The Political Economy of Early and College Education - Can Voting Bend the Great Gatsby Curve?

Job Market Paper

Christopher Rauh*

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Abstract

High earnings inequality goes hand in hand with low intergenerational earnings mobility across developed countries. I study this relationship in a dynastic overlapping generations model, in which a parent can invest in the early education of his child and decides whether to send the child to college. Countries vary in terms of tertiary education characteristics, in particular the college premium. An increase in the college premium translates into increased incentives to invest in early education because of assumed dynamic complementarities between early and tertiary education. It also increases the earnings gap between college and non-college attendants, which results in larger differences in parents’ ability to finance education. Public education could mitigate the relationship between inequality and intergenerational mobility. However, public expenditure on education is negatively correlated with inequality. I replicate this cross-country relationship by endogenizing education policies via probabilistic voting, while accounting for biases in voter turnout towards the educated. The model is calibrated to the US as the benchmark economy, which exhibits high inequality and low mobility. Experiments comparing the US to other OECD countries demonstrate that tertiary education characteristics can account for two-thirds of the differences in inequality. Patterns of voter turnout across countries explain nearly one-quarter of the differences in inequality and mobility. A counterfactual exercise for the US suggests that compulsory voting could foster intergenerational mobility, whereas the effect on pre-tax inequality is comparably low.

JEL classification: E24, H52, I23, I24, J62

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*Universitat Autònoma de Barcelona (email: christopher.rauh@uab.cat). I am grateful to Nezih Guner for his support and comments. I would also like to thank Joan Esteban, Keith Henwood, Sarolta Laczó, Rajesh Ramachandran, Alison Rauh, Alexandra Roulet, Arnau Valladares-Esteban, Jack Willis, and Yanos Zylberberg for their helpful feedback and discussions. I acknowledge financial support from the Barcelona Graduate School of Economics through the Severo Ochoa Program for Centers of Excellence (SEV-2011-0075).
1 Introduction

Inequality is negatively linked to intergenerational mobility across countries.\textsuperscript{1} Recent increases in income inequality across OECD countries highlight the importance of understanding the underlying causal mechanisms of the relationship between inequality and mobility. Why is a country such as the US, which is characterized by an unequal distribution of earnings, at the same time amongst the most rigid societies in the developed world? What causes these unequal outcomes and how are they transmitted to future generations? Education is a strong determinant of earnings and its public provision can be of redistributive nature. According to traditional voting models the provision of public education, in particular non-tertiary education, should be increasing in inequality. However, the share of GDP dedicated to non-tertiary as well as tertiary public education is negatively associated with inequality across countries. This could occur if the rich prefer private education and public policies are biased in their favor. Indeed private education expenditures are found to be increasing in inequality across countries. In this paper two potential channels, i.e. tertiary education characteristics and biased voter turnout, are investigated. I quantify how much of the differences in inequality and mobility between the US benchmark economy and other OECD countries, namely Canada, Denmark, Finland, Germany, Norway, Sweden, and the UK, these channels can explain.

The dynamic stochastic general equilibrium model adopts a structure resembling that of Restuccia and Urrutia (2004). Parents invest in early private education of their offspring, which is a substitute to public education, in order to enhance the imperfectly inherited ability. Subsequently, they decide whether or not to send their child to college, where the probability of dropping out of college is decreasing in ability. In each period households vote on two separate proportional tax rates. Thus, early public education and the college subsidy, which is decreasing in parental earnings, are determined endogenously. The model is characterized by the dynamic complementarity between early and late investment (e.g., Cunha, Heckman, Lochner, and Materov 2006, Cunha and Heckman 2008, Caucutt and Lochner 2012), while incorporating the discrete nature of the college investment as in Galor and Zeira (1993).

Tertiary education characteristics in terms of the college premium, tuition, and completion and enrollment rates vary across countries. In particular, the college premium is highly corre-

\textsuperscript{1}The curve resulting from plotting this relationship is commonly referred to as the “The Great Gatsby Curve” and is exhibited in Figure 1. The name is adopted from the novel “The Great Gatsby”, in which the author F. Scott Fitzgerald challenges the “American Dream” by telling the story of Jay Gatsby, who rises to the high society via shady business deals.
lated with inequality and intergenerational earnings persistence. By comparing steady states, I find that differences in tertiary education can explain up to 65% of the gaps in the Gini coefficient and 21% of the gaps in intergenerational earnings persistence. High returns to education create an incentive to invest in your child, while richer parents have more funds available to invest than the less well off. The combination of these two effects contributes to the positive cross-country relationship between inequality and intergenerational earnings persistence. High tuition costs magnified by a considerable probability of dropping out make college a costly lottery, relatively more affordable for wealthier households. If the probability of dropping out is decreasing in skills and dynamic complementarities exist between early and college education, then parents have greater incentives to invest in their children’s education. Given that parents earn less when they are younger and cannot borrow against the future of their children, large incentives for private investment combined with imperfect credit markets increase the gap between the education received by rich and poor children at the early stage, and consequently at the college level as well.

Rich parents are likely to prefer private early education, given that a large share of public education expenditures would have to be financed out of their pockets. Relatively high voter turnout among the educated, as in the US, might bias policies in their favor. In contrast, relatively high voter turnout among the less educated could increase public expenditures on early education due to its redistributive nature. In the model economy public education expenditures are endogenous and households vote via probabilistic voting. This allows me to exploit the skewness of voter turnout by age and level of education across countries to explain variations in education expenditures and the effects on inequality and mobility. The weights of individuals in the voting process are assigned according to voter turnout by age group and level of education using the voting supplement of the Current Population Survey (CPS) of 2006 for the US, and the European Social Survey 2010 (ESS) and the Canadian Election Study of 2008 for the experiments. I find that observed patterns of public and private education expenditures, inequality, and intergenerational mobility can be reconciled by voter turnout. On average 23% of differences in intergenerational mobility and 21% of differences in the Gini index compared to the US can be explained by voter turnout. As a robustness check, I repeat the analysis while weighing voters by the fraction of party members per age group and education level. The data is obtained from the World Values Survey 1981-2007 (WVS) and the results exhibit similar patterns. This indicates that the political participation of a society, whether through voting or through party membership, shapes public policy, and thereby influences inequality and intergenerational mobility.
Given that the patterns of voter turnout perform well at explaining cross-country differences, two possible voting policies in the US are considered. First, I enforce compulsory voting. Chong and Olivera (2008) provide empirical evidence that this has an equalizing effect on the income distribution across countries, while Fowler (2013) shows that the introduction of compulsory voting in Australia increased public pension expenditures. Second, I allow parents to vote for their children. This policy has recently received attention in the public debate and was first discussed by Demeny (1986) in order to counter decreasing fertility rates. I find that intergenerational earnings persistence is reduced by 10% under compulsory voting, whereas the extension of electoral franchise to children as of birth by letting their parents vote for them nearly halves earnings persistence. However, the equalizing effect of these policies on pre-tax earnings is comparably low.

By including the political economy of education expenditures, the model demonstrates how policies and outcomes across countries might react differently to an exogenous change in the college premium. Simulations with an exogenous increase in the college premium in the US indicate that earnings persistence could decrease substantially. More children from the bottom of the earnings distribution enroll in college, hence increasing public support for financial aid. Increased enrollment raises aggregate returns to early education, which raises the share of earnings taxed to finance early education, further augmenting intergenerational mobility.

The paper can be summarized in terms of the five principle findings, of which two explain cross-country differences and three deal specifically with the US. First, the characteristics of tertiary education in terms of the college premium, tuition costs, and completion probability, can explain a large share of differences to the US in inequality and to a lesser extent intergenerational mobility. Second, the skewness of voter turnout in terms of age and education can account for a considerable part of the gaps in intergenerational earnings persistence. Third, a further rise in the college premium in the US could increase intergenerational mobility despite pronounced earnings inequality, which is in contrast to the outcome when the political economy is ignored and households are not allowed to vote. Fourth, policies of compulsory voting or extending the electoral franchise to children as of birth could foster intergenerational mobility. Fifth, in line with recent research (e.g., Belley and Lochner 2007, Bohacek and Capicka 2012, Winter 2013) nearly one in four individuals is found to be financially constrained in the college decision.
Becker and Tomes (1979, 1986) and Loury (1981) pioneered the microfoundation of the three fundamental institutions in the determination of a child's future: the family, the labor market, and the state. Their approach is extended and formalized by Solon (2004). Galor and Zeira (1993) present on the macroeconomic level how credit market imperfections and indivisibilities in human capital investments can transmit distributions of wealth. Glomm and Ravikumar (1992), Durlauf (1996), Bénabou (1996), and Fernandez and Rogerson (1998) demonstrate how locally provided public education affects growth, intergenerational income transmission, and inequality when households are sorted geographically by income. Abstracting from different stages of education and heterogenous innate ability among individuals, Fernandez and Rogerson (1995) show that richer individuals can be those capturing higher education subsidies, thereby making the transmission of unequal distributions more likely.

The paper is most closely related to Restuccia and Urrutia (2004), Herrington (2012), and Holter (2012), who use dynastic overlapping generations models to quantitatively study intergenerational mobility. Assuming exogenous taxation and education policies, Restuccia and Urrutia (2004) find that to reduce intergenerational persistence an increase in early education expenditures would be more efficient than increasing college subsidies. Herrington (2012) accounts for a share of the gap in inequality and intergenerational persistence between Norway and the US through variations in the distribution of public spending and revenue sources. Holter (2012) exploits cross-country differences in the progressivity of income taxation to explain part of the gap in intergenerational mobility between the US and Denmark. However, in his partial equilibrium setting, as well as in Restuccia and Urrutia (2004) and Herrington (2012), the shape and level of the taxation function are taken to be exogenously given. This inevitably leads to the question of the political economy of education expenditures at the different stages of human capital formation. Ichino, Karabarbounis, and Moretti (2010) use a microeconomic approach to the political economy of the underlying structure of intergenerational income mobility considering only a single stage of education. Chetty, Hendren, Kline, and Saez (2013) corroborate the importance of the effect of tax expenditures on mobility. Using administrative tax records, they find that schools with higher expenditures per student have higher rates of upward mobility and that tax policies remain correlated with mobility even after controlling for other important factors, such as local social capital and family structure.

