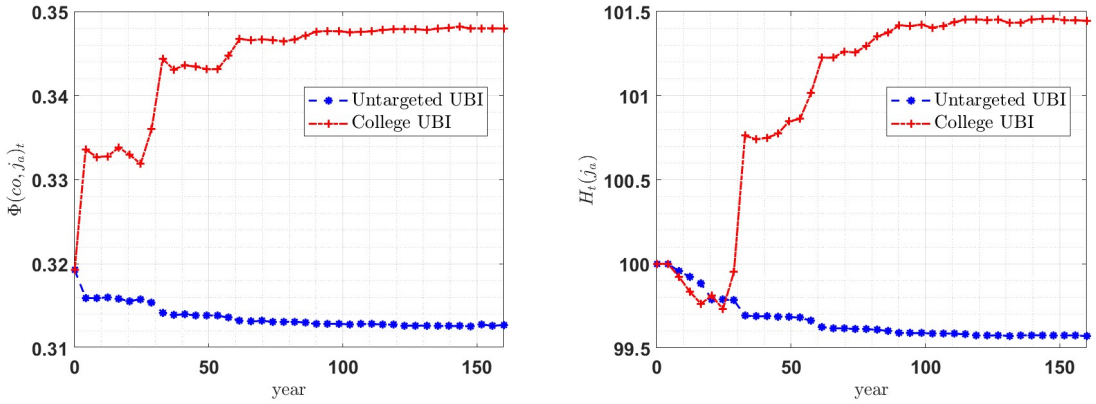
Financing is via labor income taxes (benchmark) with consumption taxes as a sensitivity check. The government maintains a constant debt-to-GDP ratio throughout the transition.

6.2 Transition Dynamics: Human Capital and College Share

Figure 4 shows the transition dynamics of the college share and average acquired human capital at age 18 (the end of childhood) for newborn cohorts under each reform.

The two reforms generate strikingly opposite long-run effects. The *Untargeted UBI* reduces the college share by approximately 0.8 percentage points in the long run. Acquired human capital at age 18 declines by about 0.5% in the long run, though the adjustment is gradual as new cohorts whose childhood unfolded under the new policy progressively replace older cohorts. The *College UBI* raises the college share by approximately 2.9 percentage points in the long run and increases average human capital at age 18 by about 1.5%.

Figure 4: Transition Dynamics: College Share and Human Capital



(a) College Share

(b) Human Capital, Age 18

Notes: Each panel shows the evolution of the variable over the transition path, comparing the Untargeted UBI (dashed) and College UBI (solid). The series tracks newborn cohorts: each point on the x-axis represents the steady-state value for a cohort born in that period. The x-axis is model periods since reform implementation (one period = 4 years); the figures show approximately 25 model periods (100 years) until the new steady state is reached. Left panel: college share in percent. Right panel: average acquired human capital at age 18 (biological), normalized to 100 in the pre-reform steady state.

Importantly, both reforms induce a similar short-run decline in human capital during the early transition: under the Untargeted UBI the incentive channel dominates immediately, while under the College UBI the higher taxes required to finance the reform in the early transition temporarily dominate before the positive long-run effects of better-targeted transfers materialize. This short-run pattern reflects the slow propagation of human capital investments through the lifecycle: improvements in children's initial conditions take 15–25 years (roughly one generation) to fully appear in the labor market.

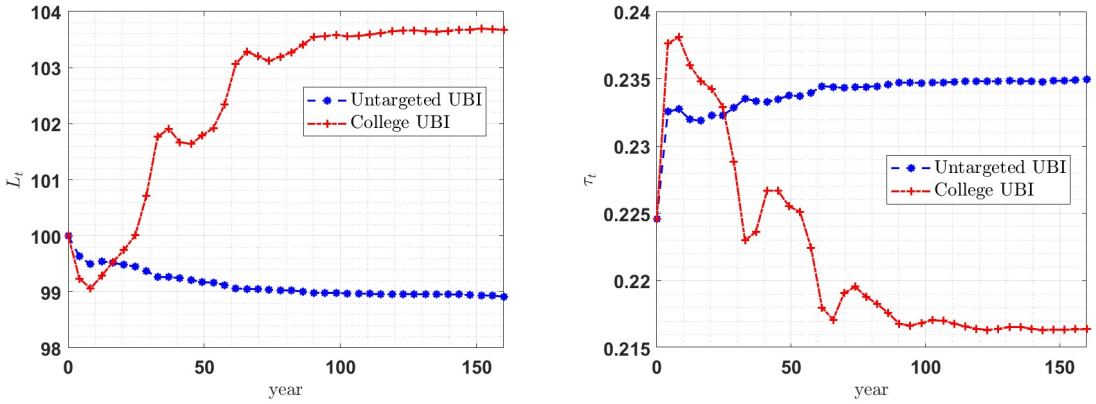
6.3 Transition Dynamics: Productivity and Fiscal Costs

Figure 5 shows the evolution of aggregate labor (a measure of effective productivity) and the labor income tax rate.

The productivity implications parallel the human capital results. The Untargeted UBI reduces aggregate labor by roughly 1% in the long run, driven by the deterioration of both human capital and educational attainment. The College UBI raises aggregate labor by approximately 4% in the long run, reflecting the substantial improvement in the educational and human capital distribution.

