Quality, Inequality, and Mobility: American vs. Canadian Systems of Higher Education*

Jacob Wright†
Princeton University

September 2026

Abstract

While the United States and Canada share many similarities, there are stark differences in their levels of income inequality and intergenerational earnings persistence. This paper investigates college quality distributions, tuition subsidies, student loan systems, and tax policies as potential sources of these differences. A heterogeneous agent model is developed where human capital investments occur over the lifecycle and across generations. The model is calibrated to the U.S. economy and matches key moments on intergenerational mobility, lifetime inequality, and higher education. The benchmark exercise finds that the system of higher education accounts for approximately 22% of the differences in income inequality and 11% of the differences in intergenerational mobility between the U.S. and Canada. The distribution of college qualities drives the majority of the inequality difference attributable to the system of higher education, whereas its net effect on intergenerational mobility is small.

JEL Codes: I2, E24

*A special thanks to Ellen McGrattan and Todd Schoellman for their invaluable guidance. I also thank Anmol Bhandari, Kyle Herkenhoff, Jacob Hess, Loukas Karabarbounis, Hannes Malmberg, Youngmin Park, Pau Pujolas, Kurt See, Kjetil Storesletten, Alex Wurdinger, Angela Zheng, and seminar participants at the Bank of Canada, McMaster University, and Midwest Macro Meetings for many helpful comments and discussions.

†email: jw0802@princeton.edu. website: jacob-wright.me.

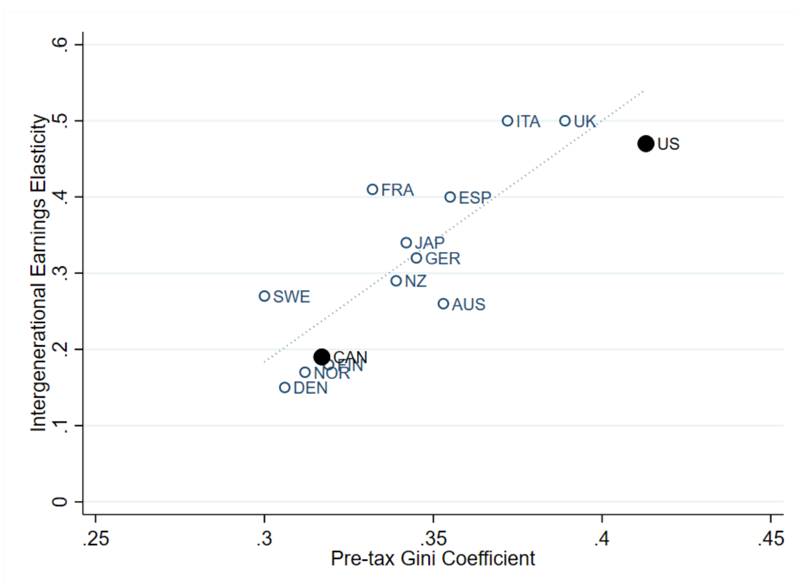
1 Introduction

Income inequality and intergenerational earnings persistence vary widely across developed countries. *Figure 1* depicts the "Great Gatsby Curve" for 14 developed countries, with intergenerational earnings elasticity plotted against the pre-tax Gini coefficient. Countries like the United Kingdom and the United States represent the far upper-right end of the curve. At the other end are the Nordic countries and Canada.

Despite exceptionally similar economic structures and levels of development, the U.S. and Canada exhibit striking differences in inequality and intergenerational mobility. Intergenerational earnings elasticity (IGE) is more than twice as high, and income inequality is more than 30% higher, in the United States than in Canada. Using these two countries as a unique test case, this paper studies the determinants of inequality and IGE across countries.

Public policies are a natural starting point for investigating the sources of these across-country differences. A large body of empirical literature has documented an intimate link between college attendance, lifetime earnings, and upward economic mobility.[1] The core research question in this paper is: "How does government subsidization of higher education affect inequality and intergenerational mobility?" To answer this question, I quantify the extent to which differences in higher education between the U.S. and Canada can account

Figure 1: **Intergenerational Mobility and Pre-tax Income Inequality Across Countries**



Notes: Pre-tax Gini coefficients are taken from the OECD for 2020. Intergenerational earnings elasticity is from Corak (2013), and is calculated by regressing the log of son earnings on the log of father earnings.

[1]See Chetty et al. (2020) or Corak (2013) for two examples most closely related to this paper.

for observed differences in inequality and intergenerational mobility. Specifically, I focus on two key differences: how college is financed and the distribution of college quality.

The system of higher education in the United States is one where the government pays relatively less than in Canada. Each full-time equivalent (FTE) student costs the Canadian taxpayer 40% more than the U.S. taxpayer. Conversely, the system of higher education in the United States is one where the household pays relatively more than in Canada. Conditional on sending a child to college, average household expenditures (adjusted for GDP per capita) on education are more than twice as high in the United States as in Canada.[2]

The sum of private and public expenditures also differs in important ways across these two countries. On average, approximately 50% more is spent per FTE on higher education in the U.S. than in Canada. However, the median amount spent per FTE is higher in Canada than in the United States. *Figure 2* plots the entire distribution of total college spending per FTE. The Canadian distribution is significantly tighter. There are fewer colleges spending small amounts per student, and no colleges spending the very large amounts per student observed in the United States. While there are many similar measures, spending per FTE is a proxy for college quality.[3]

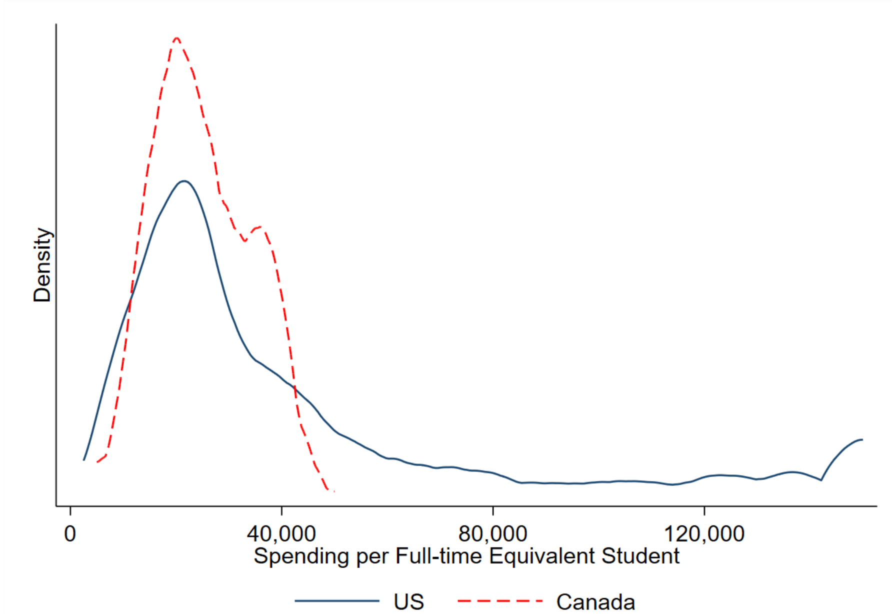
Quantitative cross-country work on higher education, inequality, and mobility typically summarizes the sector by average resources per student (e.g., Herrington (2015); Holter (2015); Krueger and Ludwig (2016)), while a large empirical and structural literature studies financial aid, merit aid, and student loans (see Athreya et al. (2021) for a survey). One of the key contributions of this paper is that it investigates the extent to which the *entire distribution* of expenditures (or qualities) matters.

Transitioning from a system where the onus of payment falls on the household, as opposed to the taxpayer, has ambiguous effects on IGE and inequality. Consider an example involving changes to inequality. Suppose only high-ability agents attend college, but due to the presence of financial frictions, not *all* high-ability agents attend college. Lowering tuition costs could increase the number of high-ability students attending college but leave the number of low- to mid-ability students attending college unchanged. In this situation, income inequality will certainly rise. However, if instead we had only agents with high parental income (of all ability levels) attending college, subsidizing the cost of education and allowing more agents of all income levels to attend college would surely decrease inequality. The benchmark U.S. economy is a mixture of these two cases, with both sorting by income and ability. Moreover, it may be that, due to the presence of a high variance in college quality in the United States, *regardless* of subsidization levels, inequality will always *persist*.

[2]See *Appendix A.1* for a more detailed comparison of college financing across the U.S. and Canada.

[3]*Section 3.1.1* discusses precisely what college quality is, both in the context of the model and the data.

Figure 2: **Distribution of Total Expenditures per FTE, Across Colleges and Countries.**



Notes: Dollar amounts are expressed in 2017 U.S. dollars at purchasing power parity. Numbers exclude defense R&D expenditures, as defense R&D expenditures differ significantly between Canada and the United States. Data is taken from IPEDS for the United States and CAUBO for Canada.

As for intergenerational mobility, the presence of very high-quality colleges (as in the U.S.) allows a small number of low-income but high-ability students to move up the income distribution rapidly. However, a large mass of mid-quality colleges (as in Canada) allows a larger number of low-income but mid- and high-ability students to move up the income distribution modestly. Hence, the effects of college financing and quality on IGE and inequality are not clear *ex-ante* and must be analyzed quantitatively.

To that end, I develop a novel quantitative model that incorporates all key differences between the American and Canadian systems of higher education. Heterogeneous high school graduates face a country-specific menu of colleges, each with its own quality and tuition. Given income-contingent student loans and an endogenous inter-vivos transfer, a college attendance decision is made. Agents then make dynamic human capital investment decisions à la Ben-Porath (1967) over their lifecycle. The model allows for the possibility that college quality affects the level and growth of lifecycle wages. Intergenerational motives are modeled in the spirit of Becker and Tomes (1979). The model also incorporates important differences in progressive taxation across the U.S. and Canada; this taxation finances government expenditures on higher education.

The benchmark exercise involves calibrating the model to match key features of the U.S.

data. The model exactly matches moments on intergenerational earnings persistence and cross-sectional moments on inequality. It also accurately matches college attendance by college quality and reproduces lifetime earnings dynamics broken down by individual college qualities. Moreover, the model is able to generate many untargeted moments, such as the proportion of students attending college by parental income.

A counterfactual economy is then computed where the American tax function, tuition schedule, quality distribution, and student loan system are replaced with the Canadian counterparts. This exercise finds that approximately 22% of differences in income inequality and 11% of differences in intergenerational mobility between Canada and the United States can be accounted for by the system of higher education.[4]

The importance of explicitly considering the distribution of college quality becomes evident from the results of these accounting exercises. The distribution of quality accounts for 57% of the differences in inequality explained by the model. This implies that existing models that do not consider the distribution of college quality will underestimate the effects of the higher education sector on inequality. This result also suggests that regardless of tuition subsidies in the United States, if the variance in college quality remains large, inequality will persist. The effects of the quality distribution on IGE are small on net; however, they are subject to opposing forces.