There is a growing political science literature investigating individual preferences for expenditures on public education. Most empirical studies are limited to general preferences on education expenditures expressed in surveys, not allowing for a distinction between early and
college education. One finding is that these preferences are not only driven by income, but are increasing in the level of education (Busemeyer 2012, Horn 2012). This occurs in my model as well, however the causality is not driven by the education of an individual. Education serves as a proxy for ability, which is positively correlated with the ability of the child. Now since returns to education are assumed to be increasing in ability, holding earnings fixed, a more educated individual on average has a greater demand for public education. Busemeyer (2012) also finds that those still enjoying the benefits of education, as well as people with children are more likely to support public education. These findings align well with the voting mechanism specified in the model, where individuals’ preferences on public education are driven by their own payoff and altruism for their children, and not by altruistic motives for the society as a whole. Ansell (2010) models preferences for tertiary education expenditures in the setting of a class conflict where coalitions are formed. When enrollment rates are low, access is restricted to the elite, and consequently the poor and the middle class do not support public expenditures. With increasing enrollment more individuals from the lower end of the income distribution enter tertiary education, thereby expanding support and consequently public subsidization. Similar dynamics emerge from the probabilistic voting process embedded in my model.\(^2\) Wolf (2009) does not focus on individual preferences, but explains the cross-country ratios of public to private expenditures through union density, federalism, the share of protestant population, and the given composition of the cabinet, thereby arguing in terms of value-related and ideology-based factors.

The remainder of the paper is organized as follows: In Section 2 the stylized facts of earnings inequality, intergenerational earnings persistence, and education expenditures are presented. The model is explained in Section 3 with the equilibrium definition following in Section 4. The parameterization is described in Section 5, whereas the benchmark results and policy experiments for the US are presented in Section 6. In Section 7 experiments explain differences between the US benchmark economy and other OECD countries. The robustness of these results is analyzed in Section 8. Finally, Section 9 concludes and outlines questions for future research.

\(^2\)Ansell (2010) goes further by showing how leftist parties support for expenditures on higher education shift with the enrollment rates. Since in my model there are no left or right parties the details of partisan behavior escape my analysis of the political economy.
2 Inequality and intergenerational earnings persistence

Intergenerational mobility is generally measured by regressing the log of son’s earnings on the log of father’s earnings to quantify earnings elasticities across generations, which captures the percentage change in a son’s adult earning that is associated with a one percentage point increase in paternal earnings. Reliable estimates are difficult to obtain due to the requirement of data on earnings of both generations and are complicated by lifecycle and macroeconomic fluctuations. The empirical estimation was pioneered by Solon (1992) and Zimmerman (1992) finding an earnings persistence of 0.4 in the US.³

Wage inequality, as captured by the Gini coefficient of household earnings before taxes and transfers of the population aged 18-65 by the OECD (2011b), is highly correlated with the intergenerational persistence of earnings summarized by Corak (2012), as exhibited in Figure 1.⁴ The positive slope of the “Great Gatsby Curve” indicates that a higher level of inequality is positively associated with a greater transmission of economic status across time in the past. Even if inequality can be justified as an outcome of differential efforts, this strong positive relationship raises the question of whether inequality also negatively affects the equality of opportunities.

In the top panels of Figure 2 one can see the high correlation between the Gini coefficient of earnings before taxes and the share of total education expenditures financed privately by households of non-tertiary and tertiary education, respectively.⁵ As exhibited in the bottom panels of

³Concerning estimates of intergenerational mobility see Blanden, Gregg, and Macmillan (2007) for the UK, Björklund and Jäntti (1997) for a comparison of the US and Sweden, and Solon (2002) or Corak (2012) for a survey of cross-country estimates. Black and Devereux (2011) provide an excellent overview of recent findings. A range of empirical papers has investigated the relationship between inter- and intragenerational inequality. Cooper (1998) finds empirically that in poor neighborhoods redistributive expenditures on human capital have a significant effect in reducing the persistence of economic status across generations, thereby hinting towards a causal relationship. Andrews and Leigh (2009) similarly find that sons that grew up in more unequal states during the 1970s experienced less social mobility by the late 1990s. Aaronson and Mazumder (2008) present how the “snapshot” and the “moving-picture” measure of inequality move parallel between 1940 and 2000 in the US. Duncan, Khalil, and Ziol-Guest (2013), controlling for family structure and characteristics, find that between two-thirds and three-quarters of the increase in schooling gaps between low and high income children of cohorts born in the 50’s and 80’s in the US can be accounted for by increases in income inequality. In contrast, Bloome (2013) finds little evidence for an effect of inequality during childhood on intergenerational mobility across US states.

⁴The fitted line and the correlation coefficient are computed excluding the outliers Chile and Switzerland.

⁵I use the expression “non-tertiary” or “early” to summarize primary and secondary education. Given the evidence of the early formation of cognitive and non-cognitive skills (e.g., Cunha et al. 2006, Heckman 2010) the consideration of pre-primary education is surely an important factor in the examined dynamics and outcomes from which I abstract. Peer and neighborhood effects, as well as health, are other channels worth mentioning, through which parental income could affect learning aptitude of children, but are not included in the model. Also
Figure 1: Gini before taxes versus intergenerational earnings persistence

Figure 2, the shares of total education expenditures financed privately by households are highly positively correlated with the intergenerational transmission of earnings.

Assuming public early education to be of redistributive nature, according to traditional voting models one would expect public education expenditures to be increasing in inequality. As can be seen in Figure 3 the opposite is the case in the data, whereas private education expenditures are indeed found to be positively related to inequality. Under the assumption that the rich prefer private education, this could be driven by a bias in voter turnout, as exhibited for a small sample of countries in Figure 10 in the Appendix. The share of GDP dedicated to public education is decreasing in the relative turnout of college graduates compared to those with no college education.

On the one hand, the provision of public education affects how much education can be guaranteed to each individual. On the other hand, high returns to education increase the incentives parental connections, though not an influence on cognitive abilities, could possibly be of high importance to the intergenerational linkage of earnings. Corak and Piraino (2011) find that about 40% of young Canadian men have worked for an employer that employed their father at some point in time, while 6-9% have the same employer in adulthood. The percentage is found to increase with paternal earnings, especially at the top.
parents have to invest in education. Therefore, assuming credit market imperfections high returns to education can drive a wedge between the education that poor and rich children achieve. An increase in the college premium raises the returns to investment directly at the college level, and assuming dynamic complementarities between early and college education also raises the returns to investment in early education. As can be seen in Figure 4, the college premium, here defined as the relative earnings of college graduates compared to upper secondary education of the population aged 25-64 (OECD 2013), is positively associated with the Gini as well as with intergenerational earnings persistence. Therefore, now we have two possible explanations for cross-country differences in inequality and intergenerational mobility consistent with the data patterns. First, a technological explanation in terms of the college premium.\(^6\) Second, a political explanation in terms of the bias in voter turnout. In the following, a model will be specified, which allows for the quantification of the contribution of these two channels to cross-country differences in inequality and mobility.

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\(^6\)The college premium has mainly been linked to technological developments. See references in Section 6.2.1.
Fig. 3: Gini before taxes versus public (top) and household (bottom) expenditure (% of GDP) dedicated to non-tertiary (left) and tertiary (right) education.

Fig. 4: College premium versus Gini (left) and intergenerational earnings persistence (right)
3 The model

The overlapping generations model resembles the one presented by Restuccia and Urrutia (2004). A household exists for two periods and is composed of either a young parent and a young child, or an old parent and an old child, which I will refer to as young and old households, respectively. In a subsequent period old parents die, whereas the old children become young parents and form households of their own. Consequently, everybody lives for four periods, but only makes decisions during the last two periods of the lifecycle. Population growth is zero and all parents have the same number of children.7 Parents take education decisions for their children. Households are heterogenous in their levels of innate ability of the offspring and human capital of the parents. Lifetime utility is composed of consumption as a young household $c_y$, consumption as an old household $c_o$, and “warm glow” for the level of human capital of their child $h_c$. The assumption that parents derive utility from ensuring that their children are equipped with an adequate level of human capital is common in the literature (Glomm and Ravikumar 1992, Galor and Zeira 1993, Bénabou 2000). The utility function for consumption $u(c)$ is increasing and concave, while altruistic utility gained from human capital of the child $v(h_c)$ is nondecreasing. Labor is provided inelastically, where human capital is remunerated by competitive firms at a wage rate $w$.

3.1 Ability and human capital

Innate ability is assumed to be correlated with parental innate ability, which is not altered over the lifecycle and can be interpreted as the genetic component. Acquired ability $\hat{a}$ is a function of innate ability and public and private education investments when young, which later will affect the probability of college completion and wages. When the child is old, acquired ability $\hat{a}$ transforms into human capital $h_c$. Once he becomes a parent, human capital evolves exogenously, while capturing the lifecycle earnings profile. When becoming a young parent human capital experiences a shock and converts to $h_y$, whereas for the old parent human capital is denoted by $h_o$.

Innate ability $a$, when passed from one generation to the next, follows a first-order discrete Markov process with mean normalized to one, and transition matrix $\Psi$, while restricting the

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7While De la Croix and Doepke (2004) demonstrate theoretically how differential fertility rates might play a considerable role in the distribution of human capital investments and preferences for public education among families, Björklund et al. (2004) find no differences in intergenerational mobility by family size in Norwegian data.
vector of states for \( a \) and the elements in the transition matrix such that the process is a discrete approximation of a continuous AR(1) process:

\[
\ln(a') = \rho \ln(a) + \epsilon \text{ where } \epsilon \sim N(0, \sigma^2_a).
\]  

(1)

Innate ability \( a \) is transformed into acquired ability \( \hat{a} \) via public education \( g \) and private early education \( e \) according to the function \( f(a, e, g) \) when the offspring is young. The function \( f(a, e, g) \) is assumed to be positive, strictly increasing, and concave in all its arguments. Public and private education are assumed to be perfect substitutes. Following the literature on early skill formation, acquired ability \( \hat{a} \) is increasing in innate ability \( a \). Also the return to investment in education is increasing in innate ability, such that \( \frac{\partial^2 f}{\partial a \partial e}, \frac{\partial^2 f}{\partial a \partial g} > 0 \), as skill has been found to beget skill (Cunha et al. 2006, Cunha and Heckman 2008).

The functional form chosen is close to the Ben-Porath (1967) specification and assumed to be given by

\[
\hat{a} = f(a, e, g) = \chi a^{1-\gamma}(g + e)\gamma.
\]  

(2)

The efficiency of private and public investment increases in parameter \( \gamma \), which is also responsible for the relative importance of innate ability versus investment. Parameter \( \chi \) is the efficiency parameter regulating the level effect of human capital creation.

Everybody enjoys public education, while choosing the level of private education to supplement it. This sort of structure is not limited to the growing number of charter schools, as investments in early private education can be imagined as anything from piano lessons to out of school tutoring. Data for the US reveals that the gap in “enrichment expenditures” between poor and rich parents has become greater over time (Duncan and Murnane 2011, Kornrich and Furstenberg 2013). Also, in the United States a large share of non-tertiary education is financed locally through property taxes or other local sources. Households are assumed to be able to choose the level of investment by moving into a neighborhood which provides the preferred level of investment and is priced accordingly due to housing prices differentials (Epple and Romano 1996, Fernandez and Rogerson 1997). Hoxby (1998) and Herrington (2012) show a positive relation between per-pupil spending and income.