The fiscal implications are also qualitatively different. Under the Untargeted UBI, the tax base shrinks over time as the economy becomes less productive, requiring a persistent

Figure 5: Transition Dynamics: Aggregate Labor and Tax Rate



(a) Aggregate Labor

(b) Labor Income Tax Rate

Notes: Untargeted UBI (dashed) versus College UBI (solid). x-axis: model periods since reform (one period = 4 years). Left panel: aggregate efficiency-weighted labor supply as an index (pre-reform steady state = 100), incorporating both extensive (employment) and intensive (hours) margins as well as the changing human capital composition of the workforce. Right panel: the level parameter τ of the HSV tax function (see eq. 26), in percentage points, adjusted each period to balance the government budget. An increase in τ indicates a higher tax burden; note that τ is a level shifter, not a marginal tax rate, so percentage-point changes in τ translate into smaller changes in average effective tax rates.

increase in the labor income tax rate of approximately 1 percentage point in the long run. Under the College UBI, the tax base expands over time as more workers hold college degrees: the reform is more than self-financing in the long run, with the tax rate eventually falling below its initial level. The College UBI requires higher taxes only in the early transition, before the productivity gains materialize.

6.4 Intergenerational Education Mobility

Table 7 documents the long-run change in intergenerational education mobility under the two reforms. The table reports changes in the conditional educational attainment distribution $\Phi(s|s^p, q)$ for the most disadvantaged children ($s^p = hsd$, low ability) and the most advantaged ($s^p = co$, high ability).[16]

Several results stand out. First, high school dropout rates among the most disadvantaged children ($s^p = hsd$, $q = si$) are unchanged under both reforms—the lowest-ability children are not at the margin of any educational transition and are largely unaffected. Second, under the Untargeted UBI the fraction of bottom-group children attending college falls by 6 percentage points in total (college dropout rate down 3 pp, college completion rate down 3 pp), while

[16] s^p denotes parental education; $q = si$ (single-income) for the bottom group and $q = cpl$ (couple) for the top group.

Table 7: Change in Intergenerational Education Mobility (Long Run)

Untargeted UBI				
	$s = hsd$	$s = hs$	$s = cod$	$s = co$
$s^p = hsd$, $q = si$ (**"Bottom"**)	0.00	0.06	-0.03	-0.03
$s^p = co$, $q = cpl$ (**"Top"**)	0.00	0.00	0.00	-0.01
College UBI				
	$s = hsd$	$s = hs$	$s = cod$	$s = co$
$s^p = hsd$, $q = si$ (**"Bottom"**)	0.00	-0.09	0.07	0.02
$s^p = co$, $q = cpl$ (**"Top"**)	0.00	0.00	0.00	0.00

Notes: Entries show percentage-point changes in the fraction of children from each parental background (s^p, q) attaining each education level s in the long-run steady state relative to the baseline. Education levels: hsd = high school dropout, hs = high school graduate, cod = college dropout, co = college graduate. Household types: $q = si$ = single-income (single-parent) household, $q = cpl$ = two-earner couple household. Red entries are positive (increase); blue entries are negative (decrease). Entries across all four education columns sum to zero for each parental-background row by construction (the reform reshuffles the distribution without changing its support). The "Bottom" group ($s^p = hsd$, $q = si$) represents the most disadvantaged children and the "Top" group ($s^p = co$, $q = cpl$) the most advantaged, providing the sharpest contrast for reading intergenerational mobility effects.

children from the top group are barely affected: the gap in college attainment between top and bottom *widens*. Third, under the College UBI the pattern reverses: college-related attainment for the bottom group increases (college dropout rate up 7 pp, college completion up 2 pp), while the top group is unaffected. The gap in college attainment between top and bottom *narrows*, representing an improvement in intergenerational mobility.

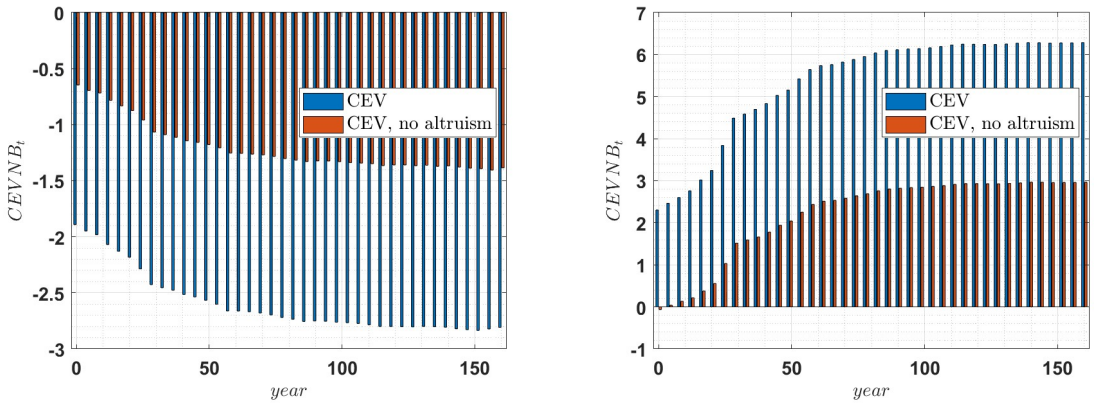
The mechanism is as follows. Under the Untargeted UBI, the incentive channel reduces the net return to college for all households, but particularly for those at the margin—low- and middle-income families whose children have moderate skill levels. Under the College UBI, the resource channel is targeted toward college-educated households, raising the income available to support children's education, while the incentive channel is mitigated because the transfer is conditioned on attendance.

6.5 Welfare Effects

Figure 6 shows the consumption equivalent variation (CEV) for (economic) newborns entering the labor market at each point during the transition, for each reform. The CEV measures the permanent consumption adjustment that would leave newborns indifferent between being born into the reform and the baseline economy.