A decomposition exercise shows that even after controlling for all other factors (ability, human capital, parental wealth, and student debt), the college quality distribution remains an important factor for determining inequality and IGE. This implies that the effects of college on lifetime outcomes are not driven exclusively by selection.

This paper relates to several strands of the quantitative literature that build upon a standard Huggett et al. (2011) or Lee and Seshadri (2019) style model. First, it connects to the literature analyzing college attendance decisions in the context of differing student loan systems. The most closely related work in this area is Matsuda and Mazur (2022), which explores the welfare implications of income-contingent loans (ICLs). The treatment of ICLs in this paper is most similar to their approach.

The present paper differs in a few important ways. My model features human capital

[4]The model is developed to isolate differences between Canada and the U.S. attributable to higher education. However, this approach ignores differences in education policies before the age of 18. Recent work shows that human capital formation at young ages is important for explaining later-life outcomes (Cunha et al., 2006; Carneiro et al., 2011; Caucutt and Lochner, 2020). In a robustness exercise, I test whether differences between Canada and the U.S. can instead be explained by initial distributions of human capital and learning ability. I find that these initial distributions are remarkably similar across the two countries, accounting for less than 3% of the differences in income inequality and essentially none of the differences in IGE. Moreover, I show that *no* initial distributions can rationalize the observed differences in IGE.

accumulation over the agent's lifecycle and across generations, allowing me to capture lifetime income dynamics that have important implications for the college attendance decision. Additionally, the model allows agents to endogenously choose debt levels. In Matsuda and Mazur (2022), a full student loan is exogenously given to any agent attending college, an assumption that is not without loss of generality.

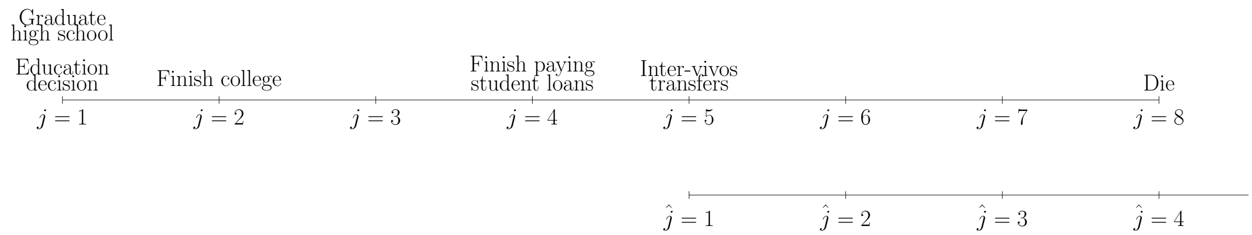
Second, this paper relates to the series of papers by Ionescu (2009), Ionescu (2011), and Ionescu and Simpson (2016), which incorporate lifecycle human capital accumulation decisions into a model of college choice and financing. Unlike these papers, the model developed here does not consider student loan risk or default. I will show that this assumption is innocuous when analyzing cross-country differences between Canada and the United States. To analyze cross-country intergenerational mobility, my model also includes progressive taxation and cross-generational linkages.

This paper closely relates to those studying the implications of education financing policies across countries. In particular, Herrington (2015) and Holter (2015) examine tax policies and government education expenditures as potential sources of across-country differences in intergenerational mobility. The most notable difference here is the rich modeling of student loans and college quality. There is also a broader literature quantitatively studying education tax and subsidy policies, as in Abbott et al. (2019) or Krueger and Ludwig (2016). I complement this literature along several dimensions, including an analysis of ICLs and the incorporation of lifecycle human capital accumulation.

Finally, this paper relates to work studying the implications of higher education policies on intergenerational mobility and income inequality, as in Hanushek et al. (2014) and Krueger et al. (2025). While there is also a larger structural literature on differentiated college quality, only the contemporaneous work of Capelle and Matsuda, 2025; Hendricks et al., 2025; Wright and Zheng, 2025 studies the effects of the college quality distribution on intergenerational mobility. Most similar is Hendricks et al. (2025), which examines how college admissions of low-income students affect IGE. They find that high-quality colleges are an important driver of upward mobility for low-income students. I differ from this work in terms of the research question, as I use the test case of Canada and the U.S. to explain cross-country differences in inequality and mobility. Additionally, my model differs significantly through the inclusion of student loans, a lifecycle consumption-savings decision, and cross-generational linkages.

There is also a small but growing literature featuring structural models of endogenous college quality (Wright, 2025; Wright and Zheng, 2025; Capelle and Matsuda, 2025; Cai and Heathcote, 2022; Epple et al., 2017). However, the objective of this paper is an accounting or decomposition exercise between the United States and Canada. Hence, I abstract from an endogenous modeling of college quality here.

Figure 3: **Lifecycle Timeline**



The remainder of this paper is organized as follows. *Section 2* lays out the quantitative model. *Section 3* describes the data and empirical analysis. *Section 4* calibrates the model. The results of the quantitative analysis are presented in *Section 5*. *Section 6* concludes.

2 Model

2.1 Timing, Demographics, and Preferences

Time is discrete and has an infinite horizon. One model period represents five biological years and is denoted by j. The economy is populated by a continuum of eight overlapping generations with a uniform demographic structure. Throughout, "hat" variables will denote the next generation (i.e. the current generation's "child") and "prime" variables will denote the next period in an agent's lifecycle. The model is developed in partial equilibrium. Only steady states are considered and so time subscripts are omitted throughout. *Figure 3* summarizes the phases of an agent's lifecycle.

The lifecycle of an agent begins at $j = 1$, (biological age 18) having just graduated high school and becoming independent from their "parent". The lifecycle before age 18 is not modeled. At the beginning of period one, agents differ heterogeneously with respect to an ability level a, an initial level of human capital h, and some inter-vivos transfers from their parents b. The agent's initial state is characterized by the vector $\mathbf{x_1} = (a, h, b)$.

At this point, the agent observes a distribution of college qualities q, with corresponding net tuition schedule $nt(q, a, b)$ and ability cut off a_q. The individual then makes a one-off decision to attend college. If the agent chooses to attend college, they choose what quality of college to attend and the size of the student loan to acquire, d. If the agent chooses to attend college, they cannot work. If the agent chooses not to attend college, they immediately enter the workforce and face a standard consumption/savings problem with endogenous human capital accumulation.

Agents are endowed with one unit of time in each period. Individuals do not value leisure but divide their time between market work and human capital accumulation. When an agent is in college they cannot work, and hence it is implicitly assumed they are devoting their entire time endowment to accumulating human capital.

At the beginning of period two, an agent's state is now characterized by $\mathbf{x}_2 = (a, h, b, q, d)$. The state b is now a general asset position of the agent. Ability level and college quality are static and remain fixed for the remainder of the lifecycle. From periods two to four inclusive, the agent repays their student loans.

In period five, the continuation value of a child enters the agent's decision problem, and an inter-vivos transfer decision to their child is made. Finally, at age $j = 8$, exogenous retirement/death is imposed.[5]

Newly born agents maximize expected lifetime utility according to,

$$\mathbb{E}_1 \left[\sum_{j=1}^{8} \beta^{j-1} u(c_j) + \beta^4 \theta \hat{V} \right]$$

where the period utility is given by the CRRA function $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$, with σ as the coefficient of risk aversion. The first term is the expected discounted sum of utility derived from own consumption c_j. The second term represents parental altruistic motives. Parents attach a weight θ to the expectation of their child's lifetime utility at age $j = 1$.

2.2 Human Capital and Ability

Agents are endowed with learning ability a. Ability is transmitted stochastically from parent to child by some transition function $\mathcal{A}(a, \hat{a})$.[6]

At age $j = 1$ the agent is endowed with an initial human capital which is drawn from some continuous distribution $H(\mu_{h_1}, \sigma^2_{h_1})$. Human capital is risky in the sense that agents do not know the size of their stock of human capital next period. This is interpreted as a market luck shock. The human capital production function is of the Ben-Porath (1967) form,

$$h_{j+1} = \epsilon_{j+1} \Big(a \cdot q \cdot (n_j h_j)^{\gamma} + (1 - \delta) h_j \Big) \tag{1}$$

where $n_j \in [0, 1]$ is the time spent accumulating human capital, $\delta \in [0, 1]$ is the period depreciation rate of human capital, ϵ_{j+1} is a market luck shock, and $\gamma \in (0, 1)$ is the elasticity of human capital production with respect to investment. The market luck shock is drawn

[5] I do not explicitly model retirement, nor allow for endogenous retirement ages. According to the OECD, average retirement age is 65 in both Canada and the United States.

[6] This assumption is standard and has been employed since at least Becker and Tomes (1979).

from an i.i.d. log-normal distribution with mean and variance μ_ϵ and σ_ϵ^2, respectively. Economically, market luck shocks act similarly to a persistent AR(1) shock to earnings, as in a standard Aiyagari model. An agent's pre-tax labor market earnings in period j are denoted as $e_j = wh_j(1-n_j)$, where w is an exogenously determined wage rate.[7]

The non-standard addition here is q, which represents college quality. q is normalized to one for agents who do not graduate college or attend college. Chetty et al. (2020) find that (controlling for observable characteristics) earnings levels and growth rates vary significantly across college qualities. Motivated by this finding, I model college quality as some factor which alters the growth of human capital over the agent's lifecycle. This is the same modeling of college quality as Hendricks et al. (2025) and Brotherhood et al. (2023) where the Roy-style model structure is able to capture selection forces. *Sections 3.1.1* and *4.2* will discuss this model assumption further, and *Section 5.1.2* reports results on the sorting versus quality mechanism.

During the calibration exercise I will allow for the parameter q to be calibrated to a value of one. Hence, results in this paper do not hinge on this modeling structure, as I am not assuming that college quality *must* affect the productivity with which an agent produces human capital. This parameter q will be used in the main accounting exercises to capture the effects of differences in college quality distributions between the U.S. and Canada.

Given that the objective of this paper (to a first-order) is to decompose differences between Canada and the United States, I model college quality exogenously. See Wright and Zheng (2025) or Capelle and Matsuda (2025) for examples of endogenous college qualities and the study of intergenerational mobility.

2.3 Colleges

As discussed in the previous section, a college quality enters the agent's human capital accumulation technology. The college also consists of an exogenously specified net tuition schedule and set of capacity constraints.

The capacity constraints are in the form of ability cut offs. That is, the set of college qualities an agent of ability a has access to is given by $\mathcal{Q}_a$.[8] There is no uncertainty over college admissions, and with probability one the agent is admitted to the college of their

[7] Endogenous post-schooling investment is the margin through which progressive taxation and income-contingent repayment distort human capital accumulation. Hence, it is central to the tax and loan counterfactuals rather than an ornament.