Old parents decide on whether or not to send their offspring to college \( s \in \{0, 1\} \). If they do not go to college the offspring works for the entire period, whereas if they do go they spend
share \( n \) of the period in college if they drop out, and share \( \bar{n} \) in case they graduate, while working the rest of the period. The earnings of the offspring are shared with the parents at the household level. If the child goes to college, he completes college with probability \( \pi(\hat{a}) \), consequently dropping out with probability \( (1 - \pi(\hat{a})) \). The probability \( \pi \) of completing college is increasing in acquired ability (Light and Strayer 2000, Chatterjee and Ionescu 2010) and is assumed to take the functional form

\[
\pi(\hat{a}) = \min\{1, \psi_0(1 + \hat{a})^\psi_1\},
\]

where \( \psi_0 > 0 \) and \( \psi_1 > 0 \). The parameter \( \psi_0 \) is responsible for the level effect of acquired ability on the probability of college completion, while the convexity of the function is increasing in \( \psi_1 \). College education comes at a tuition cost \( T \) per period. The government subsidizes a share decreasing in parental earnings. The share \( q \) of tuition cost \( T \) covered by the government is linearly decreasing in parental earnings and is given by

\[
q(h_o) = \max\{0, 1 - \kappa wh_o\}.
\]

The share covered by the college subsidy is bound from below by 0, such that no household has to pay an additional fee, and from above by 1, assuring that no household receives a subsidy beyond compensation of the actual cost of attending college. If the offspring completes college, its acquired ability is multiplied by \( \hat{\theta} \), while if it drops out only by \( \theta \) (where \( \hat{\theta} > \theta \)). Therefore, acquired ability is mapped into human capital of the old child \( h_c \) via the functional form

\[
h_c = \begin{cases} 
\hat{a} & \text{if does not attend college} \\
\hat{\theta} \hat{a} & \text{if completes college} \\
\theta \hat{a} & \text{if drops out of college,}
\end{cases}
\]

where the college completion probability is given by (3). This functional form satisfies the dynamic complementarity between early and late investments in human capital discussed by Cunha et al. (2006) and Cunha and Heckman (2008). Despite recent discussions about the importance of the increased uptake of student loans (Belley and Lochner 2007, Lochner and Monge-Naranjo 2012, Abbott, Gallipoli, Meghir, and Violante 2013), I do not allow households to borrow and abstract from physical capital accumulation.\(^8\)

In the transition from old offspring to young parents two things occur. Firstly, individuals

\(^8\)According to a Sallie Mae-Ipsos Report in 2013 student loans pay for only 18% of costs of college attendants.
can experience a shock $\zeta_y$ commonly referred to as market luck. The shock accounts for the fact that earnings dispersion within a cohort increases over the lifecycle (Huggett, Ventura, and Yaron 2006) and for the finding by Huggett, Ventura, and Yaron (2011) that only 61% of the variance in lifetime earnings can be attributed to pre-working conditions. The shock is multiplicative and takes either value $\zeta_y \in \{-\zeta, 0, \zeta\}$ with equal probability $1/3$. This shock creates no aggregate uncertainty and is permanent. Secondly, their human capital increases exogenously by the lifecycle component $\eta_0 > 1$, such that

$$h_y = \eta_0 (1 + \zeta_y) h_c. \quad (6)$$

Young parents are equipped with human capital $h_y$ and choose how much to invest in private early education $e$. Old parents have human capital $h_o$, which is given by

$$h_o = \eta_1 h_y, \quad (7)$$

where $\eta_1 > 1$ represents the increase in the earnings profile through experience later in the lifecycle. Earnings are determined by human capital and the competitive wage $w$, the rate of return to human capital in the market.

### 3.2 Households

Households take tax rates for financing of early ($\tau_p$) and college ($\tau_q$) education, as well as public expenditures on early education ($g$) and the college education subsidy ($q$) in $t$ and $t + 1$ as given when maximizing discounted lifetime utility. The discount factor is $\beta < 1$. The utility of consumption is assumed to take the functional form

$$u(c) = \frac{c^{1-\sigma}}{1-\sigma} \quad (8)$$

while the utility derived from leaving the child with human capital $h_c$ is

$$v(h_c) = \phi h_c^{\xi}, \quad (9)$$

where $\phi > 0$ and $\xi > 0$.

The state variables of the old household are $(h_o, \hat{a})$. Let $\lambda$ be equal to one if the child
completes college and zero if he drops out. Given the wage rate $w$ then the problem of the old parent household can be written as

$$V_o(h_o, \hat{a}) = \max_{s \in \{0, 1\}} \{V_o^{s0}(h_o, \hat{a}), E_\lambda[V_o^{s1}(h_o, \hat{a}, \lambda)]\},$$

(10)

where $V_o^{s0}(h_o, \hat{a})$ is the value function of not sending the child to college, whereas $V_o^{s1}(h_o, \hat{a}, \lambda)$ is the value of sending the child to college, and hence depends on the college completion probability given by (3). The value of not sending a child to college is given by

$$V_o^{s0}(h_o, \hat{a}) = \max_{c_o \geq 0} \left\{ c_o^{1-\sigma} + \phi h_c^\sigma \right\}$$

(11)

subject to

$$c_o = (1 - \tau_p - \tau_q)(wh_o + wh_c)$$

(12)

and

$$h_c = \hat{a}.$$  

(13)

The expected value of sending a child to college conditional on college completion $\lambda$ is given by

$$E_\lambda V_o^{s1}(h_o, \hat{a}, \lambda) = \pi(\hat{a})V_o^{s1}(h_o, \hat{a}, 1) + (1 - \pi(\hat{a}))V_o^{s1}(h_o, \hat{a}, 0),$$

(14)

where

$$V_o^{s1}(h_o, \hat{a}, \lambda) = \max_{c_o \geq 0} \left\{ c_o^{1-\sigma} + \phi h_c^\sigma \right\}$$

(15)

subject to

$$c_o + (1 - q(h_o))((\lambda \bar{n} + (1 - \lambda)n)T = (1 - \tau_p - \tau_q)(wh_o + (1 - (\lambda \bar{n} + (1 - \lambda)n))wh_c)$$

(16)

$$h_c = (\lambda \bar{\theta} + (1 - \lambda)\bar{\theta})\hat{a},$$  

(17)

where the probability $\pi(\hat{a})$ of completing college is given by (3) and the college subsidy $q(h_o)$ by (4). Let $b$ be the level of education obtained by a parent. This can either be high school, college dropout, or college graduate. Let the distribution of old parent households be summarized by $\mu(x_o)$, where $x_o = (h_o, \hat{a}, a, b)$, and let $s(x_o)$ and $e(x_o)$ be the solution to (10), and therefore the policy functions of the college decision and consumption of the old household, respectively.

The state variables of the young household are $(h_y, a)$. The problem of the young household
is given by
\[ V_y(h_y, a) = \max_{c_y \geq 0} \left\{ \frac{c_y^{1-\sigma}}{1-\sigma} + \beta V_o(h_o', \hat{a}') \right\} \] (18)
subject to
\[ c_y + e = (1 - \tau_p - \tau_q)w h_y \] (19)
\[ \hat{a}' = \chi a^{1-\gamma}(g + e)^\gamma \] (20)
\[ h_o' = \eta_1 h_y. \] (21)

Let \( x_y = (h_y, a, b) \) and let \( c_y(x_y) \) be the policy functions of consumption associated with the young, and \( e(x_y) \) the policy function determining early private education. The distribution of young parent households is described by \( \mu_y(x_y) \). The total mass of households is assumed to be constant and of mass unity each, young parents and old parents households. Therefore, the total mass of individuals is four (since each household contains one parent and one child).

### 3.3 Firms

A representative firm produces a single good and has a linear constant return to scale production technology producing aggregate good \( Y \) using aggregate human capital \( H \) as an input
\[ Y = F(H) = AH. \] (22)

Therefore, the firms problem can be written as
\[ \max_H \{ F(H) - wH \}. \] (23)

### 3.4 Government

The government levies two proportional tax rates, while running a balanced budget for early and late education separately. First, tax \( \tau_p \) which is used to finance public early education \( g \). Second, tax \( \tau_q \) which covers part of tuition cost \( T \) for those going to college. Therefore, government expenditures \( g \) on early education are given by
\[ g = \tau_p Y. \] (24)
The college subsidy depends not only on tax \( \tau_q \) and total production in the economy, but also on the composition of college students. More specifically, it depends on how many students attend college, how long they attend, and what the earnings of their parents are. The government budget for tertiary education can be summarized by

\[
T \int s(x_o)q(h_o)n(\hat{a}) d\mu_o(x_o) = \tau_q Y, \tag{25}
\]

where \( q(h_o) \) is given by (4), \( n(\hat{a}) = \pi(\hat{a})\bar{n} + (1 - \pi(\hat{a}))\bar{n} \) is the time spent in college, and \( \pi(\hat{a}) \) is given by (3).

An increase in tax rate \( \tau_q \), ceteris paribus, leads to a reduction in \( \kappa \), which for a household sending its offspring to college increases subsidy rate \( q \), given their earnings are not too high and satisfy \( wh_o < \frac{1}{\kappa} \).

3.5 Political economy

The two proportional tax rates are determined jointly through probabilistic voting, which allows for a weighted average of preferences across households instead of only relying on the median voter.\(^9\) Due to the two-dimensional problem preferences are unlikely to be single-peaked, not allowing for the identification of the median voter.

In probabilistic voting parties commit to policies before elections take place. The policy platform is chosen by opportunistic candidates, which only care about being elected. It is assumed that parties differ along an ideological dimension observable to the voter. Candidates know the ideological preference distribution of the voters, wherefore chosen policies are directed towards those voters that are less driven by the ideological component. Candidates have an average popularity common to all voters, which is a random variable and could be subject to a shock, such as a scandal the day before elections take place. Since the policy platform is chosen when the outcome is uncertain, parties maximize the expected share of votes, and thereby the probability of winning the election. There exists a unique political equilibrium in which both parties propose the same policy by maximizing a weighted social welfare function,

\(^9\) Voters only decide on proportional tax rates, not on the actual shape of the tax function. Holter (2012) and Herrington (2012) find that the progressivity of the tax schedule plays an important role. Additionally, Herrington finds that public expenditures on early education are not always uniformly distributed across households as in my model, which could be an outcome of the political economy, as well. Due to computational complexity I abstract from these characteristics.
where weights are determined by how responsive voters are to policies, which might vary due to the ideological component (see Lindbeck and Weibull 1987, Persson and Tabellini 2000). I use voter turnout by age and level of education as weights in the voting process, as candidates might be best of catering to the segment of population actually voting.