Under the Untargeted UBI, the welfare effect is negative throughout and accumulates primarily during the first 50 years of the transition as the initial cohorts whose human capital was formed under the new policy enter the labor market. The long-run welfare loss reflects both the lower productivity of these cohorts and the lower value they place on their own children's prospects (through altruism). Under the College UBI, the welfare effect

Figure 6: Newborn Expected Welfare (CEV) along the Transition



(a) Untargeted UBI

(b) College UBI

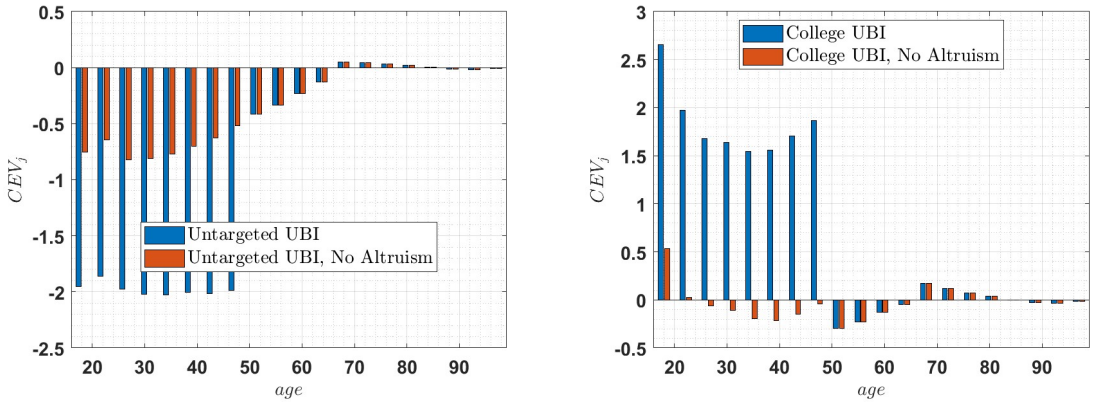
Notes: Consumption equivalent variation (CEV, in percent of baseline lifetime consumption) for newborn cohorts entering the labor market at each point during the transition. A positive value means the newborn cohort prefers to be born into the reform economy. x-axis: model periods since reform (one period = 4 years); shown for approximately 25 periods until the new steady state is reached. Solid lines: total CEV, including the altruistic value that parents place on their children's lifetime outcomes. Dashed lines: CEV abstracting from the value-of-children component (child value function held at its baseline level), isolating the direct welfare effect on the household itself. The gap between solid and dashed lines reflects the contribution of changed expected child outcomes to parental welfare.

is positive throughout and grows by almost a factor of three during the first 50 years of transition, reaching its long-run level as the full steady-state improvement in human capital and educational attainment materializes.

Crucially, more than 50% of the total welfare effect in the long run comes from the changed expected value of children's lives—the component of parental utility that reflects altruism toward children. This is revealed by the gap between the total CEV and the CEV computed holding the child value function fixed at its baseline level (dashed lines). This result underscores the importance of modeling intergenerational links explicitly: a model without parental altruism would miss the dominant component of the welfare calculus.

Figure 7 decomposes welfare effects across the age distribution of households *currently alive* at the time of the reform. Welfare is measured as the expected CEV conditional on current age for households alive in the first period of the transition.

Figure 7: Welfare Effects for Currently Alive Households (by Age)



(a) Untargeted UBI

(b) College UBI

Notes: Expected CEV (in percent of baseline lifetime consumption) by age at the time of the reform, for households alive in the first period of the transition. Each bar corresponds to one model age group (model period = 4 biological years). Solid bars: total CEV including altruistic value of children's outcomes. Dashed bars: CEV abstracting from the value-of-children component (child value function held at baseline), isolating the direct effect on each household's own consumption-leisure allocation and general equilibrium prices. CEV is computed as the expected value over idiosyncratic productivity and education states within each age group.

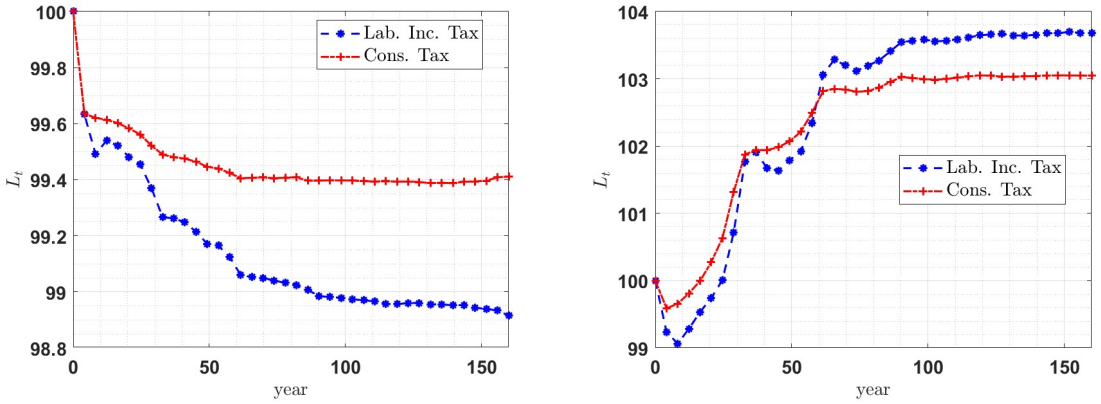
Three patterns stand out. First, households with children at home (roughly ages 30–50) experience the largest welfare effects under both reforms, driven primarily by the changed expected value of their children's lifetime outcomes through altruism. Second, older households (ages 60 and above) experience small welfare changes driven mainly by general equilibrium effects (wage and return-to-capital changes) and the fiscal adjustment in tax rates. Third,

youngest working-age households experience welfare changes from three sources simultaneously: the direct change in their own college incentives, altruistic preferences over future children, and a changed marriage market distribution.

6.6 Sensitivity: Consumption Tax Financing

Figure 8 shows the transition path for aggregate labor under each reform when financed with consumption taxes instead of labor income taxes.