[8] An alternative formulation as in Wright and Zheng (2025) or Brotherhood et al. (2023) would be to define some admission score which is a function of ability and human capital. I use this assumption here as I am not studying the human capital formation process prior to college entry.

choosing, if their ability is above some threshold a_q. The net tuition function is defined as,

$$nt(q, a, b) = t(q) - g(q, b) - s(a) + f \tag{2}$$

where $t(q)$ is the sticker tuition price by college quality, $g(q, b)$ is all needs-based (non-repayable) financial aid by an agent's wealth level and quality of college, $s(a)$ is a merit-based scholarship by the agent's ability, and f is a fixed cost of attending college.[9] The net tuition function and ability cut offs are varied between Canada and the U.S. in the main accounting exercise.

2.4 Financial Markets

In this section I present a general formulation of a student loan and repayment system that is flexible enough to capture key differences between the American and Canadian systems. In *Section 3.2* I describe each country's system in detail and show how the formulation presented here maps to the data.

Markets are incomplete due to lack of state-contingent insurance against idiosyncratic productivity shocks. Individuals can save using one-period, risk-free bonds, which yield an interest rate r. There is no access to private borrowing.

If an agent decides to attend college, they have access to a government sponsored student loan up to some limit $\bar{D}(q, b) = \min\{t(q) - g(q, b), \bar{D}\}$. The interest rate on student loans is given by $\bar{r} = r + \iota$, where ι is the premium paid on student loans above the market rate. Interest does not begin to accrue until after college, and repayments are made for three periods beginning in $j = 2$. Repayments depend on the loan size taken out while in college and an agent's current income level. Individuals with income below some threshold $\hat{y}$ make no repayments, whereas agents with income above $\hat{y}$ make repayments proportional to their income, with proportion given by ψ. Proportional repayments are made up to the level $\bar{L}(d)$, at which point they make fixed repayments of size $\bar{L}(d)$. Fixed repayments are given by,

$$\bar{L}(d) = \begin{cases} d\left(\bar{r}\frac{(1+\bar{r})^3}{(1+\bar{r})^3-1}\right) & \text{if } 2 \leq j \leq 4 \\ 0 & \text{otherwise} \end{cases} \tag{3}$$

[9] Note, f is redundant at the moment. Its role will become clear in *Section 3* when the model is taken to the data.

and hence the loan repayment schedule is given by,

$$L(y,d) = \begin{cases} \min\{\psi \cdot \max\{0, y-\hat{y}\}, \bar{L}(d)\} & \text{if } 2 \leq j \leq 4 \\ 0 & \text{otherwise} \end{cases} \tag{4}$$

where the fixed repayments are given such that the present value of fixed repayments over three periods equals the present value of student debt, inclusive of interest. If the student loan is not fully repaid within the three periods, it is assumed that the remainder is paid by the government. The option to default on student loans is not modeled. Throughout, d denotes the loan balance at origination, chosen at $j = 1$ and fixed thereafter. Both the fixed repayment and the repayment schedule are functions of this initial balance and current income only, so no time subscript on d is needed. In the main accounting exercise I vary $\bar{D}(q,b)$, $\hat{y}$, and ψ between Canada and the United States.

2.5 Agent Recursive Problems

Problems at period j=1: Upon observing a vector of initial states $\mathbf{x}_1$, and a menu of college qualities q, with corresponding net tuition schedule $nt(q,a,b)$, and ability cut off a_q, the newly independent agent decides to attend college or not by solving,

$$\max\left\{V^{nc}(j=1,a,b,h), V^{c}(j=1,a,b,h)\right\} \tag{5}$$

where the value functions V^{nc} and V^c denote the maximum possible continuation value of not attending college and attending college for someone with ability a, initial human capital h and wealth b.[10] For agents who never attend college, $q = 1$ and $d = 0$ and these arguments are suppressed above in the V^{nc} formulation. Note that expectations are not being taken with respect to market luck shocks here. That is, it is assumed that the agent realizes their initial market luck shock before making the decision to attend college or not.

Contingent upon deciding to attend college, an agent chooses consumption c, savings b', quality of college to attend q, and a student loan amount d to solve,

[10]The college discrete choice is subject to preference shocks to improve computational accuracy. The variance is set to a small value, and I verify that its inclusion does not affect the model results.

$$
\begin{aligned}
V^c(j=1,a,b,h) = \max_{c,b',q,d} \Big\{ u(c) + \beta\Big(& (1-\pi_q)\mathbb{E}_\epsilon\big[V^c(j=2,q>1,a,b',h',d)\big] \\
& + \pi_q \mathbb{E}_\epsilon\big[V^{nc}(j=2,q=1,a,b',\zeta h',\xi d)\big]\Big)\Big\} \\
\text{subject to,} \qquad & \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad (6) \\
& c + b' + nt(q,a,b) = b + d \\
& h' = \epsilon'\big(a \cdot q \cdot (1 \cdot h)^\gamma + (1-\delta)h\big) \\
& 0 \le d \le \bar{D}(q,b) \\
& q \in \mathcal{Q}_a \\
& b' \ge 0
\end{aligned}
$$

An agent who attends college is assumed to have chosen $n = 1$, which implies they cannot work while in college. They enter period $j = 2$ with the human capital level implied by setting $n = 1$ in equation (1). π_q is the dropout rate by college quality.[11] Under the same assumption as Matsuda and Mazur (2022), if an agent drops out, they enter the following period with the value function of someone who did not attend college and a haircut ξ on their level of student loans. Additionally, agents take a haircut of ζ on the level of human capital, which they would have accumulated had they graduated college.

Notice that agents use loan amount d and initial wealth b to pay for college expenses while in college. This is an important assumption since agents do not have access to private borrowing. Needing to immediately pay for college in full prevents agents from attending college to gain access to borrowing and smooth consumption over their lifecycle.

The problem of someone who chooses not to attend college is given by the standard consumption savings problem with endogenous human capital accumulation. The agent chooses consumption c, human capital investment n, and savings b', to solve,

[11] I do not vary π_q across countries in the counterfactual exercise due to data limitations at the disaggregated level in Canada. However, average dropout rates are quite similar across Canada and the U.S. at 27% and 31%, respectively, and hence it is unlikely to have a large effect on main results.

$$
\begin{aligned}
V^{nc}(j, q=1, a, b, h, d) = \max_{c,n,b'} & \Big\{ u(c) + \beta \mathbb{E}_\epsilon \big[V^{nc}(j+1, q, a, b', h', d) \big] \Big\} \\
\text{subject to,} & \\
& c + b' = y(e, b) + b \\
& h' = \epsilon' \big(a \cdot q \cdot (nh)^\gamma + (1-\delta)h \big) \\
& e = wh(1-n) \\
& n \in [0, 1] \\
& b' \geq 0
\end{aligned}
\tag{7}
$$

where $q = 1$ for non-college graduates, $d = 0$ for those who never attended college, and the loan balance is $\xi \cdot d$ for college dropouts. The full formulation of the college dropout problem is omitted. Defining $y_j = e_j + rb_j$, for an arbitrary tax function $\tau(y)$, after tax income $y(e, b)$ is given by,

$$
y(e, b) = (1 - \tau(y_j))y_j \tag{8}
$$

The tax function will be estimated for each of the U.S. and Canada and varied in the main accounting exercise.

Problem for $2 \leq j \leq 4$: The problem of an agent is to choose consumption c, human capital investment n, and savings b', which solve,

$$
\begin{aligned}
V^{s}(j, q, a, b, h, d) = \max_{c,n,b'} & \Big\{ u(c) + \beta \mathbb{E}_\epsilon \big[V^{s}(j+1, q, a, b', h', d) \big] \Big\} \\
\text{subject to,} & \\
& c + b' + L(y, d) = y(e, b) + b \\
& e = wh(1-n) \\
& h' = \epsilon' \big(a \cdot q \cdot (nh)^\gamma + (1-\delta)h \big) \\
& n \in [0, 1] \\
& b' \geq 0
\end{aligned}
\tag{9}
$$

where $s \in \{nc, c\}$. The problem is identical to equation (7) except for the term $L(y, d)$ (appearing if the agent attended college), to denote that an agent is repaying student loans. If the agent chose not to attend college at age $j = 1$ then $L(y, d) = 0$, as in equation (7).

Problem at $j = 5$: All agents have one child, and during this period it becomes independent. The agent now chooses consumption c, human capital investment n, savings b', and an inter-vivos transfer $\hat{b}$, which solve,

$$\begin{aligned} V^s(j=5,q,a,b,h) = \max_{c,n,b',\hat{b}} \Big\{ & u(c) + \beta \mathbb{E}_\epsilon \big[V^s(j=6,q,a,b',h') \big] \\ & + \theta \mathbb{E}_{\hat{a},\hat{h},\epsilon} \big[\max \big\{ V^{nc}(\hat{j}=1,\hat{a},\hat{b},\hat{h}), V^c(\hat{j}=1,\hat{a},\hat{b},\hat{h}) \big\} \big] \Big\} \\ \text{subject to,} & \\ & c + b' + \hat{b} = y(e,b) + b \\ & e = wh(1-n) \\ & h' = \epsilon' \big(a \cdot q \cdot (nh)^\gamma + (1-\delta)h \big) \\ & n \in [0,1] \\ & b', \hat{b} \geq 0 \end{aligned} \tag{10}$$

The intergenerational transfer $\hat{b}$ is subject to a non-negativity constraint, meaning that parents cannot borrow against their child's future income. The parent has imperfect information or uncertainty over a child's initial draw of ability, human capital, or market luck upon graduation from high school. Given their own ability, they form expectations when deciding on the level of transfer and make the transfer before the child makes any decisions, so that the child takes as given the inter-vivos transfer level when making first period decisions.

Problem for $6 \leq j \leq 8$: The individual's problem solved here is identical to the problem defined by equation (9) with the exception that there is no longer a term $L(y,d)$ (even when $s = c$), as student loans are no longer being repaid. The terminal condition is given by $V(j=9,q,a,b,h) = 0$.

2.6 Government

Government revenues consist of tax proceeds and student loan repayments. The government levies taxes on labor earnings and returns to household savings using the tax function $\tau(y)$. Government expenditures consist of student loan disbursements, needs-based and merit-based tuition grants, and government consumption.

Government consumption is given as the residual of revenues less expenditures and ensures a balanced budget each period. Government consumption provides no utility to the household. I verify in all quantitative exercises that government consumption is strictly positive.

3 Data

The theoretical framework described in *Section 2* incorporates four essential differences between the U.S. and Canada, which will be varied in the main accounting exercise: (1) system of taxation, (2) net tuition schedule, (3) college quality distribution and ability cut offs, and (4) system of student loans.[12] This section describes the data and empirical analysis conducted to estimate these four elements for the United States and Canada.