The decision of the young parent household does not only depend on tax rates in $t$, but also on tax rates in $t+1$ (denoted by a prime), which will be decided upon in the following period. Therefore, the current policy choices $(\tau_p, \tau_q)$ depend on anticipated future policy choices $(\tau'_p, \tau'_q)$ for two reasons. Firstly, the tax rates are important for them, as given returns to wages, the tax rates will determine disposable income. Secondly, $\tau'_q$ will determine $q'$, which for parents wanting to send their children to college could be of importance. Current policy choices and the current distributions of households are mapped via $G$ into the distributions of households in the subsequent period, such that

$$(\mu'_y(x'_y), \mu'_o(x'_o)) = G(\tau_p, \tau_q, \mu_y(x_y), \mu_o(x_o)).$$ (26)

It is assumed that when voting on the preferred policy in $t$, they take the anticipated value of $t+1$ to be the same as in $t$ and ignore the impact their choice will have on the future policy choice. Since agents are atomistic this is a plausible assumption as they do not influence the outcome by themselves. In the steady state equilibrium agents will have rational expectations. Agents take correctly into account, how current policy choices affect aggregate decisions and, hence, consider how $g$ and the function $q(h_o)$ react.

The welfare function $W$ is composed of the weighted (remaining) lifetime utility of the young and old households and is maximized over the set of tax rates $S$. Assigning $\omega_y$ as the weight of the young and $\omega_o$ as the weight of the old household in the voting process, which depend on the level of education $b$, the problem is

$$Z(\mu_y(x_y), \mu_o(x_o)) = \arg\max_{\tau_p, \tau_q \in S} W$$ (27)

$$W = \int \omega_y(b)V_y(x_y)d\mu_y(x_y) + \int \omega_o(b)V_o(x_o)d\mu_o(x_o).$$ (28)

where $S = \{(\tau_p, \tau_q) \in [0,1]^2 | 0 \leq \tau_p + \tau_q \leq 1\}$. Since $W$ is strictly concave in $\tau = (\tau_p, \tau_q) \in S$ the solution is unique.
3.6 Timing

1. Ability \(a\) of the offspring and earnings shock \(\xi\) are realized.

2. Voting on the contemporaneous tax rates takes place. Agents have expectations of future policies and do not vote strategically. When voting on preferred policy in \(t\) voters assume their choice will be in effect in \(t + 1\) and ignore the impact their choice will have on the future policy choice. Voters anticipate how their decision will affect economic decisions.

3. The investment in public early education and the college subsidy determine investment decisions of young and old parents.

4. Equilibrium

Let total consumption of young and old parent households be

\[
C_y = \int c_y(x_y) \, d\mu_y(x_y) \quad \text{and} \quad C_o = \int c_o(x_o) \, d\mu_o(x_o).
\]

**Definition 1.** Given prices, policies, and tax rates, \(V_y\) solves the functional equations (18) satisfying (19), (20), and (21), while \(V_o\) solves (10) satisfying (11), (12), (14), (15), and (16), with \(c_y(x_y), c_o(x_o), s(x_o), \text{and } e(x_y)\) as associated policy functions.

1. Price \(w\) satisfies

\[
w = A
\]  

(29)

2. Goods market clearing:

\[
Y = AH
\]  

(30)

\[
Y = C_y + C_o + E + F + g
\]  

(31)

\[
E = \int e(x_y) \, d\mu_y(x_y)
\]  

(32)

\[
F = T \int s(x_o)(\pi(\hat{a})\bar{n} + (1 - \pi(\hat{a}))\bar{n}) \, d\mu_o(x_o)
\]  

(33)

3. Labor market clearing:

\[
H = \int h_y d\mu_y(x_y) + \int h_o d\mu_o(x_o) + \int ((1 - s(x_o)) + s(x_o)(\pi(\hat{a})(1 - \bar{n})\bar{\theta} +
\quad + (1 - \pi(\hat{a}))(1 - n)\theta) \, d\mu_o(x_o)
\]  

(34)

4. The government balances budgets (24) and (25), which determines \(g\) and \(q\).
5. The laws of motion $\Phi$ which map from state $x_y = (h_y, a, b)$ of the young to state $x'_o = (h'_o, a', b')$ of the old in the following period, such that $\mu'_y(x'_y) = \Phi(\mu_y(x_y))$, are given by (2) and (7). The laws of motion $\Omega$ which map from state $x_o = (h_o, \hat{a}, a, b)$ of the old to state $x'_y = (h'_y, a')$ of the young in the following period, $\mu'_y(x'_y) = \Omega(\mu_o(x_o))$, are given by (1), (5), and (6).

6. The tax rates $(\tau_p, \tau_q)$ to finance public education expenditures on early education $g$ and the individual college subsidy $q$, respectively, are given by (27).

A stationary equilibrium is a competitive equilibrium in which policy functions, as well as subsidies and tax rates, are constant. It is a fixed point in the mapping (26), such that the expected tax rates $\bar{\tau}_p$ and $\bar{\tau}_p$ are equal to the solution for $\tau_p$ and $\tau_p$, respectively, which are the solution to (27). Also the distributions $\mu_y(x_y) = \mu'_y(x'_y)$ and $\mu_o(x_o) = \mu'_o(x'_o)$ are stationary, hence the distributions can be summarized by $\mu(x)$.

5 Model parameterization

In order to analyze the US economy and conduct cross-country experiments the model is calibrated to the US benchmark economy by matching facts on inequality, mobility, and public and private education expenditures. The model is governed by 21 parameters summarized in Table 2. Eight parameters are chosen from a priori information or are standard in the literature, while the remaining are determined in the calibration by minimizing the squared distance between model output and 13 data moments. Of the targeted data moments two relate to public expenditures on education, two to private expenditures on education, three to college statistics, and six relate to the distribution of earnings.

5.1 Independently chosen parameters

One period in the model is equivalent to 16 years. The discount rate is standard at 0.96 per year, which results in $\beta$ being set to 0.52. I choose a standard value in the consumption literature of 1.5 for the intertemporal preference parameter $\sigma$. The firm productivity parameter $A$, and hence the return per unit of human capital, is normalized to unity. College completion requires four years of attendance, which given a period length of 16 years translates into $\bar{n} = 0.25$. Supported by evidence of Stinebrickner and Stinebrickner (2007) dropping out occurs after two years of college attendance ($n = 0.125$). The increases in earnings through the lifecycle are determined...
by the earnings ratio of working males in the given age groups. For \( \eta_0 \) I take the ratio between those aged 33 and 48 to those between 22 and 32, whereas for \( \eta_1 \) I take the ratio of males aged between 49 and 64 to those between 33 and 48. Using the IPUMS data of 2011, the increases of earnings over the lifecycle are determined to be \( \eta_0 = 1.8 \) and \( \eta_1 = 1.1 \).

### 5.1.1 Voting

Participation in the elections of the president and of congress is highly correlated with the level of education in the US. Since it is more likely for the higher educated to vote, politicians might be better off catering to their interests. In frameworks based on the median voter theorem, this has been incorporated in models by Bénabou (2000) and Ichino et al. (2010) to account for the fact that the decisive voter might not actually be the median voter. Recent research points out the effects of skewed voter turnout and a bias in responsiveness towards policy preferences of the affluent (e.g., Gilens 2012, Schlozman, Verba, and Brady 2012, Bonica, McCarty, Poole, and Rosenthal 2013). Additionally, the older an individual, the more likely he is to cast his vote. To account for these potential biases, I use the 2006 voting supplement of the CPS to compute the share of eligible individuals by education and age group that casted their vote in the 2006 election of congress. The patterns of voter turnout by age and education are fairly constant across the three elections of congress and the three presidential elections of the years available in the CPS data (1996-2006), as can be seen in Table 7 in the Appendix. The political science literature has established a cross-country relationship between inequality and voter turnout (e.g., Ljiphart 1997), but to my knowledge there is no empirical evidence of this relationship holding or being causal within a country. Given that additionally no theoretical model is able to explain patterns of voter turnout consistently, we can take participation as exogenous.\(^{10}\)

The voting weight for the old parent household \( \omega_o \) is composed of the sum of the weight assigned to the parents as well as to the offspring. This accounts for the fact that they are on the verge of completing the age of eligibility to vote at the beginning of the period. Since the old offspring has not taken all educational decisions yet, individuals in this age group are only weighted by their age-specific weight, while disregarding education to have an exogenous voting weight. Otherwise, tax rates could alter decisions, and thereby the voting weights of the old offspring. The weights assigned to each age and education level are displayed in Table 1.

Voting preferences are determined at the household level because all decisions in the model are

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\(^{10}\)For more on this discussion see Section 7.1.
Table 1: Voting weights

<table>
<thead>
<tr>
<th>Age</th>
<th>High school or less</th>
<th>Some college</th>
<th>College</th>
</tr>
</thead>
<tbody>
<tr>
<td>18 - 32</td>
<td>.27</td>
<td>.27</td>
<td>.27</td>
</tr>
<tr>
<td>33 - 48</td>
<td>.32</td>
<td>.48</td>
<td>.64</td>
</tr>
<tr>
<td>49 - 64</td>
<td>.47</td>
<td>.63</td>
<td>.77</td>
</tr>
</tbody>
</table>

Datasource: CPS November voting supplement 2006

determined at the household level. Additionally, Niemi and Jennings (1991) find that parents play a major role in determining the initial political direction in the early adulthood of their offspring. I abstract from voters’ influence varying by income. Given the strength of lobbies and the importance of election campaign financing in the US, this could play an important role.

5.2 Calibrated parameters

In the following the targets of the remaining parameters are specified. The parameters are related to costs and expenditures of education, educational decisions and outcomes, and the distribution of earnings.

5.2.1 Education costs and expenditures

In 2009 the share of GDP dedicated to public early education was 3.9% (OECD 2011a), which is targeted by $\gamma$, the productivity parameter of early education investment. The parameter determining the curvature of the “warm glow” function, $\xi$, is anchored by the share of household wages parents spend on early private education, estimated to be a total of 2,198 US$ per child in 2007 according to Kornrich and Furstenberg (2013).¹¹ Using the IPUMS data for 2007, I calculate the average household earnings per child, where no parent is older than 48 and at least one parent is older than 32, and determine it to be 41,068 US$. Therefore, I estimate that an average parent spends 5.4% of his earnings on private early education of a child.

In 2010-2011 average costs of one year of undergraduate full-time studies at a 4-year institution are 22,092 US$ according to the U.S. National Center for Education Statistics (NCES).¹² Given a GDP per capita of 49,800 US$ in 2011 on average the costs of one year of college rack

¹¹Their analysis includes expenditures on education, child care, and other miscellaneous goods and services, such as games and instruments, for children.