Figure 8: Sensitivity: Consumption Tax Financing



(a) Untargeted UBI: Aggregate Labor

(b) College UBI: Aggregate Labor

Notes: Each panel compares the transition path for aggregate efficiency-weighted labor (same index as Figure 5, pre-reform steady state = 100) under labor income tax financing (dashed) and consumption tax financing (solid). x-axis: model periods since reform (one period = 4 years). Consumption tax financing attenuates the distortion to the return to education by lowering the labor income tax rate, resulting in stronger college enrollment and human capital responses. The College UBI panel shows a substantially higher long-run labor level under both financing modes, confirming the result is not driven by the tax instrument.

Consumption tax financing substantially improves long-run efficiency for both reforms. The intuition is straightforward: a higher consumption tax falls on current consumption rather than on the return to skills acquisition, leaving the incentive channel less distorted. Under the Untargeted UBI, switching to consumption tax financing transforms a shrinking tax base into a roughly stable one. Under the College UBI, consumption tax financing amplifies the long-run productivity gain: higher returns to education (because the labor income tax is lower) strengthen the college enrollment response, and the tax base expands even more than under labor income tax financing, making the reform even more self-financing.

6.7 On the Role of Intergenerational Linkages

The welfare effects documented above are large precisely because the human capital and educational attainment effects operate through two generations: the currently alive parents (who invest in their children) and the children themselves (whose labor market entry conditions are altered). To gauge the importance of this channel, I compare the welfare of newborns who enter in the first period of the transition—whose childhood human capital was formed entirely under the baseline policy and who are thus exposed only to the change in their own college incentives—with the welfare of newborns who enter the economy after one or two generations have been raised under the reform.

The first cohort born into the transition experiences a welfare change that is roughly one-fifth of the long-run steady-state change. The second cohort experiences a change roughly half as large as the long-run value. This rapid buildup illustrates that the main welfare effect is not the contemporaneous impact on currently alive households but the cumulative deterioration (or improvement) in the initial conditions of successive newborn cohorts as more and more of their childhood takes place under the reform. In other words, the intergenerational propagation of human capital is the dominant driver of the welfare difference between the two reforms.

Additionally, comparing the welfare of parents who still have children at home (ages 30–46) against households of similar age without children reveals that the former group accounts for a disproportionate share of the welfare effects—more than half in the long run—consistent with the altruism result from Figure 6.

7 Application: Historical EITC Expansions and Long-Run Fiscal Costs

This section is work in progress.

7.1 Background and Motivation

The Earned Income Tax Credit is the largest means-tested transfer program in the United States, with annual expenditures exceeding $70 billion and over 25 million recipient households. Since its introduction in 1975 it has undergone three major federal expansions—in 1990, 1993, and 2009—each substantially raising both the maximum credit amount and the income range over which it phases in and out. The 1993 expansion under OBRA93 was by far the largest, roughly doubling the maximum credit for families with two or more children and extending eligibility to childless workers for the first time.

The fiscal costs of these expansions have been studied extensively from a short-run perspective. Bastian and Jones (2021) calculate that the EITC's net budgetary cost is only about 17 percent of its gross expenditure, once the induced increases in labor force par-

ticipation and taxable income are accounted for. This near self-financing result, driven by the EITC's well-documented positive effects on labor supply at the extensive margin (Eissa and Liebman, 1996), has shaped the conventional view that the EITC is among the most cost-effective anti-poverty programs.

What this calculation omits is the long-run human capital channel documented in this paper. EITC expansions raise family income for recipient households with children—activating the resource channel—while simultaneously compressing the after-transfer return to higher education for the adolescents in those households—activating the incentive channel. The net effect on the human capital distribution of future labor market entrants, and through it on future tax revenues, is not captured in any existing fiscal accounting of EITC reforms.

7.2 Setup

To quantify this channel, I map the major EITC expansions into the model's tax and transfer schedule. The three-parameter tax function in eq. (26) is re-estimated to match the pre- and post-expansion EITC schedules for each major reform episode, holding other fiscal parameters at their contemporaneous values. For each episode I then compute the full transition path of the economy, including the endogenous adjustments in parental investment, college enrollment, and human capital accumulation, and compare the long-run tax base and fiscal balance against a counterfactual in which the expansion did not occur.

The key objects of interest are: (i) the human capital feedback on the tax base—the long-run change in aggregate effective labor supply due to the shift in the educational attainment and human capital distributions; (ii) the implied additional fiscal feedback relative to the short-run labor supply channel quantified by Bastian and Jones (2021); and (iii) the distributional consequences for intergenerational mobility, measuring whether the expansions widened or narrowed educational gaps between children from high- and low-income families.

7.3 Preliminary Discussion

The stylized experiments in Section 6 provide guidance on the likely sign of the human capital channel for EITC-style reforms. The EITC is an employment-conditional, means-tested transfer—a design that lies between the untargeted UBI and the college-conditional transfer analyzed above. Relative to an untargeted transfer, the employment conditionality of the EITC partially mitigates the incentive channel, since the transfer is unavailable to non-working households and thus compresses the return to education less severely than an unconditional payment. At the same time, the EITC phases out with income, which introduces a high marginal tax rate over a range of the income distribution that includes many households with college-age children, potentially reinforcing the disincentive effect at that margin.

The net direction of the human capital channel for the EITC is therefore an open quantitative question. The framework developed in this paper is well-suited to answer it: the model's calibration to the U.S. income and education distribution, its explicit treatment of both parental investment and the college enrollment margin, and its full general-equilibrium transition dynamics together provide a complete accounting of the EITC's long-run effects on human capital and public finances. Results are forthcoming.

8 Conclusion

The standard toolkit for evaluating tax and transfer reforms—static incidence analysis, labor supply elasticities, distributional tables—focuses on the direct effects on currently alive households. This paper argues that for any reform of meaningful scale, a second set of effects deserves equal attention: the dynamic adjustments in human capital formation by children, adolescents, and young adults that the reform sets in motion. These adjustments operate through the entire childhood and transition into the labor market—a horizon of 15–25 years—and their fiscal and welfare consequences can dwarf the contemporaneous redistribution that motivates the reform in the first place.