3.1 Colleges

In the model a college is a quality, which affects the efficiency of human capital production. This quality is tied to a corresponding tuition schedule and set of ability cut offs. This section describes how these elements are identified in the data. To be consistent across all variables and countries, all datasets used for college statistics are for the 2017-2018 academic year.[13] For more details see *Appendix A*.

United States – The sample of colleges used for all analysis consists of 1,369 4-year institutions, granting bachelor's degrees and above, with at least 150 students enrolled. This sample of colleges represents 92% of all students pursuing a bachelor's degree in the United States. The sample is derived by linking Integrated Postsecondary Education Data System (IPEDS) and College Scorecard data which contains information on tuition fees, revenues, expenditures, and population measures to the dataset of Chetty et al. (2020). Public, private non-profit, and private for-profit colleges are included.

Canada – The sample of colleges used for all analysis consists of 89 4-year institutions, granting bachelor's degrees and above, with at least 150 students enrolled. This sample of colleges represents 95% of all students pursuing a bachelor's degree in Canada. Data for college expenditures and revenues originate from the Canadian Association of University Business Officers (CAUBO). Data for student enrollments are obtained from provincial reporting agencies or individual college disclosures. Data for sticker tuitions are taken from Statistics Canada tables. The sample of colleges in Canada excludes private colleges. This is an innocuous exclusion as less than 3% of FTEs attend a private college, and no private college ranks inside the top 2000 globally ranked colleges.[14]

[12] Throughout this paper I will refer to (2)-(4) as the "system of higher education".

[13] The one exception to this is college level data from Chetty et al. (2020) which spans several years.

[14] For both Canada and the United States, college rankings are obtained from the Center for World University Rankings (CWUR), which is one of the more widely used proxy-based ranking systems.

3.1.1 College Qualities

This section describes how college qualities are defined in the data. It also provides details on moments that will be used to identify college qualities in equation (1) and described further in *Section 4.2*.

United States – In the model, attending college provides access to a more efficient technology for producing higher wages. Hence, to be most consistent with how qualities are defined in the model, I define college qualities in the data in terms of average earnings growth observed by individuals who attend a given college. Using data from Chetty et al. (2020) I obtain earnings growth from ages 23-37 inclusive, by each individual college in the sample defined above.[15] Given these earnings growth rates, high-quality colleges are defined as those in the top 25 percentiles of earnings growth, mid-quality colleges as those in the middle 50 percentiles, and low-quality colleges as those in the bottom 25 percentiles.[16] The quality distribution q that enters the model in equation (1) is then identified using these earnings profiles. *Section 4.2* reports these earnings profiles in the data and the internally calibrated values of q which most closely generate the corresponding earnings profiles in the model.

Note, while these moments from Chetty et al. (2020) are unconditional, the Roy-style modeling structure is able to account for selection versus college quality. I discuss this mechanism specifically in *Section 5.1.2*, where I show that, even after conditioning on the state variables that drive selection, college quality still accounts for a portion of lifetime variance.

Canada – Ideally, Canadian qualities would be defined symmetrically to the U.S., from institution-level earnings profiles. Linkages between Postsecondary Student Information System (PSIS) records and administrative tax data (Statistics Canada's Education and Labour Market Longitudinal Platform) make such measures feasible in principle, but access is restricted and the linked graduating cohorts are recent. I therefore proxy Canadian college quality with total spending per FTE and map this definition into the earnings-growth definition used for the United States.

For the United States, when low, mid, and high qualities are defined as the bottom 15, middle 70, and top 15 percentiles of spending per FTE, the resulting earnings profiles are

[15] Later-life growth differences are not used for identification. As a robustness exercise, using earnings levels at age 37 to map each college into the ACS lifetime earnings profile at the corresponding percentile gives similar results.

[16] Note, there are also significant level differences in wages across these college qualities, which will also be matched when calibrating the model.

nearly identical to those given by qualities defined in terms of earnings growth.[17] For Canada, I use this as the definition of low-, mid-, and high-quality colleges. I then compare spending per FTE in Canada relative to that of the United States, for each of these three college qualities. Using relative spending by college qualities and the internally calibrated American college qualities q_1, q_2, and q_3, I calculate qualities q for the Canadian counterfactual distribution.

Two pieces of evidence support the spending proxy. First, spending per FTE is strongly positively correlated with earnings growth among U.S. colleges, and as noted above, spending-percentile tiers reproduce the earnings-growth tiers. Second, international rankings provide evidence for the tighter Canadian distribution. *Figure C.2* shows Canadian enrollment concentrated in the middle of the global rank distribution, while U.S. enrollment has substantial mass both at the very top and outside the top 2000. Spending per FTE is nonetheless an imperfect proxy for human capital production efficiency, as it also reflects cost structures and program composition; in particular, the far right tail of the U.S. distribution is populated by research universities with medical schools and academic hospitals, so part of the measured U.S. dispersion reflects professional and research activity rather than undergraduate resources. As a robustness check, defining tiers by instructional spending per FTE yields similar results.

3.1.2 Ability Cut Offs

The model developed in *Section 2* includes capacity constraints, in the form of ability cut offs. Individuals wishing to attend a college of a given quality must first meet a minimum ability threshold. Capacity constraints are necessary for the Canadian counterfactual. Without differing prices by quality in Canada, it would never be optimal for agents to attend anything other than the highest quality college. To be consistent with Canada, ability constraints are also included for the calibration of the benchmark U.S. economy. Details on the implementation in the model are given in *Appendix B.3*.

United States – Many low-quality colleges have "open admission" policies. This means that the only criterion for entrance is a high school diploma or a General Educational Development certificate. Correspondingly, I interpret this as a lack of capacity constraints and do not set an admission cut off for the lowest quality college.

Ability cut offs for the high and mid-quality colleges are set to roughly match attendance patterns by quality. Moments on attendance by quality are then exactly matched during

[17] In fact, the model was originally calibrated to quite similar results using this definition of college qualities.

the calibration procedure. Given the definition of college qualities defined in *Section 3.1.1*, relative attendance across qualities is obtained. Of those attending college, 18%, 57% and 25% attend low, mid, and high-quality colleges, respectively. As a robustness check I then confirm that these ability cut offs are consistent with data on the ability levels of those entering mid and high-quality colleges.

While there is no ideal measure of ability, I link IPEDS data on entrance SAT scores to the data defining college qualities. I consider the 25th percentile of entering SAT scores to be the minimum entrance score. This score corresponds to the 81$^{\text{st}}$ and 40$^{\text{th}}$ percentile of all SAT takers for the high and mid-quality college, respectively. *Appendix B.3* describes the details of how ability cut offs are set in the model and shows that the ability cut offs used in the model are set at similar ability percentiles as in the data.

Canada – A much larger proportion of students attend the highest quality colleges in Canada. Approximately 20% of FTEs in Canada attend the University of Toronto, McGill University, or the University of British Columbia. These are the top three colleges in Canada, and all rank inside the top 50 colleges in the world. Canada also displays a larger mass of agents attending mid-tier colleges than in the United States. This implies loosening ability constraints at both the high and mid-quality colleges for the Canadian counterfactual. These new ability cut offs are chosen to match the proportion of students attending colleges of the given quality in Canada. As in the United States, the lowest quality colleges have open admission policies and hence admission to the low-quality college is not constrained.

3.1.3 Net Tuition Schedules

This section describes the method employed to take each element of equation (2) to the data for both the U.S. and Canada. I follow a similar method to Belley et al. (2014). The tuition schedules are crucial to model outcomes as they are directly tied to which, and how many individuals decide to attend college, and what quality of college they wish to attend. The college decision alters how an agent accumulates human capital over their lifecycle and hence all aggregate outcomes in the model are affected by net tuition schedules. See *Appendix A.3* for more details.

United States – Data for sticker tuition cost by quality is taken from IPEDS, using the sample of colleges and qualities defined in *Section 3.1*. This is given by the function $t(q)$ in equation (2). Sticker tuition is taken to be average tuition and compulsory fees, calculated separately for in-state and out-of-state students. Average values are then obtained by taking the proportions of in and out of state students by each college's quality and weighting by total FTEs at each college. Sticker tuition costs are \$11,025, \$16,800, and \$32,551 for low, mid, and high-quality colleges, respectively.[18]

The schedule $g(q, b)$ is estimated using data from the National Post-secondary Aid Study-Administrative Collection, Undergraduates (NPSAS-AC), with needs-based aid from all sources, including institutional grants. Within-institution price discrimination by family resources, a distinctive feature of U.S. pricing, is therefore reflected in the U.S. net tuition schedules, and is largely absent from the Canadian schedules, which follow provincial formulas. What the tier-level schedules do not capture is heterogeneity in discounting across institutions within a quality tier. Income is observed by \$5,000 bins from \$10,000-\$15,000 to greater than \$200,000.

The NPSAS-AC also reports needs-based financial aid by college selectivity. I let "very selective" denote high-quality, "moderately selective" and "minimally selective" denote mid-quality, and "open admission" denote low-quality. Due to data limitations, this is not entirely consistent with how quality is defined in the model or elsewhere in the empirical analysis. However, given the degree to which needs-based grants vary across college quality level, it would too seriously overstate the cost of high-quality colleges to low-income agents to assume constant needs-based grant levels across quality levels.

Merit-based scholarships/grants, represented by the function $s(a)$ in equation (2) are also calculated using the NPSAS-AC. Given the lack of a better measure available in the data, it is assumed that SAT entrance scores represent ability. Scores are binned in increments of 200, from 400 to 1600, which defines six ability levels.

Finally, the term f in equation (2) is fixed to be 10% of average income and is assumed to be constant across the U.S. and Canada. This is set to incorporate some average "catch all" term, which includes items such as textbooks and transportation costs. These costs must be incurred when attending college, and are not considered as consumption in the model.

Table 1 summarizes the calibration of the U.S. and Canada net tuition function. All functions are near linear and so for ease of taking the functions to the quantitative model they are linearized using endpoint values. Values are expressed as a fraction of mean earnings to obtain model costs of college.[19]

Canada – *Table 1* summarizes the calibration of the Canadian net tuition functions. The method for obtaining net tuition schedules for colleges in Canada roughly follows the work

[18] All dollar amounts are expressed in 2017 real U.S. dollars.

[19] Mean earnings from the American Community Survey (ACS) are \$52,501. ACS data is publicly available from IPUMS USA, University of Minnesota, www.ipums.org.