¹²For more information see the website http://nces.ed.gov/fastfacts/display.asp?id=76.
up to 44% of GDP per capita, which I target via the tuition cost $T$. The total expenditures of households on tertiary education sum up to 1.1% of total GDP according to the OECD (2011a), which is targeted by the “warm glow” parameter $\phi$, the importance parents attach to the human capital outcome of their children. The share of students receiving federal grants is retrieved from the 2011 Digest of Education Statistics.\textsuperscript{13} Of all full-time undergraduate students 64% received financial aid through grants in 2007-2008, which pins down $\kappa$, the parameter determining the slope of the college subsidy with respect to parental earnings.

<table>
<thead>
<tr>
<th>Description</th>
<th>Independently chosen</th>
<th>Calibrated</th>
<th>Target</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Parameter</td>
<td>Value</td>
<td>Reference</td>
<td></td>
</tr>
<tr>
<td>Coefficient of relative risk aversion $\sigma$</td>
<td>$\sigma$</td>
<td>1.5</td>
<td>Standard</td>
<td></td>
</tr>
<tr>
<td>Discount factor $\beta$</td>
<td>$\beta$</td>
<td>0.96</td>
<td>Standard</td>
<td></td>
</tr>
<tr>
<td>Time for college completion $\bar{n}$</td>
<td>$\bar{n}$</td>
<td>4 years</td>
<td>Standard</td>
<td></td>
</tr>
<tr>
<td>Time for college dropout $\bar{n}$</td>
<td>$\bar{n}$</td>
<td>2 years</td>
<td>Stinebrickner and Stinebrickner 2007</td>
<td></td>
</tr>
<tr>
<td>Lifecycle wage premium $\eta_0$</td>
<td>$\eta_0$</td>
<td>1.8</td>
<td>IPUMS 2011</td>
<td></td>
</tr>
<tr>
<td>Lifecycle wage premium $\eta_1$</td>
<td>$\eta_1$</td>
<td>1.1</td>
<td>IPUMS 2011</td>
<td></td>
</tr>
<tr>
<td>Voting weights of young HH $\omega_y$</td>
<td>$\omega_y$</td>
<td>See Table 1</td>
<td>CPS voting supplement 2006</td>
<td></td>
</tr>
<tr>
<td>Voting weights of old HH $\omega_o$</td>
<td>$\omega_o$</td>
<td>See Table 1</td>
<td>CPS voting supplement 2006</td>
<td></td>
</tr>
<tr>
<td>Elasticity wrt early education $\gamma$</td>
<td>$\gamma$</td>
<td>0.34</td>
<td>Public early education/GDP</td>
<td>0.039</td>
</tr>
<tr>
<td>Tuition cost per period $T$</td>
<td>$T$</td>
<td>0.44</td>
<td>Annual tuition costs/GDP per cap.</td>
<td>0.44</td>
</tr>
<tr>
<td>Slope college subsidy wrt earnings $\kappa$</td>
<td>$\kappa$</td>
<td>0.46</td>
<td>Share college students with grant</td>
<td>0.64</td>
</tr>
<tr>
<td>“Warm glow” $\phi$</td>
<td>$\phi$</td>
<td>1.375</td>
<td>Private college expenditure/GDP</td>
<td>0.011</td>
</tr>
<tr>
<td>Curvature of “warm glow” $\xi$</td>
<td>$\xi$</td>
<td>0.78</td>
<td>Private early educ./Mean earnings</td>
<td>0.054</td>
</tr>
<tr>
<td>College completion wrt ability $\psi_{0}$</td>
<td>$\psi_{0}$</td>
<td>0.29</td>
<td>Fraction attending college</td>
<td>0.62</td>
</tr>
<tr>
<td>College completion wrt ability $\psi_{1}$</td>
<td>$\psi_{1}$</td>
<td>1.02</td>
<td>College completion rate</td>
<td>0.58</td>
</tr>
<tr>
<td>College completion premium $\theta$</td>
<td>$\theta$</td>
<td>1.31</td>
<td>Average college premium</td>
<td>2.53</td>
</tr>
<tr>
<td>College dropout premium $\theta$</td>
<td></td>
<td>0.87</td>
<td>Average dropout premium</td>
<td>1.32</td>
</tr>
<tr>
<td>Persistence ability transmission $\rho$</td>
<td>$\rho$</td>
<td>0.25</td>
<td>Intergenerational earnings persist.</td>
<td>0.40</td>
</tr>
<tr>
<td>Level effect of HC prod. func. $\chi$</td>
<td>$\chi$</td>
<td>1.075</td>
<td>Gini before tax</td>
<td>0.45</td>
</tr>
<tr>
<td>STD of noise in ability trans. $\sigma_a$</td>
<td>$\sigma_a$</td>
<td>0.50</td>
<td>Variance of log hourly wages</td>
<td>0.47</td>
</tr>
<tr>
<td>Magnitude of market luck shock $\zeta$</td>
<td>$\zeta$</td>
<td>0.375</td>
<td>Share earnings variance post-educ.</td>
<td>0.39</td>
</tr>
</tbody>
</table>

5.2.2 Education decisions and outcomes

In 2009 of those completing high school 71% enrolled into college according to the National Science Foundation, while the high school completion rate is estimated at 88% (Heckman and Lafontaine 2010). This results in 62% enrolling into college and 38% of non-college workers, which I approach through $\psi_0$, a parameter of the probability of college completion. The other parameter of the college completion function, $\psi_1$, is pinned down by the fraction of individuals completing college, 58% of first-time, full-time students who enrolled at a 4-year institution in fall 2004 according to the NCES. I use the IPUMS data of the year 2011 to calculate the college completion as well as the dropout premium. The ratio of the average earnings of men aged 33 to 48 with at least four years of college to those with no college education is 2.53, while the ratio of those with less than four years of college to those with no college education is 1.32. These are targeted in the model by the college completion and dropout premium $\bar{\theta}$ and $\underline{\theta}$, respectively.

5.2.3 Earnings

Intergenerational mobility in the US, as captured by the coefficient of the intergenerational earnings persistence, is 0.4 (e.g., Solon 1992, Zimmerman 1992, Solon 1999) and is targeted by the parameter for the intergenerational transmission of innate ability $\rho$, the coefficient of the autoregressive process. The variance of the random shock in the transmission of innate ability $\sigma_a$ is linked to the variance of log hourly wages of males. In the US in 2005 the variance of log hourly wages of males was 0.47 (Heathcote, Perri, and Violante 2010). The Gini coefficient of hourly male wages in the US, my measure for earnings inequality, is 0.39 in 2005 (Heathcote et al. 2010) and is targeted by $\chi$, which is the parameter in charge of the level effect of human capital creation at the early stage. The relevant moment for the post-education earnings shock $\zeta$ is the share of the variance in earnings of 0.39 which is not explained by initial conditions, such as education, when entering employment (Huggett et al. 2011).

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16 The focus is on the pre-tax and pre-transfer Gini in form of hourly wages as I am trying to capture inequalities coming about through education and human capital accumulation and their respective returns in the market.
Table 3: Calibration of the US economy

<table>
<thead>
<tr>
<th>Target</th>
<th>Data</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public early education exp./GDP</td>
<td>0.039</td>
<td>0.044</td>
</tr>
<tr>
<td>Annual tuition costs/GDP per capita</td>
<td>0.44</td>
<td>0.42</td>
</tr>
<tr>
<td>Share of college students with grants</td>
<td>0.64</td>
<td>0.57</td>
</tr>
<tr>
<td>Private college expenditure/GDP</td>
<td>0.011</td>
<td>0.010</td>
</tr>
<tr>
<td>Private early education exp./Mean earnings</td>
<td>0.054</td>
<td>0.061</td>
</tr>
<tr>
<td>Fraction attending college</td>
<td>0.62</td>
<td>0.62</td>
</tr>
<tr>
<td>College completion rate</td>
<td>0.58</td>
<td>0.59</td>
</tr>
<tr>
<td>Average college premium</td>
<td>2.53</td>
<td>2.91</td>
</tr>
<tr>
<td>Average dropout premium</td>
<td>1.32</td>
<td>1.61</td>
</tr>
<tr>
<td>Intergenerational earnings elasticity</td>
<td>0.40</td>
<td>0.39</td>
</tr>
<tr>
<td>Gini before tax</td>
<td>0.39</td>
<td>0.38</td>
</tr>
<tr>
<td>Variance log wages</td>
<td>0.47</td>
<td>0.44</td>
</tr>
<tr>
<td>Share of earnings variance post-schooling</td>
<td>0.39</td>
<td>0.34</td>
</tr>
</tbody>
</table>

6 Benchmark economy

The model performs well at replicating the fraction of individuals going to college, the dropout rate, the share tuition costs of one year of college relative to GDP per capita, and the share of GDP households dedicate to tertiary education, as can be seen in Table 3. The average college and dropout premium are overestimated, whereas the share of college students receiving federal grants and intergenerational earnings persistence are slightly underestimated. While the correlation in innate ability $\rho$ is 0.25, the intergenerational elasticity in earnings is 0.39. A large part of intergenerational mobility is determined by the underlying structure of the model.\footnote{The finding that the correlation of the permanent component of wages of brothers is higher than for their physical attributes such as height and weight (Mazumder 2008), which are arguably transmitted more directly via genes, casts doubts on accepting “nature” as the sole explanation of intergenerational persistence in earnings.}

In the calibration public early education investment accounts for 4.4% of GDP, which is slightly higher than the 3.9% in the data. This can be attributed to the high elasticity of returns to early education expenditures ($\mu = 0.34$). The elasticity of returns to education expenditures has been estimated to be lower, taking values around 0.2 (e.g. Card and Krueger 1992, 1996). However, these estimates might be underestimating the returns, as they exclude private investments (remember in the model investments are $e + g$) and tend to have small time horizons. Increasing a teacher’s salary might increase motivation marginally, but in the long-run this measure would also improve the talent pool of teachers.
The model estimates that 57% of the students receive grants, whereas in the data 64% of full-time undergraduates do so. Even though not targeted by the calibration, I find that those receiving grants on average can cover 36% of tuition, which is fairly close to the 32% (7,100 US$) in the data of the NCES.\textsuperscript{18} In the model public expenditures account for 21% of total tertiary education expenditures, which is far from the 41% in the data. This discrepancy originates in the assumption that colleges do not require input in the model, implemented due to the emphasis on financial aid given tuition costs. Since colleges in the model do not require inputs to produce, their productivity is not dependent on funding. According to the OECD (2012) public expenditures on tertiary education account for 1.3% of GDP in the US, while 18.5% of these funds are spent on scholarships and grants. Therefore, the US invests 0.24% of GDP in grants and scholarships, which is close to the 0.25% endogenously determined through probabilistic voting in the model.

The college premium parameter $\bar{\theta}$ is 1.31, but since it is multiplied with acquired ability the actual average college premium is 2.91, 15% higher than what we observe in the data. The college dropout parameter $\theta$ is 0.87. The fact that the dropout premium is smaller than unity can be interpreted as dropping out being a negative signal in the labor market and/or the time spent in college without graduating is lost in terms of learning on the job, leading to a relatively lower work experience, which is penalized in the labor market.