The mechanism is not specific to education policy. General-purpose transfers—EITC expansions, welfare reforms, UBI proposals—are not designed to affect schooling. Yet because they simultaneously change the resources available to parents and the expected returns to education for the next generation, they inevitably reshape the human capital distribution of future labor market entrants. Through its effect on the skill composition of the workforce, any such reform also reshapes the future tax base—a *fiscal externality* of the human capital channel that does not appear in any static or short-run fiscal accounting. A reform that looks fiscally modest today may be fiscally costly or self-financing tomorrow, depending on whether this externality works with or against the direct budgetary effect.

We establish this point in a dynastic general equilibrium model where the distribution of initial conditions at labor market entry—human capital and educational attainment—is endogenously shaped by government policy. The central analytical result is that transfers create two counteracting forces: a *resource channel* that improves children's outcomes by relaxing parental budget constraints, and an *incentive channel* that discourages skill acquisition by compressing expected returns to education. These two forces are generically asymmetric—knife-edge neutrality results require proportional taxes, symmetric compression of costs and returns, and the absence of parental investment, none of which hold in realistic environments. The net effect is therefore a quantitative question, and its answer depends critically on how the transfer is targeted.

The main quantitative results emerge from contrasting two reforms of equal fiscal cost: an untargeted universal transfer (UBI) and a college-conditional transfer (College UBI). The untargeted UBI reduces college attainment by 0.8 percentage points and aggregate human capital by 0.5%, lowers economy-wide productivity by 1%, widens the college attainment gap between children from rich and poor families, erodes the tax base, and generates long-run welfare losses. The College UBI raises college attainment by 2.9 percentage points and aggregate human capital by 1.5%, increases productivity by 4%, narrows intergenerational educational inequality, expands the tax base, and generates long-run welfare gains—while being more than self-financing in the long run. Both reforms have identical short-run fiscal costs by construction. Their long-run fiscal consequences are opposite in sign. No static or single-period analysis can detect this divergence.

Several additional results reinforce the broader message. First, more than half of the total welfare effect comes from the changed expected lifetime outcomes of children, transmitted through parental altruism. A representative-agent or single-generation model would miss the dominant component of the welfare calculus. Second, the welfare effects accumulate gradually over 50 years as new cohorts shaped by the reformed policy replace older cohorts in the labor market—the long-run steady state is reached only after roughly two generations. Standard analyses anchored to the first few years of a reform therefore substantially mismeasure both the sign and magnitude of its welfare consequences. Third, financing transfer reforms with consumption rather than labor income taxes substantially improves long-run efficiency by attenuating the distortion to human capital returns while leaving redistribution intact.

The broader implication is that dynamic human capital adjustments should be part of the standard toolkit for evaluating fundamental tax reforms—not as a second-order correction but as a potentially first-order determinant of fiscal and welfare outcomes. The framework developed here suggests several concrete applications. First, a fully optimal joint design of the transfer schedule and education subsidies, accounting for the human capital externalities identified here. Second, a structural quantification of the human capital channel in the fiscal costs of the major EITC expansions of the 1990s: Bastian and Jones (2021) document that EITC expansions were nearly self-financing through labor supply responses alone; the long-run human capital feedback identified here is an additional fiscal channel that remains unquantified. Third, a study of the interaction between general-purpose transfers and public education spending, which our analysis suggests are policy complements when the resource channel dominates and policy substitutes when the incentive channel does.

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A Welfare Programs in the United States: Overview and Discussion

The U.S. social safety net is a collection of overlapping means-tested programs that differ substantially in their eligibility rules, benefit structures, work requirements, and target populations. This appendix describes the major programs, their quantitative magnitudes, and their key design features—particularly those relevant for understanding how the safety net affects labor supply, parental investment, and education decisions.

A.1 Income Floor Programs

Temporary Assistance for Needy Families (TANF). TANF is the primary cash assistance program for low-income families with children. It was created by the Personal Responsibility and Work Opportunity Reconciliation Act of 1996 (PRWORA), which replaced the prior entitlement program, Aid to Families with Dependent Children (AFDC). Unlike AFDC, TANF is a block grant to states: the federal government provides a fixed annual contribution of approximately $16.5 billion, and states have broad discretion over eligibility rules, benefit levels, and program structure.

Key design features include: (i) a 60-month lifetime limit on federally funded assistance; (ii) mandatory work requirements after 24 months of receipt, with states required to have a minimum share of recipients in approved work activities; (iii) asset limits (typically $1,000–$2,000 in liquid assets) that discourage wealth accumulation; and (iv) benefit levels that vary substantially across states. The maximum monthly cash benefit for a family of three ranges from approximately $170 in Mississippi to over $900 in New Hampshire. The national average benefit is roughly $400–$450 per month for a family of three.

Caseloads have fallen dramatically since the 1996 reform—from approximately 12 million recipients in 1996 to around 2 million by the early 2020s—reflecting both the work requirements and, arguably, the administrative barriers to enrollment. TANF reaches only a fraction of eligible families: the ratio of TANF families to families in poverty has fallen from around 68 percent in 1997 to below 25 percent in recent years (Hoynes and Schanzenbach, 2018). As a result, TANF plays a substantially smaller role in the safety net today than AFDC did before 1996.

Supplemental Nutrition Assistance Program (SNAP). SNAP—formerly the Food Stamp Program—is the largest means-tested program in the United States by caseload, serving approximately 40–42 million individuals (about 22 million households) at an annual federal cost exceeding $80 billion in recent years. Benefits are provided on electronic benefit cards restricted to food purchases. The program is administered federally with uniform national eligibility rules, though states have some flexibility over categorical eligibility.