Table 1: **Components of Net Tuition Function**

Parameter	U.S.	Canada	Description
$t(q_1)$	0.21	0.11	Sticker tuition for low-quality college
$t(q_2)$	0.32	0.11	Sticker tuition for mid-quality college
$t(q_3)$	0.62	0.11	Sticker tuition for high-quality college
$g(q_1, \bar{b})$	0.01	0.0	Needs-based aid for >$200,000 and low-quality
$g(q_2, \bar{b})$	0.02	0.0	Needs-based aid for >$200,000 and mid-quality
$g(q_3, \bar{b})$	0.04	0.0	Needs-based aid for >$200,000 and high-quality
$g(q_1, \underline{b})$	0.14	0.14	Needs-based aid for $10,000-$15,000 and low-quality
$g(q_2, \underline{b})$	0.18	0.14	Needs-based aid for $10,000-$15,000 and mid-quality
$g(q_3, \underline{b})$	0.40	0.14	Needs-based aid for $10,000-$15,000 and high-quality
$s(\bar{a})$	0.09	0.08	Merit-based grants for 1400-1600 SAT score
$s(\underline{a})$	0.005	0.005	Merit-based grants for 400-600 SAT score
f	0.10	0.10	Fixed cost (books, transportation, etc.)

Notes: Values are expressed as a fraction of mean earnings. All functions are linearized between endpoints for the model. Canadian numbers are expressed as a fraction of the average U.S. income.

of Belley et al. (2014).[20] There is no publicly available data source on tuition costs and financial aid reported at the level of individual colleges in Canada. Therefore, I generate my own dataset by province and by colleges using provincial financial aid rules and calculators. The aggregate numbers obtained are compared to publicly available data from Statistics Canada tables and match closely.

The analysis for Canada is conducted using data for the two largest provinces of Ontario and Québec, which together represent 62% of the Canadian population. Tuition costs and provincial financial aid rules are quite similar between Ontario and the rest of Canada, with the exception of Québec.[21] Therefore, when aggregating numbers, Ontario is assigned the weight of the Canadian student population outside Québec.[22] Average tuition, as well as provincial financial aid rules, differ significantly in Québec and so estimates must specifically include this province.

Sticker tuition in Canada displays no relationship to college quality as in the United States. Hence, average sticker tuition is set to be $6,501 and $2,376 in Ontario and Québec,

[20]The numbers obtained in this paper differ from Belley et al. (2014) as their analysis is for the 2003-2004 academic year and college prices have changed significantly since then in both Canada and the United States.

[21]Tuition in Ontario is marginally higher than other Canadian provinces, and so the numbers estimated here are slightly overstated when compared to the Statistics Canada aggregates.

[22]The three territories Yukon, Nunavut, and the Northwest Territories are excluded from the analysis. Together they amount to less than 1% of the Canadian population.

respectively, for all college qualities.[23] This yields an average value of $5,775 for sticker tuition price in Canada.

The vast majority of needs-based aid in Canada is distributed by federal and provincial governments subject to standard rules. For Ontario I use the Ontario Student Assistance Program (OSAP) aid estimator to determine the level of grants and loans available by parental income. Financial aid is given as a combination from the Ontario and Canadian government; however, the exact composition is not observed. For Québec, student aid is more generous than in Ontario and comes exclusively from the provincial government. The "Financial assistance for educational expenses assessment simulator" is used to calculate needs-based aid and loan levels for Québec.

Measuring merit-based grants by student ability with publicly available data is challenging, as there are no standardized tests used for college admission in Canada. I obtain rough estimates using average college and government expenditures on merit-based grants per FTE. Canadian colleges spend an average of $1,432 per student on merit-based scholarships. This number includes spending originating from all sources. Given that this is the average across all ability levels, I assume that the highest ability students receive $4,200 in scholarships on average. This number is derived using the ratio of top ability scholarships to average scholarships, from data for the United States.

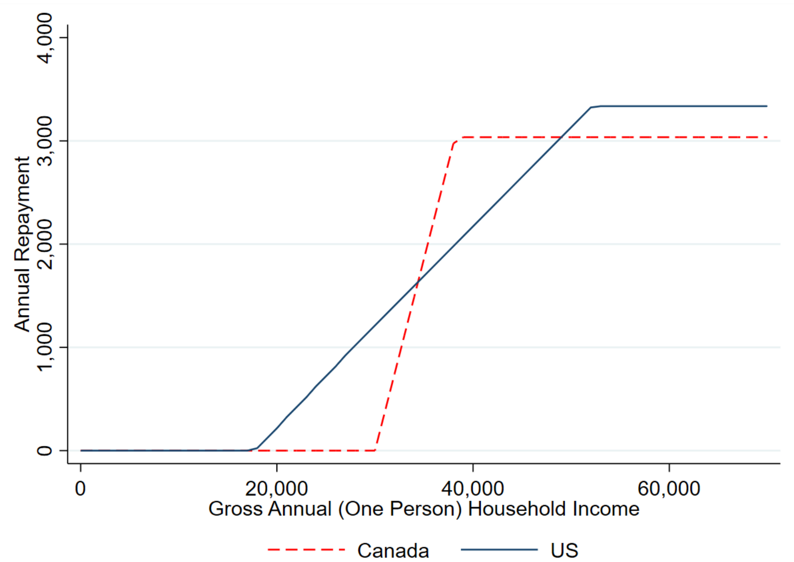
3.2 Loan Systems

This section lays out the method used to estimate $\hat{y}$, ψ, and $\bar{D}(q, b)$ from equation (4), which will be varied across the U.S. and Canada. The loan system alters the attractiveness of attending college for an agent, and determines how many, and what type of agents attend college. Additionally, the level of repayments affects how agents invest in human capital in each period. An agent with a high level of student loan repayments relative to income invests less in human capital accumulation as they must supply more time to the labor market. The needs-based character of each system enters through $\bar{D}(q, b)$. In the U.S., limits net out needs-based aid up to a federal cap and in Canada, limits fall with parental resources and reach zero for high-income households. *Figure 4* plots annual loan repayments across Canada and the U.S. by college graduate income level and *Figure 5* plots Canadian loan limits by the income level of a college attendee's parents. For a detailed study of student loans in the U.S. see Athreya et al. (2021) and Neill (2021) for Canada.

The loan repayment period is 15 years and is common across both countries. In Canada, government policy is that all outstanding loan principal is forgiven after 15 years out of

[23] All Canadian amounts are expressed in 2017 U.S. dollars at purchasing power parity (PPP).

Figure 4: **Student Loan Repayment by Income and Country**



Notes: Repayments for a $25,000 loan. U.S. numbers are calculated using standard fixed 10-year plans and the PAYE plan. The fixed repayment in Canada is smaller than in the United States, as on average the interest rate on student loans is slightly less. Dollar amounts are expressed in 2017 U.S. dollars at purchasing power parity.

college. For the United States, the statutory repayment length of student loans under Fixed Repayments is 10 years. However, Athreya et al. (2021) and Scherschel (1998) find that many borrowers consolidate their debt, or switch to an income contingent plan, in order to repay over a longer time frame. Interest rates on student loans are on average close to the prime rate, plus 2%, and so in both countries it is assumed that ι does not vary.

The option to default on student loans is not allowed. This assumption is inconsequential, as student loan default rates in the U.S. and Canada are historically quite similar.[24] Moreover, these default rates are less than 9% of loans in both countries. This approach is standard in almost all of the literature on student loans, with the exception of Ionescu (2009), Ionescu (2011), and Ionescu and Simpson (2016).

The model only considers access to government student loans and does not consider private loans. In the United States, private student loans are generally only available to students of wealthier parents and represent less than 8% of total student loans. Private student loans are essentially non-existent in Canada.

[24] See *Figure C.1* in *Appendix C*.

United States – In general, the U.S. student loan system is complicated and unlike Canada (discussed below) there is not one type of repayment system to model. I highlight some of the key elements here and discuss the specific plan used in the quantitative model. The system of student loans is implemented closely following Matsuda and Mazur (2022).

Some form of subsidized or unsubsidized loans are available to households of all income levels. I abstract from different types of loan subsidization and assume a constant interest rate of $r+\iota$. There are several types of income-contingent loans (ICLs) in the United States. The plan modeled here is Pay-As-You-Earn (PAYE) and is the most common ICL. Under PAYE, agents making less than 150% of the federal poverty level make no repayments. This means that for the United States, $\hat{y}$ is set to \$18,060. Someone making in excess of $\hat{y}$ pays 10% of discretionary income, i.e. $\psi = 0.1$ in the United States.[25]

Loan limits are given by either: (1) total cost of attending college less expected financial contribution, or (2) the federal undergraduate loan limit of \$57,500. Together, these two components define the function governing loan limits, $\bar{D}(q,b) = \min\{t(q) - g(q,b), \bar{D}\}$.

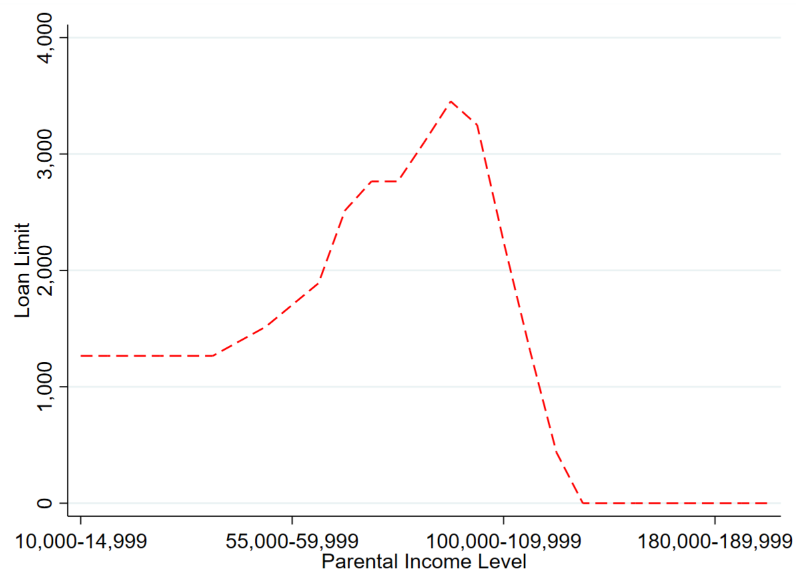
Canada – Unlike the United States, student loans are only available to those in low and middle income households. *Figure 5* plots student loan limits, by parental income. Students receive fewer loans at lower income amounts as more aid is provided in the form of grants. Dependent students with a two-parent household income above \$120,000 are not eligible for any student loans.

Households in Canada are eligible for an income-contingent plan (RAP) if regular payments are more than 20% of gross household income. Canadian households on RAP are expected to make larger income proportional payments than in the United States, at 20% of discretionary income.[26] However, the threshold for zero repayments is higher in Canada at \$32,000. Hence, in *Figure 4*, we see that in Canada there is a much smaller window between zero repayments and full fixed repayments. Repayment schedules for Canada are calculated using formulas in the Canada Student Financial Assistance Act.

[25]Discretionary income is defined as after-tax income in excess of $\hat{y}$.