The “warm glow” parents feel for the human capital accumulation of their offspring ($\phi = 1.375$) is close to the value of 1.37 calibrated by Blankenau and Youderian (2012). This is supported by comments by Keane and Wolpin (2001), Johnson (2012), and Lochner and Monge-Naranjo (2012) pointing out the high parental valuation of children’s education given that the young would not attend college without attendance-contingent transfers by their parents even if credits were abundant.

\subsection{Performance beyond targets}

The model does not only perform well at replicating targeted moments, but also comes close to a range of other moments related to inequality and intergenerational mobility. The ratio of mean to median earnings is 1.29 compared to 1.34 in the data using only employed males between 18

\textsuperscript{18}According to a Sallie Mae-Ipsos Report in 2013 grants and scholarships pay for 30% of costs of college attendants.
and 64 of the IPUMS 2011. For male earnings in 2005 Heathcote et al. (2010) determine the P50/P10 percentile ratio to be 2.31 compared to 2.54 in the calibration, and the P90/P50 percentile ratio to be 2.33, close to 2.23 in the benchmark economy. Jäntti et al. (2006) estimate the mobility trace index at 0.86 in the US. In the benchmark economy the mobility trace index is 0.89, marginally higher than the value obtained by Jäntti et al. (2006).

Additionally, I compare a 3x3 matrix of intergenerational transition probabilities between earnings terciles of the model to those I obtain using fathers and sons of the PSID between 2000 and 2008. Correcting for lifecycle effects by taking the residuals of a regression controlling for age and age square and year fixed effects, and then averaging observations over various years, I find, as displayed in Table 4, that persistence is especially high at the bottom and the top, where about half of all sons end up in the same earnings tercile as their father. Comparing the data to the transition matrix obtained for the benchmark case, one can see that the model replicates intergenerational dynamics accurately. While for fathers in the bottom earnings tercile it matches the data closely, it benignly overestimates persistence for sons who’s fathers are in the top tercile, where 54% end up in the same cell as their father, compared to only 50% in the data. For sons of the middle quintile the model overestimates downward mobility, which is due to the punishing effect of dropping out of college.

\[ M_T = \frac{5 - tr(P)}{5 - 1} \]

where \( tr(P) \) is the trace of the matrix \( P \). The index is bound below by zero and is increasing in mobility.

Table 4: Earnings transition matrix

<table>
<thead>
<tr>
<th>Father</th>
<th>Data</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bottom</td>
<td>Middle</td>
</tr>
<tr>
<td>Bottom tercile</td>
<td>.48</td>
<td>.34</td>
</tr>
<tr>
<td>Middle tercile</td>
<td>.30</td>
<td>.37</td>
</tr>
<tr>
<td>Top tercile</td>
<td>.21</td>
<td>.29</td>
</tr>
</tbody>
</table>

Note: The left panel is calculated using permanent earnings of fathers and sons of the PSID between 2000-2008.

6.1.1 Credit constraints

In Figure 5 the correlation between parental earnings and college attendance and completion becomes apparent. The model accurately replicates the pattern of college attendance conditioned on the parental earnings quintile determined by Bailey and Dynarski (2011) using the National Longitudinal Survey of Youth (NLSY). In the data more children of the bottom quartile drop
out of college, which could be linked to two causes. First, despite the finding of Stinebrickner and Stinebrickner (2007) that dropout is usually explained by ability, as implemented in the model, financial constraints tightening during college attendance might force some students to drop out. Second, in the model abilities and completion probabilities are perfectly known, whereas in reality some students might realize that they are not prepared for college once they are actually attending college.

![Graph showing data vs model of college attendance and completion rates](image)

Datasource: Bailey and Dynarski 2011

Fig. 5: Data vs model of college attendance and completion rates (y-axis) by parental earnings quartile (x-axis)

In order to determine the share of individuals that are credit constrained in their college decision I use the methodology of Carneiro and Heckman (2002). They define as credit constrained the sum of the gaps between the percentage of the highest income quartile enrolled for each ability tercile and the percentage enrolled in the remaining income quartiles of the given ability tercile. When undertaking the same exercise in terms of acquired ability the model exhibits a large share of 23.2% of credit constrained individuals, compared to only 5.2% identified by Carneiro and Heckman (2002) using a sample of white males of the 1979 cohort of the NLSY.
Belley and Lochner (2007), using the NLSY97, find that family income has become a much more important component of the college enrollment decision in the recent past. Given that tuition costs have more than doubled in real terms since the 80’s this is not a surprising development. Recent estimates using the same approach have increased to 16.6% (Bohacek and Kapicka 2012), 24% (Winter 2013), and an upper bound of half of all children (Brown, Scholz, Seshadri 2012). In the benchmark economy the same exercise in terms of innate ability instead of acquired ability, reveals that 27.5% of individuals are credit constrained in their college decision when one does not condition on early investments. In Figure 11 in the Appendix one can see how early investment increases with innate ability and parental earnings.

6.2 The role of political economy

With few exceptions (e.g., Ichino et al. 2010), the relationship between inequality and mobility is analyzed in isolation from the political economy. In order to develop a better understanding of the underlying mechanism, I illustrate voter preferences by age and earnings. In the left panel of Figure 6 the aggregate utilities as a function of $\tau_p$ of young and old households are displayed. For old households there is no gain from investment in early education, hence their utility is strictly decreasing in $\tau_p$. For young households public early investment is beneficial due to its effect on their children, however at a decreasing rate. At some point the substitution effect of own earnings outweighs the benefits from the additional education investment and aggregate utility of the young household begins to decline. The aggregate utility of old households as a function of $\tau_q$ is presented in the right panel of Figure 6. Aggregate utility of the old is increasing until the function has a kink where tuition costs of all college attendants can be fully covered by the revenues, after which it is strictly decreasing.

In Figure 7 the utility of the 10th to the 90th earnings percentile by varying innate ability levels of the offspring is shown as a function of $\tau_p$. The calculations are made given steady state private investments in early education, which is important because public and private education are substitutes. Comparing the trajectories for a low (top left panel) and a lower medium (top right) ability child, one can tell that parents of low ability children with earnings in the bottom tercile are less responsive to increases in $\tau_p$ than parents of children with slightly higher ability. This is due to low returns to investments in low ability children. For wealthier parents this is not

20The share of potentially credit constrained children estimated by Brown et al. (2012) is so high due to the assumption that not all parents are willing to contribute the expected amount according to the expected family contribution schedule, which is used as a guide for the calculation of individual financial aid.
Fig. 6: Aggregate utility of households as a function of $\tau_p$ (left) and $\tau_q$ (right).

necessarily the case because they have already allocated private funds to the child’s education, wherefore marginal returns to investment are lower. In the bottom right panel, where children are of high ability, one can see that the poorest deciles are still in favor of a higher $\tau_p$. This means that even when children are of high ability poor parents are still underinvesting in their children despite the high returns.

6.2.1 What if the college premium changes in the US?

Many argue that the digital revolution caused the rise in the college premium through a skill-biased demand shift combined with globalization (e.g., Katz and Murphy 1992, Krusell, Ohanian, Rios-Rull, and Violante 2000, Acemoglu 2002, Hornstein, Krusell, and Violante 2005). Given that both, technological development and globalization remain dynamic, further shifts in the college premium could take place. In order to demonstrate the effects of voting, exogenous movements of the college premium parameter $\bar{\theta}$ from 1.21 to 1.41 are simulated. The effects on intergenerational earnings persistence are illustrated in the left panel, and on earnings inequality in the right panel of Figure 8, where the dashed line represents the trajectory when taxes are fixed as in the benchmark model and the solid line displays what happens when taxes are voted on.
When the college premium declines, college enrollment decreases and the composition of college attendants changes. Fewer less well off households send their kids to college as the prize of the college lottery diminishes. Therefore, public support for college subsidies wanes. When the college premium is low, richer households do not have high incentives for investing in education, thus intergenerational earnings persistence decreases. Also rich households are not as rich, hence the distance and the incentive effect lead to a reduction in intergenerational earnings persistence. However, these reducing forces are countered by a lower chosen tax rate for early education. As a consequence the intergenerational earnings persistence is only 4% lower than in the benchmark case.

An exogenous increase in the college premium acts as a boost to the economy. The chosen tax rate $\tau_p$ dedicated to early public education increases. Thereby, the improved early education combined with the higher payoffs of college completion augment the share of college attendants. Given that amongst those entering, many are from less well off households, people vote for higher college subsidies, hence increasing the fraction of college students receiving
grants and thereby alleviating the barriers to access. The effect of enrollment on increased public financing has been emphasized by the political science literature (e.g., Ansell 2010, where it is shown that in a range of countries left-leaning parties only started supporting public expenditures on tertiary education after more children from poorer families began attending college). The intergenerational earnings persistence drops down to 0.31 when $\theta$ takes its maximum value of 1.41, while the Gini declines only marginally to 0.37.

This simulation exhibits, though, that the general assumption of a positive relation between returns to tertiary education on the one side, and inequality and intergenerational earnings persistence on the other, does not hold when public expenditures are determined through voting. During an interval where incentives for investment increase and poorer households suffer from credit constraints, intergenerational earnings persistence and inequality increase. Then they peak before returns become so high that it is worth taking the risk of enrollment for less well off individuals, after which the intergenerational earnings persistence and the Gini decline.

I compare these outcomes to simulations where the tax rates are fixed as in the benchmark model. Here we do not observe the large decline in intergenerational earnings persistence when
the college premium increases. However, at the highest simulated college premium intergenerational persistence decreases marginally, due to increased incentives for less wealthy households to dedicate a large share of their earnings to college tuition.

In order to decompose this effect I simulate the exogenous variations in the college premium while allowing households to vote only on one single stage of public education financing in isolation, as displayed in Figure 21 in the Appendix. For a lower college premium voting has a smaller impact, whereas considerable differences emerge towards the maximum value of $\bar{\theta}$. When only allowing for voting on college subsidies intergenerational earnings persistence reduces to 0.38, whereas it decreases to 0.36 when only permitting voting on early education. Therefore, 4% of the drop the political economy in earnings persistence can be attributed to the endogenous changes in public financing of late education alone, while 32% can be accomplished by endogenous changes in early education. This decomposition highlights the importance of sound coordination of reforms in early and late education, as the increases in public subsidies at both levels combined allow for a multiplicator effect, which decreases intergenerational earnings persistence by three times the amount compared to when public subsidies at only one level are adjusted endogenously.

Pre-tax earnings inequality is affected less by the inclusion of voting on taxes. For the largest value of the college premium the Gini decreases by 4% compared to no voting, with only a small difference to when individuals only vote on one of the levels of education financing.