Eligibility requires household income below 130 percent of the federal poverty line (FPL) and assets below $2,500 ($3,750 for households with elderly or disabled members). The benefit formula is designed to supplement household food expenditures: the maximum monthly benefit (the "Thrifty Food Plan" cost) was approximately $835 for a family of four in 2023, and households are expected to contribute 30 percent of their net income toward food, so the actual SNAP benefit is reduced dollar-for-dollar by 30 cents for each additional dollar of net income. This creates an effective 30 percent benefit reduction rate over the income range of eligible households—an implicit marginal tax rate on top of whatever income taxes are owed.

Long-run studies of SNAP have documented lasting effects on children's health and human capital. Hoynes et al. (2016) exploit the county-by-county rollout of the Food Stamp Program in the 1960s and 1970s to show that access to food stamps in early childhood significantly improves adult health, educational attainment, and labor market outcomes—evidence that directly motivates the resource channel in this paper.

Supplemental Security Income (SSI). SSI provides cash assistance to low-income individuals who are aged, blind, or disabled, including children with qualifying disabilities. Annual expenditures are approximately $60 billion and caseloads exceed 8 million recipients. While SSI is not primarily a program for working-age families, it interacts with other programs and its asset limits ($2,000 for individuals, $3,000 for couples) affect saving incentives across the low-income population.

Housing Assistance. Federal housing assistance takes several forms, including Housing Choice Vouchers (Section 8), public housing, and project-based rental assistance. Combined federal expenditure exceeds $50 billion annually. Only about one in four eligible households receives housing assistance, as funding has never been sufficient to serve all who qualify; waitlists in major cities often run to several years. Housing assistance is not modeled explicitly in the quantitative framework but contributes to the effective income and consumption floor for recipient households.

A.2 Earnings Subsidies

Earned Income Tax Credit (EITC). The EITC is the largest means-tested cash transfer program in the United States, with annual expenditures exceeding $70 billion and over 25 million recipient households. It is structured as a refundable income tax credit: eligible workers with earned income below certain thresholds receive a credit that can exceed their tax liability, yielding a direct cash payment. The credit is strictly conditional on employment—households with no earnings receive nothing—which makes the EITC a workfare-type program despite the "tax credit" label.

The EITC schedule has three regions: a *phase-in* range over which the credit increases with earned income; a *plateau* over which the maximum credit is paid; and a *phase-out* range over which the credit is reduced as income rises. The parameters of these ranges vary with household composition. For tax year 2023, the maximum credit is $560 for childless workers, $3,995 for families with one qualifying child, $6,604 for families with two children, and $7,430 for families with three or more children. The phase-in rate is 7.65 percent for childless workers and up to 45 percent for families with three or more children. The phase-out rate is 15.98–21.06 percent, depending on filing status and number of children. These phase-in and phase-out rates interact with other taxes and transfers to create the effective marginal tax rate schedule faced by low- and moderate-income households.

The EITC has undergone three major federal expansions since its introduction in 1975: in 1990 (OBRA90), in 1993 (OBRA93), and in 2009 (ARRA). The 1993 expansion was by far the largest: it roughly doubled the maximum credit for families with two or more children and, for the first time, extended meaningful credits to childless workers. These expansions are the focus of the application in Section 7.

A large empirical literature documents significant behavioral responses to the EITC. On labor supply: Eissa and Liebman (1996) provide early evidence of large extensive-margin responses among single mothers; more recent work confirms these findings and documents smaller intensive-margin effects. On fiscal cost: Bastian and Jones (2021) estimate that EITC expansions were nearly self-financing through the induced increase in labor force participation and taxable income, with a net budgetary cost of only about 17 cents per dollar of gross expenditure. On children: Dahl and Lochner (2012) show that EITC expansions raise children's test scores; Bastian and Michelmore (2018) find lasting effects on educational attainment and adult earnings; and Bastian and Lochner (2022) document changes in maternal time allocation.

The EITC also generates incentive effects that work against education. The phase-out range creates effective marginal tax rates of 16–21 percent on top of regular income and payroll taxes, pushing effective marginal rates above 40 percent for many low- and moderate-income workers in the phase-out range. Since the expected return to college education is partly a return to higher lifetime earnings, and since those earnings face high effective marginal rates for the range of income typical of college-educated workers from low-income backgrounds, the EITC can reduce the expected net return to acquiring education. Albertini et al. (2025) find that EITC expansions significantly increased high school dropout rates, consistent with this incentive channel.

Child Tax Credit (CTC). The CTC provides a credit of up to $2,000 per qualifying child under age 17. Prior to 2017, the credit was non-refundable for most households; the Tax

Cuts and Jobs Act of 2017 made $1,400 refundable (as the "Additional CTC"). The American Rescue Plan Act of 2021 temporarily expanded the CTC to $3,600 per child under age 6 and $3,000 per child aged 6–17, made the full credit refundable, and extended it to monthly advance payments—effectively creating a near-universal child allowance for one year. This expansion expired at the end of 2021, returning the CTC to its pre-ARP parameters. Combined with the EITC, the CTC makes the U.S. tax and transfer system substantially more generous for families with children than for childless households at the same income level.

Child and Dependent Care Tax Credit (CDCTC). The CDCTC subsidizes child and dependent care expenses for working families. The credit is 20–35 percent of qualifying care expenses up to $3,000 for one child ($6,000 for two or more), depending on income. Unlike the EITC, the basic CDCTC is not refundable, limiting its value for the lowest-income households who owe little or no income tax.

A.3 Key Design Features and Implicit Marginal Tax Rates

A defining feature of U.S. means-tested programs is that they are all phased out as income rises. When multiple programs overlap, their cumulative phase-out rates can create very high effective marginal tax rates for low-income households—the so-called "benefit reduction cliff" or poverty trap. Consider a single mother with two children earning near the poverty line: she may simultaneously face SNAP phase-out (30 cents per dollar of net income), EITC phase-out (21 cents), federal income tax (10 cents), and payroll tax (7.65 cents), implying an effective marginal rate exceeding 70 percent over some income ranges. This feature of the tax-transfer system significantly affects labor supply incentives and, through them, the resource channel: high effective marginal rates reduce the net return to an additional hour of work and compress the income gradient that drives variation in parental investment.