[26]On November 1st, 2022, the Canadian government announced changes to RAP that would lower the proportional income repayments to 10% of income. However, at the time of writing this, the changes have yet to be implemented.

Figure 5: **Student Loan Limits by Parental Income in Canada**



Notes: Dollar amounts are expressed in 2017 U.S. dollars at purchasing power parity.

3.3 Tax Schedules

This section describes the estimation procedure for the American and Canadian tax schedules given in equation (8). Tax systems in Canada and the U.S. affect economic outcomes relevant to the model in several ways. Average and marginal tax rates distort an agent's decision to invest in human capital by changing the after-tax return to investment. They also affect the levels of parental inter-vivos transfers, and consequently college attendance decisions.

I estimate tax functions using data from the Organization for Economic Co-operation and Development (OECD) that are comparable across countries and publicly available. The data include central and local government taxes, family tax benefits, and social security tax contributions, levied on income. Following Guvenen et al. (2014) and Herrington (2015), the net average tax function is estimated using the form,

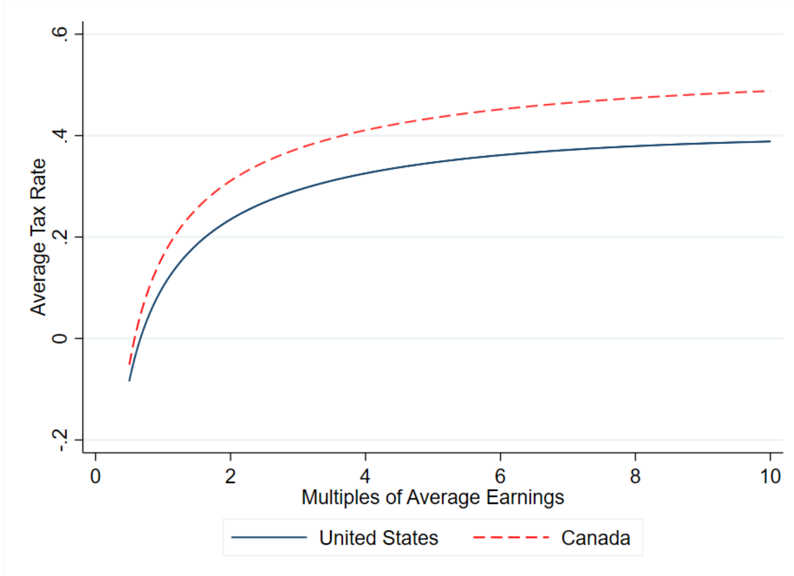
$$\tau({}^{y}\!/\!_{AW}) = a_0 + a_1({}^{y}\!/\!_{AW}) + a_2({}^{y}\!/\!_{AW})^{\phi} \tag{11}$$

where AW denotes average earnings for the given country. The resulting estimated tax functions are shown in *Figure 6*.[27]

From *Figure 6* we see that average tax rates are higher for all earnings levels in Canada than in the United States. The Canadian tax function is clearly more progressive, as the

[27]See *Table C.1* in *Appendix C* for details of the regression results.

Figure 6: **Average Tax Rates by Earnings and Country**



Notes: This figure plots estimated tax functions for the U.S. and Canada. Data is taken from the OECD.

tax rates are nearly identical for low wages and quickly rise to levels above the American counterpart. For low wages the net average tax rates are negative for both the U.S. and Canada. This is a result of some individuals receiving transfers from the government in excess of tax payments. Following Herrington (2015) I bound the tax function from below at -0.1 to ensure that some agents do not receive arbitrarily large transfers from the government.

4 Calibration

The main quantitative exercise involves first choosing parameters for the model to match important elements of the U.S. data, and then computing a counterfactual economy in which the U.S. tax function, net tuition function, college quality distribution, and student loan system are replaced by their Canadian counterparts, while holding all other parameters constant. Differences in income inequality and intergenerational earnings persistence between the benchmark and counterfactual economies are then used to calculate the share of observed cross-country differences attributable to taxes and the system of higher education alone.

The quality counterfactual depends on three ingredients: the dispersion of college quality, sorting across quality tiers, and the complementarity between ability and quality in human capital production. For the U.S., college quality is disciplined by earnings profiles across quality tiers (*Section 3.1.1*), while the Canadian quality distribution is constructed using the spending-based mapping described in the same section. Sorting is disciplined by attendance shares by quality and SAT-based admission thresholds (*Section 3.1.2*), and validated against untargeted attendance patterns by parental income (*Figure 7*). The complementarity follows from the multiplicative human capital technology and is therefore a maintained structural assumption. *Section 5.1.2* then shows that, within the model, college quality continues to account for differences in lifetime outcomes after conditioning on ability, wealth, human capital, and student debt.

The remainder of this section describes the estimation of all externally and internally calibrated parameters needed to conduct this exercise.

4.1 External Calibration

In this section I describe how the exogenously set parameters are chosen. The exogenous calibration of the college quality distribution, tuition schedule and ability cut offs, student loan system, and tax system was described in *Section 3*. *Table C.6* summarizes the remaining parameters that are taken from the existing literature or take standard values.

Agents live eight model periods of five biological years each, which corresponds to a biological life of 18 to 57. The annualized discount factor is given by 1/1.02, where the average risk-free rate in 2019 is 0.02. The interest premium on student loans is set to 0.02 to reflect standard student loan terms in both Canada and the U.S. and will not be varied in counterfactual exercises. The wage rate is normalized to 1.0. The relative risk aversion is set to 1.0 which implies $u(c) = \ln(c)$.

Annualized depreciation of human capital is taken to be 1.5% which is standard in the literature. Weber (2014) reviews the literature and finds a value in the range of 0.5% to 4.5%. I set the elasticity of investment in the human capital production function, γ, to 0.55. Estimates of this parameter are reviewed in Browning et al. (1999) and range from 0.5 to 0.9. The value is chosen to be at the lower end of this range, as 0.5 is standard in more recent literature and similar models.

The dropout rates by college qualities are taken from IPEDS using the 6-year dropout rate and the sample of colleges described in *Section 3.1*. They are set to 47%, 31%, and 23% for low-, mid-, and high-quality colleges, respectively.

I assume that individuals who drop out enter the second period with half the student loan position they decided on at the beginning of period one (i.e. $\xi = 0.5$), which is a modeling assumption borrowed from Matsuda and Mazur (2022). When an agent drops out of college it is also assumed that they take a haircut on the human capital they would have accumulated during college had they graduated. In the data, college dropouts closely resemble a high school graduate with a small earnings premium. ζ is set to be 0.75 to mimic this observed pattern.

4.2 Internal Calibration

The remaining eight parameters are chosen to minimize the distance between the 33 simulated moments (25 earnings profile moments and eight income and college moments) and their empirical counterparts. Empirical moments are from the ACS, IPEDS, OECD, and two moments on intergenerational persistence are taken from the literature. I now describe the functional forms used for the remaining model objects.

It is assumed that the function $\mathcal{A}(a, \hat{a})$ which describes the transmission of ability across generations is given by the first-order auto-regressive process (AR(1)),

$$\ln(\hat{a}_i) = \rho_a \ln(a_i) + \epsilon_i^a \tag{12}$$

where $\hat{a}_i$ and a_i denote the ability of child and parent in family i, ρ_a determines the persistence of ability across generations, and $\epsilon_i^a \sim N(0, \sigma_a^2)$. The idiosyncratic market luck shock is distributed according to a log-normal distribution with expectation one and variance σ_ϵ^2. Initial human capital of children is also drawn from the log-normal distribution, with expectation one, and variance $\sigma_{h_1}^2$.

Altruism and persistence of abilities, (θ and ρ_a), govern intergenerational persistence of wealth, and earnings. Empirical estimates of intergenerational persistence of earnings are taken from Corak (2013) who regresses child's earnings in their mid-30s on parent's income in their mid-50s. The model counterpart moment is estimated in the same manner. For the intergenerational transfer share of net worth, I use the method employed in Lee and Seshadri (2019). Specifically, the simulated moment is calculated as the ratio of total inter-vivos transfers over total savings. This is then targeted to intergenerational transfers as a share of the economy's total net worth, for which data is from the Survey of Consumer Finances. In the broader empirical literature estimates vary but generally lie within the range of 30% (see Lee and Seshadri, 2019).

The parameters governing the variance of abilities, the variance of market luck shocks, and the initial distribution of human capital determine the pre-tax Gini coefficient, college attainment, and the variance of earnings by age, which together amount to 12 moments. $\sigma_{h_1}^2$ is identified by initial variance in earnings upon entering the labor market for non-college graduates.

For these parameters, this is a calibration strategy similar to that of many other papers in the literature, including Lee and Seshadri (2019), Holter (2015), and Huggett et al. (2011).

Appendix B.1 also presents direct empirical evidence on the initial distributions of ability and human capital between the U.S. and Canada, showing that they are unlikely to explain a significant portion of cross-country differences.

For comparability with Canada, the pre-tax Gini and college attainment rate (defined as at least bachelor's degree) are taken from OECD (2023). College attainment rates by quality level are taken from IPEDS and applied to the sample described in *Section 3.1*. Numbers for attendance by college quality add to 100% and represent the number of full-time equivalent (FTE) students attending the given college quality, as a fraction of total FTEs in the sample of colleges. Variances of earnings by age are taken from the ACS. Numbers are calculated individually for each age bin and then averaged to ensure a uniform demographic structure, as in the model. Earnings profiles are also calculated using the ACS and following closely the method of Lagakos et al. (2018).

Finally, the three parameters q_1, q_2, and q_3 are identified using the average earnings profiles across college qualities defined in *Section 3.1.1*. The value of non-college is normalized to be $q_0 = 1$. Together, q_1, q_2, and q_3 are used to target nine moments from average earnings profiles for each quality level. These parameters also play a role in determining relative attendance across college qualities.

The method of simulated moments is then used to minimize the distance between the vector of 33 empirical moments and the simulated moments from the model. Specifically, the parameter vector $\Theta = [\theta, \sigma_\epsilon^2, \rho_a, \sigma_a^2, \sigma_{h_1}^2, q_1, q_2, q_3]$, is chosen to minimize the distance between the data and the model. The calibrated values are summarized in *Table C.7*. Details of the procedure can be found in *Appendix B.3*.

4.3 Model Fit

Prior to using the model to conduct the accounting and counterfactual exercises, I verify that the model replicates important features of the U.S. economy. In general, the model is able to produce accurate targeted and untargeted moments.

4.3.1 Targeted Moments

The model produces a good match to key moments in the U.S. economy. *Table 2* shows that the model does well at replicating moments on income inequality, intergenerational persistence, and college attainment. For average moments, the model achieves a nearly exact fit. Importantly, the two moments of interest for the counterfactuals, intergenerational mobility, and pre-tax Gini coefficient are replicated by the model exactly.