### 6.2.2 Voting policy experiments in the US

Voter turnout in the US is lower and more skewed towards the educated than in most OECD countries. Therefore, one possible policy to counter this would be compulsory voting, as already exists in a number of countries (e.g., Argentina, Australia, Brazil, Peru). I simulate the policy experiment by imposing mandatory voting for all. If everybody were to cast their vote, public education funding of early education would increase from 4.4% to 5.2% of GDP and financial aid expenditures on college would augment from 0.25% to 0.28% of GDP, providing financial aid to 59% of the college students, who would account for 66% of the population. As a consequence the Gini reduces marginally to 0.37, whereas earnings persistence drops to 0.36.21 Another policy, which recently has received attention in the public debate, is the extension of

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21 This is not to claim that these changes would be immediate, as surely politicians would take time to identify preferences of the electorate, which would take several elections.
electoral franchise to children as of birth.\textsuperscript{22} The practical implementation discussed would include parents voting for their children. I simulate this by doubling the benchmark voting weight of young parent households.\textsuperscript{23} As a result inequality reduces to a Gini of 0.36, whereas intergenerational mobility surges due to the increases in public early education expenditures, thus reducing earnings persistence to 0.21.

7 Cross-country differences

As visible in the “Great Gatsby Curve” inequality and intergenerational mobility are negatively associated across countries. In order to identify potential drivers of this relationship I conduct experiments exploiting cross-country differences in voter turnout and tertiary education characteristics jointly and in isolation.

7.1 Voter turnout

To decompose the drivers of cross-country differences in inequality and intergenerational mobility, I run the simulations with the US benchmark specification while only adapting one of the explanatory factors separately, either the voting weights or the characteristics of tertiary education. Voter turnout shows strong variations across age groups and levels of education across countries. I am agnostic here on whether this is due to culture or political institutions.\textsuperscript{24} I use this variation to adjust the voting weights in the probabilistic voting process and explain differences in individual earnings inequality and intergenerational earnings persistence. The voter turnout by age group and education is determined using the ESS 2010 for European countries and the Canadian Election Study 2010 for Canada, as displayed in the Appendix in Table 10, and assign these weights to the respective age groups and education levels in the probabilistic

\textsuperscript{22} The extension of franchise to children is commonly referred to as “Demeny voting”, named after Paul Demeny, the author of a paper suggesting half a vote for children to counter low-fertility (Demeny 1986).

\textsuperscript{23} This is debatable given that increased voting weight raises incentives to vote, which thereby could feedback into turnout of young parent households as well. Given that voter turnout is not modelled in the framework, I refrain from speculating about the magnitude of the possible increase in turnout among young parents.

\textsuperscript{24} There is strand of literature attempting to explain cross-country differences in voter turnout and specifically low turnout in the US (e.g., Wolfinger and Rosenstone 1980, Powell 1986, Jackman 1987, Blais 2000, Perea 2002). General explanations for cross-country differences range from legal differences, such as compulsory voting or voting facilitation through postal or advanced voting, organizational factors and electoral systems, such as number of parties, party-group alignment, and proportional representation, and population size. Specifically concerning the US there seems to be consensus that the complexity of registration is one reason for the low turnout. Blais (2000) summarizes that there is a lack of solid explanations and there are few robust findings, which explain cross-country differences, with compulsory voting being an exception. So far neither theoretically nor empirically has anybody found a consistent answer to the voting paradox.
Voting turnout alone on average explains 21% of the difference in the Gini and 23% of the difference in intergenerational earnings persistence to the US. The results are summarized in Table 5 and in Figures 14, 15 and 16, in the Appendix. The model performs well in terms of replicating data moments of the Gini, intergenerational earnings persistence, and public expenditures on non-tertiary and tertiary education. In the following the results of each country are specified.

The Swedish society is characterized by a relatively low intergenerational earnings persistence of 0.27 (Corak 2012) and a pre-tax Gini of individual earnings of 0.32 (Domeij and Floden 2010). Swedes of all age groups are similarly likely to vote, and voter turnout is not biased towards the highly educated as in the US. This voting pattern causes an increase of $\tau_p$ from 4.4% in the benchmark case to 5.3%, while $\tau_q$ increases from 0.26% to 0.37%. These higher levels of public education funding decrease the intergenerational earnings persistence by 10% to 0.35 and the Gini to 0.37. Thereby, the voter turnout can explain 28% and 7% of the gaps between Sweden and the US in earnings persistence and inequality, respectively. These improvements in inter- and intragenerational equity are accompanied by a 4% increase in aggregate consumption. In Sweden inequality increased over the 90’s, however to a lesser extent than in the US. Similarly, intergenerational mobility remains high despite increases in earnings inequality. The model indicates that the political economy, and more specifically voter participation, might be able to explain why the increase in the skill premium in the 90’s had a less harsh effect on inequality and mobility in Sweden than in the US.

In the United Kingdom the Gini of individual earnings is 0.383 (OECD 2011b), while the intergenerational earnings persistence is estimated to be 0.31 (Jäntti et al. 2006). In the UK voter turnout is increasing in age and education, but the bias is relatively lower than in the US. The simulation reveals an earnings persistence of 0.35 accounting for 40% of the gap. The Gini only drops to 0.37, but this accounts for 66% of the difference in inequality between the UK and the US. Canada has a Gini of 0.37 (OECD 2011b) and a relatively low earnings persistence of 0.21 (Corak 2012). Voter turnout patterns are capable of explaining 19% of the difference in earnings persistence to the US and 23% of the difference in earnings inequality. Denmark is amongst the most equal countries and has the lowest intergenerational earnings persistence of the OECD. The Gini of individual pre-tax earnings is estimated to be 0.294 (OECD 2011b), while the intergenerational earnings persistence is 0.15 (Corak 2012). In Denmark voter turnout
is relatively high across all age groups and levels of education resulting in a Gini of 0.37 and intergenerational earnings persistence of 0.35, accounting for 6% and 19% of the gaps, respectively. Norway has a similarly low level of intergenerational earnings persistence of 0.17 (Corak 2012) and a Gini of 0.35 (OECD 2011b). In Norway voter turnout explains 10% of the difference in inequality and 13% of the difference in intergenerational earnings persistence. Finland matches the pattern of the other Scandinavian countries with a pre-tax earnings Gini of 0.31 (OECD 2011b) and an intergenerational earnings persistence of 0.18 (Corak 2012). For the case of Finland voter turnout patterns can account for 3% and 12% of the respective gaps.

In Germany the pre-tax earnings Gini is estimated to be 0.37 (Fuchs-Schuendeln, Krueger, and Sommer 2010) and the intergenerational earnings persistence is 0.32 (Corak 2012).25 Both values are in the middle of the distribution of OECD countries. Voting participation in Germany is biased towards the older and more educated, but not to such an extreme extent as in the US. As expected the publicly chosen education expenditures as well as the Gini and intergenerational earnings persistence are in the middle range, closing 29% and 33% of the gaps, respectively

Table 5: Counterfactuals (voter turnout)

<table>
<thead>
<tr>
<th>Country</th>
<th>Intergenerational elasticity</th>
<th>Gini</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Data</td>
<td>Model</td>
</tr>
<tr>
<td>US</td>
<td>.40</td>
<td>.385</td>
</tr>
<tr>
<td>Sweden</td>
<td>.27</td>
<td>.348</td>
</tr>
<tr>
<td>UK</td>
<td>.31</td>
<td>.350</td>
</tr>
<tr>
<td>Canada</td>
<td>.21</td>
<td>.349</td>
</tr>
<tr>
<td>Denmark</td>
<td>.15</td>
<td>.34</td>
</tr>
<tr>
<td>Norway</td>
<td>.17</td>
<td>.355</td>
</tr>
<tr>
<td>Finland</td>
<td>.18</td>
<td>.358</td>
</tr>
<tr>
<td>Germany</td>
<td>.32</td>
<td>.358</td>
</tr>
</tbody>
</table>

Note: The share of a gap between a data moment in the US \(d_{US}\) and another country \(d_{country}\) explained by moments \(m_j\) produced by the model, is calculated using the following definition:

\[
\Delta = \frac{(m_j - m_{country})}{(d_{US} - d_{country})}
\]

7.2 Tertiary education and voter turnout

Countries are characterized by varying types of tertiary education. Roughly labeling the countries included in the analysis into the categories defined by Ansell (2010), the Scandinavian

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25 In Germany tuition costs vary strongly by state, which is why Germany is excluded from the simulation with tertiary education characteristics.
countries and Canada could be considered as mass public, the US, and the UK as partially private, and neither as an elite tertiary education system.\textsuperscript{26} Using data from the OECD (2012, 2013) I calculate the college premium and tuition costs relative to the US, which are displayed in Table 8 in the Appendix, and assign them as exogenous factors in the model.\textsuperscript{27} Then I calibrate the model while targeting dropout rates of each country via $\psi_0$, a parameter of the college completion probability function, and enrollment via the dropout premium $\theta$. Expenditures on early education and, for those countries with non-zero tuition costs, financial aid is determined endogenously via probabilistic voting given country-specific voter turnout, which is in Table 10 of the Appendix and discussed in further detail in section 7.1.\textsuperscript{28} On average I find that the differences in tertiary education and voter turnout combined can explain 71\% of the differences in inequality compared to the US and 29\% of the gaps in intergenerational earnings persistence. The results are summarized in Table 6 and Figure 9. The high correlations of 0.67 and 0.83 between data and model moments in terms of the Gini and intergenerational earnings persistence, respectively, are illustrated in Figure 12 in the Appendix.

In Sweden college access is free of tuition costs and is rewarded with one-third of the premium of the US. I find that differences in the characteristics of tertiary education and voter turnout explain 38\% of the difference in intergenerational earnings persistence, which drops to 0.34, and 62\% of the gap in the Gini, which reduces to 0.33.\textsuperscript{29} In the United Kingdom the college premium is relatively high and about three-quarters of the US college premium, whereas average tuition costs are nearly half as cheap. While 29\% of the gap in intergenerational earnings persistence is explained, the gap in inequality is fully accounted for. Canada’s average tuition costs for tertiary education are about 40\% of those of the US (Belley, Frenette, and Lochner 2011), while the college premium is about half as high as in the US (OECD 2013). Also the dropout rates are substantially lower at around 30\% (Finnie and Qiu 2008). The model estimates inequality to be 0.35, which is even lower than it actually is in Canada, thereby covering the entire gap. Intergenerational earnings persistence drops to 0.34 explaining 24\% of the difference.