Asset testing—the requirement that household liquid assets remain below a threshold to qualify for benefits—creates an additional distortion to saving behavior. Households near or below program thresholds may reduce precautionary savings to maintain eligibility, reducing the buffer stock of wealth available for human capital investments in children. Hoynes and Schanzenbach (2018) discuss the evidence on whether asset limits discourage saving among SNAP-eligible households.

Work requirements, present in TANF and as a condition of SNAP for able-bodied adults without dependents (ABAWDs), create a labor supply margin distinct from the tax incentives discussed above. By conditioning the transfer on employment, work requirements push some households from non-participation to employment, generating both income effects (raising resources available for children) and substitution effects (reducing time available for child

investment). The net effect on the resource channel is therefore ambiguous a priori and is part of what the quantitative model is designed to resolve.

A.4 The Safety Net and Children

A notable feature of the U.S. safety net is that it is substantially more generous for households with children. The EITC provides credits up to thirteen times larger for families with three or more children than for childless workers. The CTC is explicitly per-child. TANF and SNAP benefits scale with household size. Medicaid and CHIP provide near-universal health coverage for children in low- and moderate-income families.

This child-centeredness has two implications for the analysis in this paper. First, the marginal dollar of transfer income reaches households that are precisely those with the largest potential resource channel—families with school-age children where parental investment in human capital is ongoing. Second, the design of these programs means that their effective marginal tax rates, work requirements, and benefit phase-outs fall disproportionately on households with children, creating the conditions under which the incentive channel is also operative. Understanding how these two forces interact is the central question of the paper.

A.5 Mapping to the Quantitative Model

The quantitative model employs the three-parameter tax function of **?** to approximate the combined federal tax and transfer schedule: $T(y) = y - \lambda y^{1-\tau}$, where τ governs progressivity and λ governs the level of taxes net of transfers. An intercept term captures the unconditional floor provided by SNAP and (residual) TANF. This parametric form is flexible enough to match the aggregate mapping from pre-tax income to disposable income in the U.S. data, and its parameters are estimated directly from the tax and transfer schedules prevailing in the calibration year.

Several features of actual U.S. programs are abstracted from in the model. The work conditionality of the EITC is not explicitly modeled: the EITC is treated as a transfer that is proportional to earnings over the phase-in range and then phased out, rather than as strictly conditional on positive labor supply. Asset limits are not modeled, so the distortion to precautionary saving is absent. Household composition effects (the scaling of benefits with number and age of children) are incorporated only approximately through the aggregate calibration rather than at the household level. The quantitative results should be interpreted with these abstractions in mind: they capture the aggregate income and marginal-tax-rate effects of the transfer system, but not the detailed behavioral distortions arising from program-specific rules.

B Simple Model

Using implicit function theorem obtain:

$$\frac{\partial i}{\partial T^p} = \frac{\nu\varrho}{i^{\varrho-1}\Big[i\varrho(1+\nu)+(1-\varrho)\big(\nu\varrho(y-i)\big)\Big]} > 0 \tag{27}$$

$$\frac{\partial i}{\partial T^k} = \frac{-1}{w^k A(i)^{\varrho-2}\Big[i\varrho(1+\nu)+(1-\varrho)\big(\nu\varrho(y-i)\big)\Big]} < 0 \tag{28}$$

$$\frac{\partial i}{\partial \tau^p} = -\frac{\partial i}{\partial T^p} y < 0 \tag{29}$$

$$\frac{\partial i}{\partial \tau^k} = -\frac{w^k A i^{\varrho-1}\Big[i+\nu\varrho(y-i)\Big]}{w^k A i^{\varrho-2}\Big[i\varrho(1+\nu)+(1-\varrho)\big(\nu\varrho(y-i)\big)\Big]} < 0 \tag{30}$$

$$\frac{\partial i}{\partial i^g} = -\frac{i+(\varrho-1)\Big[i-\nu\varrho(y-i)\Big]}{i\varrho(1+\nu)+(1-\varrho)\big(\nu\varrho(y-i)\big)} < 0 \text{ (and also, observe that } \frac{\partial i}{\partial i^g} > -1). \tag{31}$$

We are interested in the net effect of a marginal reform of T^p and T^k, i.e. $\frac{\partial i}{\partial T} = \frac{\partial i}{\partial T^p} + \frac{\partial i}{\partial T^k}$.

No government budget rebalancing. For $\frac{\partial i}{\partial T}$ to be positive the following condition has to hold:

$$\nu\varrho A(i+i^g)^{\varrho-1}\hat{l}(1-\tau^k)w^k > 1.$$

Use the closed form solution for i obtained in eq. 4 to get:

$$\nu\varrho A\left[\frac{\nu\varrho(w^s h^s l(1-\tau^p)+i^g)}{1+\nu\varrho}\right]^{\varrho-1}(1-\tau^k)w^k > 1. \tag{32}$$

Since the analysis focuses on marginal reforms, set all policy instruments to zero in the baseline, rearrange and obtain the following condition:

$$\bar{A} = \frac{1}{(\nu\varrho)^{\varrho}(1+\nu\varrho)^{1-\varrho}}\frac{y^{1-\varrho}}{w^k}. \tag{33}$$

Rebalanced government budget. For parental generation the government budget writes as

$$T^p + i^g = \tau^p \int (hw^p l) d\Phi_h$$

where Φ_h denotes parental human capital distribution.