Given the over-identification of three parameters against 12 moments, *Table 3* shows

Table 2: **Model Fit – Targeted Moments**

Moment	**Data**	**Model**	**Source**
IG earnings elasticity	0.470	0.470	Corak (2013)
IG transfer share	0.30	0.29	Lee and Seshadri (2019)
Pre-tax Gini	0.414	0.414	OECD (2021)
Std. income	1.01	1.00	ACS (2015)
College attainment rate	0.33	0.33	OECD (2017)
q_1 Relative college attainment	0.18	0.17	IPEDS (2017)
q_2 Relative college attainment	0.57	0.56	IPEDS (2017)
q_3 Relative college attainment	0.25	0.27	IPEDS (2017)

Notes: The columns compare the model to the data for selected targeted moments. The rows provide eight moments: the intergenerational elasticity of earnings; aggregate inter-vivos transfers to savings ratio; the pre-tax Gini coefficient; the normalized standard deviation of lifetime earnings; college attainment rate across all college qualities; and college attainment by college qualities.

that the model also does well in replicating earnings profile growth rates and attendance patterns across college qualities. *Table 3* reports matched growth rates, whereas matched earnings levels across college qualities are reported in *Table C.4*. In *Table C.2*, we see that the model fits the average earnings profile well and replicates the dynamics of college quality earnings profiles. Recall that, due to data limitations from Chetty et al. (2020) I am unable to plot earnings profiles by college quality until the end of the lifecycle. Given that the mean and variance of lifetime earnings and income are the most important for the counterfactual analysis, the model's fit of earnings profiles is sufficient to validate the model and lend confidence to the subsequent analysis.

4.3.2 Untargeted Moments

Importantly, the framework developed in this paper is able to endogenously match untargeted moments which are central to the mechanisms determining IGE and inequality across countries.

Because the counterfactuals operate through who attends which quality, I verify the model's sorting on both ability and parental resources. On ability, the calibrated cut offs place admission thresholds at the 85$^{\text{th}}$ and 37$^{\text{th}}$ percentiles of the model's ability distribution, close to the 81$^{\text{st}}$ and 40$^{\text{th}}$ percentiles of SAT takers implied by 25$^{\text{th}}$-percentile entrance scores in IPEDS. On parental resources, *Figure 7* shows the model reproduces, as untargeted moments, the share of each quality tier's student body drawn from each parental income quintile and from the top 1%. That is, the model generates patterns observed in the data where the

Table 3: **Earnings Profiles by College Quality**

	q_1 **College**		q_2 **College**		q_3 **College**	
Age	Data	Model	Data	Model	Data	Model
23-27	1.00	1.00	1.00	1.00	1.00	1.00
28-32	1.49	1.33	1.67	1.46	2.09	1.84
33-37	1.98	1.70	2.34	2.00	3.26	2.81

Notes: This table reports earnings profiles for the model and data, by college quality. Earnings profiles are calculated by obtaining average wages for each age group bin, and indexing by first bin. The process for obtaining earnings profiles by college quality is discussed in detail in *Section 3.1.1* with data taken from Chetty et al. (2020).

wealthiest children sort positively to the highest quality colleges and low-income children disproportionately attend lower quality colleges. *Section 5* then quantifies the contribution of quality conditional on ability, wealth, and human capital.

Additionally, the framework used in this paper can endogenously produce lifecycle earnings dynamics for agents who did not attend college. Relative wages for students not attending college can be found in *Appendix C*. *Table C.3* shows the earnings profiles for those who did not attend college.

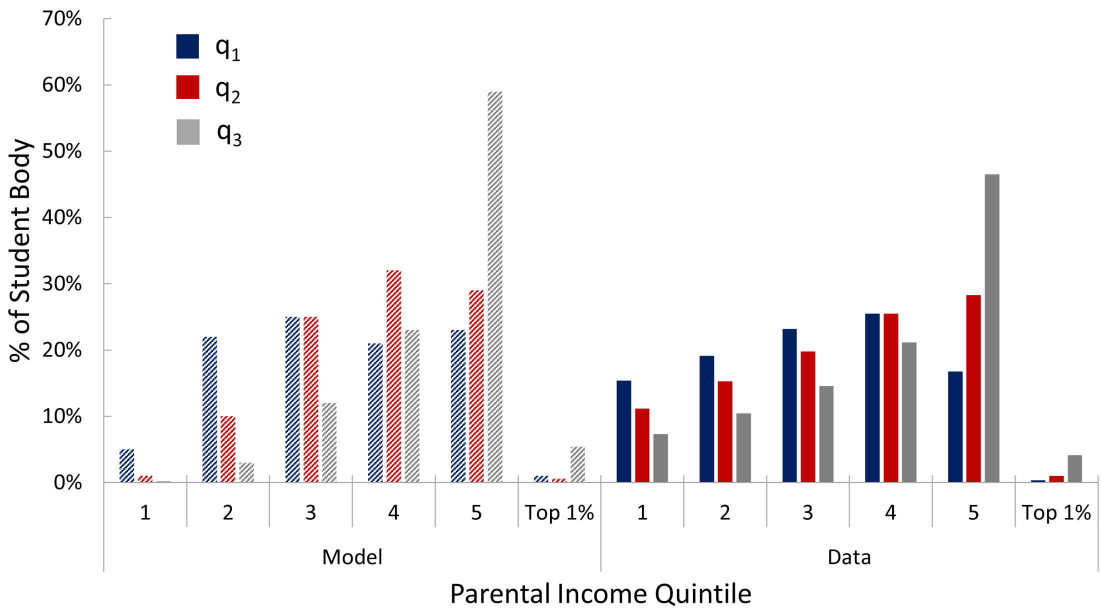
5 Results

The main exercise here is an accounting decomposition. I quantify the share of observed U.S.-Canada differences in inequality and IGE attributable to observed differences in tax, tuition, loan, and quality distributions. *Section 5.1* conducts this main accounting exercise. *Sections 5.1.1* and *5.1.2* discuss the two main drivers of IGE and inequality: college tuition subsidization and college quality. *Appendix B.1* presents empirical evidence showing that education prior to the start of college cannot explain differences in mobility or inequality between the U.S. and Canada.

5.1 Effects of Taxes and System of Higher Education

The objective of this exercise is to establish how much of the observed differences in income inequality and intergenerational persistence between the U.S. and Canada is due to differences in tax schedules, net tuition schedules, college quality distributions and systems of

Figure 7: **Share of Students Attending a College Quality by Parental Income Ranks**



Notes: This figure plots college attendance patterns across qualities by parental income, compared between model (left) and data (right). Data is taken from Chetty et al. (2020).

student loan limits and repayments.[28]

Lowering tuition costs has uncertain effects on inequality, and changing the distribution of qualities has indeterminate effects on intergenerational earnings persistence. Consider an example for changes to inequality. Suppose only high-ability agents attend college, but due to the presence of financial frictions, not *all* high-ability agents attend college. Lowering tuition costs could increase the number of high-ability students attending college but leave the number of low- to mid-ability agents attending college unchanged. In this situation, income inequality will certainly rise. However, if instead we had only agents with high parental income (of all ability levels) attending college, subsidizing the cost of education and allowing more agents of all income levels to attend college would surely decrease inequality. The benchmark U.S. economy is a mixture of these two cases, where one observes both sorting by income and ability.

For intergenerational mobility, very high-quality colleges (as in the U.S.) allow a small number of low-income but high-ability students to move up the income distribution rapidly. However, a large mass of mid-quality colleges (as in Canada) allows a larger number of low-income but mid/high-ability students to move up the income distribution modestly.

[28]Note, college choice exhibits home bias in both countries. The accounting exercise here treats the menu of colleges as national. See Wright, 2025 for a study of the college spatial distribution. Examining cross-country differences through this spatial lens is an interesting avenue for future work.

Table 4: **Effects of the Components of Canadian System of Higher Education**

	Taxes	Tuition	Loans	Quality	**Gini**	**IGE**
U.S. Data	U.S.	U.S.	U.S.	U.S.	0.414	0.470
(1)	Canada	U.S.	U.S.	U.S.	0.413	0.467
(2)	Canada	Canada	U.S.	U.S.	0.408	0.442
(3)	Canada	Canada	Canada	U.S.	0.405	0.441
(4)	Canada	Canada	Canada	Canada	0.393	0.438
Canada Data	Canada	Canada	Canada	Canada	0.317	0.190

Notes: This table reports results for the main accounting exercise. The first row reports the benchmark economy, calibrated to exactly match observed U.S. data. Each subsequent row reports a counterfactual economy with the addition of a Canadian system. The last row reports the observed data in Canada. Differences between the last row and second last row represent differences between Canada and the U.S. which are not accounted for by the model.

Hence, the effects of college financing and qualities on IGE and inequality are not clear *ex-ante* and must be determined quantitatively. I now present these quantitative results.

Table 4 summarizes the results of the main counterfactual for the pre-tax Gini coefficient and intergenerational earnings elasticity. The first counterfactual involves replacing the tax function with that of Canada, while holding *everything* else fixed. See row (1) of *Table 4*.[29] The Gini coefficient is subject to two opposing forces and falls slightly. High human capital individuals invest less in producing human capital (lifecycle profiles flatten) and earnings become more compressed. On the other hand, college attendance falls by just under six percentage points, which tends to increase inequality.[30] Aggregate earnings also fall significantly by 2.8%, due to the reduced investment in human capital accumulation and fewer individuals attending college. Finally, due to higher taxes and earnings compression for high earners, on average parents leave smaller bequests, which reduces intergenerational earnings persistence.

Next, the model is solved using the net tuition schedule, equation (2), calculated for Canada, however keeping fixed the distribution of college qualities and student loan system calibrated for the United States. See row (2) of *Table 4*. Attendance rises by roughly 11

[29]It is assumed throughout that additional revenues needed to finance larger government expenditures on colleges are funded through these higher taxes. Conducting the counterfactual exercises in a different order yields quite similar results, which are omitted here for ease of exposition.

[30]This is interesting, as it suggests that Canada does not have high taxes simply to fund larger college subsidies, but rather that, due to high taxes, Canada *must* subsidize colleges more heavily to ensure that "enough" agents can afford to attend.

percentage points, which is in line with attendance rates in Canada. This further validates the model's ability to endogenously generate patterns in the data.

There are several key channels which cause the increase in college enrollment. The first is simply that some agents were unable to "afford" to attend college before the subsidization. The second channel acts through the tradeoff between ability and human capital in the college enrollment decision. The subsidization of tuition causes IGE to fall and accounts for the largest portion of the total change. On net, increased attendance causes the average human capital profile of a college graduate to flatten *relative to* the average profile of a non-graduate, and inequality falls. *Section 5.1.1* discusses the model mechanisms underlying this counterfactual exercise.