\textsuperscript{26}Elite tertiary education system are more prevalent in low and middle income countries with high inequality, such as Chile, Brazil, or Mexico.
\textsuperscript{27}Since not all the data for Canada is available in the OECD report I obtain them from the literature.
\textsuperscript{28}Since financial aid in the model is a tuition discount, there is no point in voting on financing of college education when tuition costs are zero.
\textsuperscript{29}The share of a gap between a data moment in the US $d_{US}$ and another country $d_{country}$ explained by moments $m_j$ produced by the model, is calculated using the following definition:

$$\frac{(m_{US} - m_{country})}{(d_{US} - d_{country})}.$$
In all Scandinavian countries tuition is free and, except for Finland, the college premium is about one-third of the US. In Denmark tertiary education combined with the patterns of voter turnout accounts for 17% of the difference in intergenerational earnings persistence and 40% of the gap in the Gini between Denmark and the US. Both, Gini and earnings persistence, diminish to 0.34 in the simulation. In Norway 22% of the gap in earnings persistence and the entire difference in earnings inequality are explained by the simulation. In Finland the college premium is nearly two-thirds of the US, and hence the model closes only 23% and 18% of the gaps in inequality and intergenerational earnings persistence, respectively.

7.3 Tertiary education

In order to isolate the importance of tertiary education I simulate the economy with the voting weights of the US, but the country-specific characteristics of tertiary education. The results are summarized in Table 6 and Figure 17 in the Appendix. For all countries the Gini is lower than when only using country-specific voter turnout, and therefore the gap in earnings inequality is
Table 6: Counterfactuals (tertiary education and voter turnout)

<table>
<thead>
<tr>
<th>Country</th>
<th>Data</th>
<th>Ter.&amp;Vote</th>
<th>Δter.&amp;vote</th>
<th>Tertiary</th>
<th>Δter.</th>
<th>Data</th>
<th>Ter.&amp;Vote</th>
<th>Δter.&amp;vote</th>
<th>Tertiary</th>
<th>Δter.</th>
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<td>.385</td>
<td>.385</td>
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<td>Norway</td>
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<td>.20</td>
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</tbody>
</table>

Note: The column “Ter.&Vote” refers to results where country-specific voter turnout and tertiary education characteristics are varied, whereas the column “Tertiary” refers to results where only country-specific characteristics in tertiary education are varied. The share of a gap between a data moment in the US \( d_{US} \) and another country \( d_{country} \) explained by moments \( m_j \) produced by the model, is calculated using the following definition:

\[
\Delta = \frac{(m_{US} - m_{country})}{(d_{US} - d_{country})}.
\]

\( \Delta_{ter.&vote} \) and \( \Delta_{ter.} \) refer to the share of the difference explained by voting as well as tertiary education, and tertiary education, respectively.

closed to a larger extent. On average 65% of the differences in the Gini and 21% of the differences in intergenerational mobility are accounted for by characteristics of tertiary education. Concerning the intergenerational earnings persistence, varying levels of education expenditures at the two education stages caused by differences in voter turnout seem to be of a greater importance than the characteristics of tertiary education in some cases. In Canada, Norway, and Sweden tertiary education contributes more to the lower intergenerational elasticity than voter turnout, whereas in Denmark, Finland, and the UK the opposite is the case. In Denmark, Norway, and Sweden, where access to college is free and the premium is relatively low, the model exhibits the lowest levels of earnings inequality, as is the case in the data.

8 Robustness check

The educated are more likely to participate in a range of political activities such as signing petitions, attending meetings, writing to congress, or contributing to campaigns (Schlozman et al. 2012). As a robustness check to the voter turnout experiment I instead use variations in party membership. Party members spread political propaganda, mobilize voters, and form and shape agendas.\(^{30}\) Ichino et al. (2010) find that across countries intergenerational mobility is positively associated with party membership of the poor relative to the rich. I use the first, third, and fifth wave of the World Values Survey to determine the membership rate (active as well as inactive) by age group and level of education to assign these shares as weights, as displayed in Table 10 in the Appendix, in the probabilistic voting process. Including all countries, on average weight-
ing voters by party membership propensity explains 3% of the difference to the Gini and 14% of the difference to intergenerational earnings persistence to the US, whereas if we exclude the UK these shares increase to 12% and 22%, respectively. The results are summarized in the Appendix in Table 9 and in Figures 18, 19, and 20.

In the US the share of individuals that are active or inactive members of a political party is highest among the countries examined. However, once again participation is biased towards the older and more educated. This causes intergenerational earnings persistence to increase slightly compared to the benchmark model due to public early education decreasing to 4.1% of GDP, which is even closer to the 3.9% in the data. The share of subsidies to college education remain unchanged, while earnings inequality experiences a benign increase.

In Sweden there is hardly a bias in party membership by age, and contrary to other countries, particularly the highly educated are less likely to be party members. This results in high subsidies to early and late education decreasing earnings persistence to 0.35 and the Gini to 0.37, thereby closing 34% and 10% of the gaps to the US, respectively. In Germany party membership is unusual. The relative membership propensity explains 30% of the difference in intergenerational earnings persistence and 17% in earnings inequality.

In the UK the old and educated are relatively more likely to be party members than in the US. This leads to an increase in intergenerational earnings persistence and inequality, thereby increasing the differences to the US. In Canada 11% of the gap to the US is closed, as well as 14% of the difference earnings inequality. In Norway party membership is not habitual, but more common among the older, yet there is no recognizable bias towards the more educated. The patterns of party membership in Norway account for 9% of the gap in inequality and 11% of the gap in intergenerational earnings persistence.

9 Conclusions

I calibrate a model characterized by dynamic complementarity between early and college education to the US economy. Households vote on tax rates dedicated to the funding of each education level. The model performs well at replicating the US economy across several dimensions including inequality, intergenerational mobility, the share of GDP dedicated to early education, and financial aid to college students. In addition, the model matches details not targeted, such as
the intergenerational earnings transition matrix and college attendance by earnings quartile. In
the benchmark economy almost one in four individuals is financially constrained in the college
decision and mobility is found to be low at the top and the bottom of the earnings distribution.

The negative relation between inequality and intergenerational mobility observed in the
data is replicated by the model when simulating with country-specific characteristics of ter-
tiary education. I find that differences in tertiary education can account for 65% of the gaps
in earnings inequality and 21% of the gaps in intergenerational earnings persistence between
the US and Canada, Denmark, Finland, Norway, Sweden, and the UK. When controlling for
country-specific voter turnout by age and level of education in the probabilistic voting process,
the negative association between inequality and public expenditures on education observed in
cross-country data is reconciled. Political participation in form of voter turnout explains nearly
one-quarter of the differences in inequality and intergenerational earnings persistence. As a
robustness check, I assign voting weights according to party membership by age and education
obtaining similar results.

Concerning voting policies in the US, I find that compulsory voting would reduce earnings
persistence by one-tenth, whereas extending electorate franchise to children as of birth and let-
ting their parents vote for them would nearly halve the share of earnings transmitted across
generations. However, the effects of these policies on inequality are found to be comparably
low.

Simulations with an exogenous increase in the college premium in the US exhibit a non-
linearity in the otherwise negative relation between inequality and mobility, a characteristic not
identified in models that ignore the political economy. The incentives for poorer households to
enroll their children in college increase, driving broader public support for college subsidies,
as stressed by the political science literature. This raises aggregate returns to early education
through the dynamic complementarity between the two educational stages, thereby increasing
public funding to early education, hence increasing mobility further.

The model neglects pre-primary education and abstracts from savings and borrowing deci-
sions, which play a role in college financing, thereby providing fruitful areas for future research.
References


Noncognitive Skills, Ability and Education. The Economic Journal, 117(519), C43-C60.


ESS Round 5: European Social Survey Round 5 Data (2010). Data file edition 3.0. Norwegian Social Science Data Services, Norway - Data Archive and distributor of ESS data.


Finnie, R., and Qiu, T. (2008). The Patterns of Persistence in Post-Secondary Education in Canada:
Evidence from the YITS-B Dataset. Educational Policy Institute.


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## Appendix

Table 7: Voting patterns US 1996-2006

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<th>Age</th>
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Table 8: Tertiary education characteristics

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<th>Completion</th>
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Datasources: College premium OECD 2013 Table A6.1, Tuition OECD 2012 Table B5.1 (for Canada: Belley et al. 2011), Enrollment OECD 2012 Table C3.3, Completion rates OECD 2011a Table A4.1 (For Canada: Finnie and Qiu 2008).

Note: The relative college premium $\tilde{c}_j$ of country $j$ is calculated by comparing the college premium $c_j$ to $c_{US}$ in the following manner: $\tilde{c}_j = \frac{c_j}{c_{US}} - 1$. Then $\bar{\theta}_j = 1 + \tilde{c}_j (\bar{\theta}_{US} - 1)$.

Table 9: Counterfactuals (party membership)

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<th>Gini $\Delta_{explained}$</th>
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Note: The share of a gap between a data moment in the US $d_{US}$ and another country $d_{country}$ explained by moments $m_j$ produced by the model, is calculated using the following definition:

$$\Delta_{explained} = \frac{m_{country} - m_j}{d_{US} - d_{country}}.$$
Table 10: Voting weights based on voter turnout and party membership

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<th>Age*</th>
<th>Voter turnout</th>
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*Age at time of elections
Fig. 10: Turnout ratio of college graduates to those that did not attend college aged 18-65 versus public expenditures on early (left) and college (right) education.
Fig. 11: The share of parental earnings allocated to private early education as function of innate ability and parental earnings

Fig. 12: Comparing model moments with country-specific tertiary education and voter turnout by age and education and data moments of the Gini (left) and intergenerational earnings persistence (right)
Fig. 13: Comparing model moments with voter turnout by age and education (red) with data moments (blue) of the Gini versus intergenerational earnings persistence

Fig. 14: Comparing model moments with country-specific voter turnout by age and education (blue) and data moments (red) of the Gini versus public expenditures (% of GDP) on non-tertiary (left) and tertiary (right) education
Fig. 15: Comparing model moments with country-specific voter turnout by age and education and data moments of Gini (top left), intergenerational earnings persistence (top right), and public expenditures (% of GDP) on non-tertiary (bottom left) and tertiary (bottom right) education.

Fig. 16: Comparing model moments with country-specific tertiary education (red) and data moments (blue) of the Gini versus intergenerational earnings persistence.
Fig. 17: Comparing model moments with country-specific tertiary education and data moments of the Gini (left) and intergenerational earnings persistence (right).

Fig. 18: Comparing model moments with country-specific party membership (red) and data moments (blue) of the Gini versus intergenerational earnings persistence.
Fig. 19: Comparing model moments with country-specific party membership by age and education moments (red) with data moments (blue) of the Gini versus public expenditures (% of GDP) on non-tertiary (left) and tertiary (right) education.
Fig. 20: Comparing model moments with country-specific party membership by age and education with data moments of the Gini (top left), intergenerational earnings persistence (top right), and public expenditures (% of GDP) on non-tertiary (bottom left) and tertiary (bottom right) education.

Fig. 21: The effects of voting on early and/or late education on the intergenerational earnings persistence.