Thus, τ^p can be obtained as

$$\tau^p = \frac{T^p + i^g}{\int (hw^p l) d\Phi_h}.$$

And

$$\frac{\partial \tau^p}{\partial T^p} = \frac{1}{\int (hw^p l) d\Phi_h}.$$

For child generation the government budget is

$$T^k = \tau^k \hat{l} w^k \int \int A(i(h, A) + i^g)^{\varrho} d\Phi_A d\Phi_h$$

Thus,

$$\tau^k = \frac{T^k}{\hat{l} w^k \int \int A(i(h, A) + i^g)^{\varrho} d\Phi_A d\Phi_h}$$
$$\frac{\partial \tau^k}{\partial T^k} = \frac{1}{\hat{l} w^k \int \int A(i(h, A) + i^g)^{\varrho} d\Phi_A d\Phi_h}.$$

Since I focus on a marginal reform of T, I can use expression 4 to substitute for $i(h, A)$ in the above. This gives

$$\frac{\partial \tau^k}{\partial T^k} = \frac{1}{\hat{l} w^k \int A(\frac{\nu \varrho [w^p h l (1-\tau^p) + T^p] - i^g}{1+\nu \varrho} + i^g)^{\varrho} d\Phi_h}.$$

Under a balanced government budget the effect of T^k on parental i is given by

$$\Big(\frac{\partial i}{\partial T^k}\Big)^{bal} = \frac{\partial i}{\partial T^k} + \frac{\partial i}{\partial \tau^k} \frac{\partial \tau^k}{\partial T^k}$$

The net effect of a joint reform of T^p and T^k on parental i is given by:

$$\Big(\frac{\partial i}{\partial T}\Big)^{bal} = \Big(\frac{\partial i}{\partial T^p}\Big)^{bal} + \Big(\frac{\partial i}{\partial T^k}\Big)^{bal}.$$

This object is characterized below.

$$\Big(\frac{\partial i}{\partial T^p}\Big)^{bal} = \frac{\nu\varrho A(i+i^g)^{\varrho-1}\hat{l}(1-\tau^k)w^k}{w^k A(i+i^g)^{\varrho-2}\hat{l}(1-\tau^k)\Big[(i+i^g)\varrho(1+\nu)+(1-\varrho)\big(\nu\varrho(w^p hl(1-\tau^p)+T^p-i)\big)\Big]}\left(1-\frac{w^p hl}{\int(hw^p l)d\Phi_h}\right) > 0 \tag{34}$$

$$\Big(\frac{\partial i}{\partial T^k}\Big)^{bal} = -\frac{1+\frac{w^k A(i+i^g)^{\varrho-1}\hat{l}\Big[(i+i^g)+\nu\varrho(w^p hl(1-\tau^p)+T^p-i)\Big]}{\hat{l}w^k\int A(\frac{\nu\varrho[w^p hl(1-\tau^p)+T^p]-i^g}{1+\nu\varrho}+i^g)^\varrho d\Phi_h}}{w^k A(i+i^g)^{\varrho-2}\hat{l}(1-\tau^k)\Big[(i+i^g)\varrho(1+\nu)+(1-\varrho)\big(\nu\varrho(w^p hl(1-\tau^p)+T^p-i)\big)\Big]} < 0 \tag{35}$$

Thus, the condition for the net effect $\left(\frac{\partial i}{\partial T}\right)^{bal}$ to be positive writes as

$$A(i+i^g)^{\varrho-1}\hat{l}w^k\left(\nu\varrho(1-\tau^k)(1-\frac{w^p hl}{\int(hw^p l)d\Phi_h})-\frac{\Big[(i+i^g)+\nu\varrho(w^p hl(1-\tau^p)+T^p-i)\Big]}{\int A(\frac{\nu\varrho[w^p hl(1-\tau^p)+T^p]-i^g}{1+\nu\varrho}+i^g)^\varrho d\Phi_h}\right) > 1 \tag{36}$$

$$A(i+i^g)^{\varrho-1}\hat{l}w^k\left(\nu\varrho(1-\tau^k)(1-\frac{w^p hl}{\int(hw^p l)d\Phi_h})-\frac{\Big[i(1-\nu\varrho)+i^g+\nu\varrho(w^p hl(1-\tau^p)+T^p)\Big]}{\int A(\frac{\nu\varrho[w^p hl(1-\tau^p)+T^p]-i^g}{1+\nu\varrho}+i^g)^\varrho d\Phi_h}\right) > 1 \tag{37}$$

$$\begin{aligned}&\nu\varrho A(\frac{\nu\varrho[w^p hl(1-\tau^p)+T^p]-i^g}{1+\nu\varrho}+i^g)^{\varrho-1}(1-\tau^k)\hat{l}w^k\\&\times\left((1-\frac{w^p hl}{\int(hw^p l)d\Phi_h})-\frac{\Big[\frac{\nu\varrho[w^p hl(1-\tau^p)+T^p]-i^g}{1+\nu\varrho}(1-\nu\varrho)+i^g+\nu\varrho(w^p hl(1-\tau^p)+T^p)\Big]}{(1-\tau^k)\nu\varrho\hat{l}w^k\int A(\frac{\nu\varrho[w^p hl(1-\tau^p)+T^p]-i^g}{1+\nu\varrho}+i^g)^\varrho d\Phi_h}\right) > 1\end{aligned} \tag{38}$$

Finally, given the focus on marginal reforms set all policy instruments to zero in the above equation, rearrange and obtain:

$$\bar{A} = \frac{1}{(\nu\varrho)^\varrho(1+\nu\varrho)^{1-\varrho}}\frac{y^{1-\varrho}}{w^k}\frac{1}{\left(1-\frac{y}{\int(y)d\Phi_y}-\frac{2y(1+\nu\varrho)^\varrho}{w^k(\nu\varrho)^\varrho\int\int Ay^\varrho d\Phi_A d\Phi_y}\right)}. \tag{39}$$