Under this counterfactual, aggregate earnings rise dramatically by 3.5% due to higher college attendance and the resulting larger portion of the population with access to a more productive function for producing human capital.

In the next counterfactual exercise, the system of student loans is changed to that of Canada. See row (3) of *Table 4*. In general, the effects are relatively small for both the Gini coefficient and IGE. The changes stem from making it marginally less attractive for already wealthy individuals to attend college, as they have no access to student loans. This means fewer high-income people attend colleges, whereas the number of low-income attending is unaffected. This causes inequality and earnings persistence to fall. The higher income threshold for no repayment of student loans makes attending college less risky. The higher threshold provides agents with insurance against receiving many low market luck shocks in later life, that would otherwise make repaying student loans difficult.

For the final counterfactual exercise the distribution of college qualities is changed to that of Canada. Using the method described in *Section 3.1.1* the counterfactual values for q_1, q_2, and q_3 are calculated to be 1.29, 1.33, and 1.43, respectively. This defines a quality distribution where q_1 is now higher quality and q_3 is lower quality than what was calibrated for the U.S. benchmark economy. That is, the distribution of qualities is now tighter.[31]

This counterfactual shows that the distribution of college qualities is crucial for determining the extent to which the system of higher education explains differences across countries. See row (4) of *Table 4*. The fall in inequality under this counterfactual accounts for 57% of the total change.[32] Moreover, this is not a result of changing ability cut offs, if the counterfactual is conducted keeping ability cut offs fixed at the U.S. levels, changing the quality distribution still accounts for the majority of changes in inequality.

[31] The model is non-linear, and so the order in which the counterfactuals are conducted is not innocuous. However, averaging over all possible orderings yields quite similar results. For simplicity and clarity of exposition, I instead focus on the order presented above.

[32] This is calculated as $\frac{\Delta_{quality}}{\Delta_{model\ total}}$.

This result suggests an important conclusion. Regardless of subsidization levels in the United States, high inequality will persist as a consequence of a high variance in college qualities. Hence, public education policy aimed at combating inequality would need to go beyond simply adopting a Canadian, or European style system.

The converse is true for changes in intergenerational mobility, where the change to the Canadian distribution of college qualities is quite small and accounts for less than 10% of the overall change in IGE. Moreover, the ability cut offs do matter for even the qualitative changes in intergenerational mobility. If the ability cut offs are kept fixed at the U.S. levels, intergenerational earnings persistence rises slightly.

Section 5.1.2 more fully illustrates the role college qualities play in determining inequality and intergenerational mobility. I show that college qualities are important, even after controlling for ability and parental wealth.

Aggregate earnings now rise by only 0.9%, which is roughly a quarter of the increase found when keeping fixed the U.S. quality distribution and using Canadian subsidies. This implies that models which investigate optimal subsidization of higher education with one fixed level of college quality, will grossly overestimate the benefits in terms of aggregate earnings, and seriously underestimate the effects on income inequality.

5.1.1 The Role of College Tuition

College tuition subsidization explains the largest portion of intergenerational mobility differences accounted for by the model, between the U.S. and Canada. Additionally, as discussed in *Section 5.1*, tuition subsidization has ambiguous effects on income inequality. This section discusses the model mechanisms underlying these two results.

All higher education components considered in *Section 5.1* affect college attendance. However, subsidizing college tuition is the main force affecting both the decision to attend college and which agent types attend which quality colleges. The college attendance decision is subject to a tradeoff between ability and human capital. High-ability agents have an incentive to forgo consumption today and invest more in human capital accumulation. Similarly, agents with low (high) levels of human capital have the incentive to invest more (less) in increasing their stock of human capital, and there is lower (higher) opportunity cost associated with forgoing the supply of labor to the market. Hence, there is a tradeoff between high-ability and high human capital that makes attending college (or setting $n_1 = 1$) optimal.

This results in positive sorting by both income and ability to quality of schools. The highest quality schools are populated by high-ability, high-income agents. In order to capture the complementarities between quality and ability, high-ability, low-income agents find it optimal to attend cheap, low-quality schools. In the benchmark U.S. economy, low-ability agents do not find it optimal to attend any college, regardless of income level.

When tuition costs are subsidized, this lowers the ability threshold and raises the human capital threshold necessary to make it optimal for an agent to attend college. This lowers the average ability of college graduates. *Figure 8* plots the changing distribution of abilities for those who attend college and the distribution of human capital for college graduates.

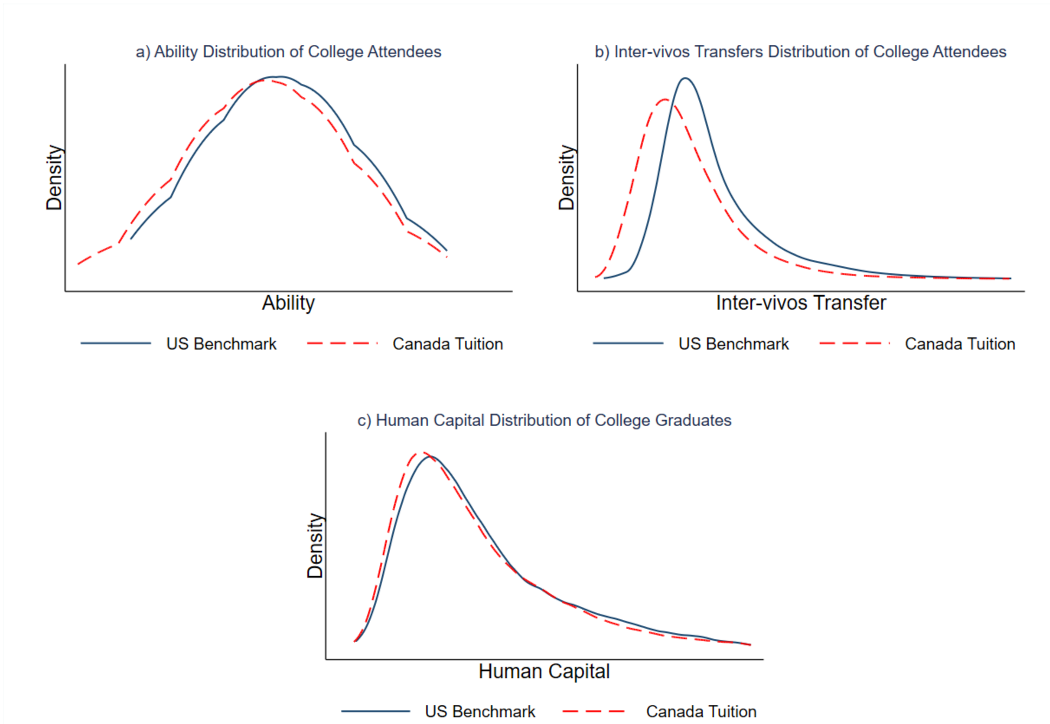
Panel *a)* shows that under the counterfactual Canadian level of tuition, the lowest ability agents now find it optimal to attend college. This results in lowest ability agents accumulating more human capital over their lifetime and will act to reduce inequality. This dynamic is reflected in panel *c)*, where there is now a larger mass of students graduating college with lower levels of human capital, and an overall smaller variance in human capital of college graduates entering the labor force.

Increased access to college lowers persistence of college attendance and provides a larger number of agents in the economy with a more productive technology, subsequently increasing the chance of moving up the income distribution. As seen in panel *b)* of *Figure 8* changing the cost of tuition and lifetime human capital accumulation also changes how agents make inter-vivos transfers. Average inter-vivos transfers fall for those attending college, since parents can now require smaller transfers to induce their children to attend college. However, transfers rise slightly for agents who did not attend college under the American tuition, and still do not attend college under the Canadian tuition. The intuition for this result is that under the American tuition schedule, low-income agents had little incentive to leave inter-vivos transfers as it would not alter their child's education decision. However, with the Canadian tuition schedule, low-income agents are able to leave large enough bequests to induce their child to choose to attend college. The distribution of inter-vivos transfers also tightens, which will tend to reduce inequality.

Changing the cost of education also distorts the relative price of accumulating human capital for an agent, over their lifecycle, hence affecting inequality and IGE. An increased number of agents gain access to a more productive technology for producing human capital. This causes the average human capital profile to steepen. However, as just discussed, the average ability of college graduates falls causing the average human capital profile of a college graduate to flatten. Lifecycle human capital accumulation changes most dramatically for the high-ability, low-income agent, who was unable to attend college under the American tuition schedule. These agents will typically now attend a high-quality college and observe much faster human capital growth over the lifecycle.

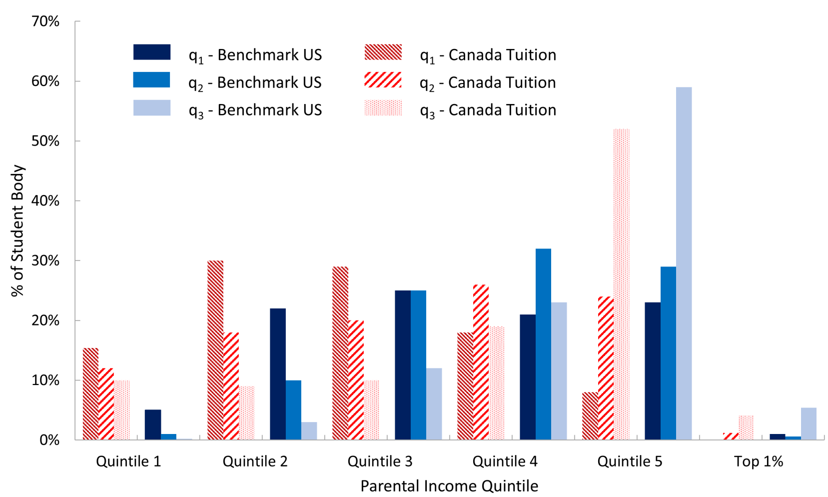
Lifecycle human capital accumulation is also affected for agents not on the margin of attending college. These agents now take on much lower levels of student debt. As a result,

Figure 8: **Distribution of Initial States Under Benchmark Economy and Canada Tuition**



Notes: This figure plots differences in the distribution of state variables between the benchmark U.S. economy and a counterfactual economy with Canadian taxes and net tuition. *a):* Distribution of abilities for agents who attend college. *b):* Distribution of inter-vivos transfers for agents who attend college. *c):* Distribution of human capital for agents who graduated college.

Figure 9: **College Income Sorting Under Benchmark Economy and Canada Tuition**



Notes: This figure plots differences in the share of students attending a given college quality by parental income ranks between the benchmark U.S. economy, and the counterfactual economy with Canadian taxes and net tuition.

during periods $j = 2$ to $j = 4$ agents effectively have higher earnings and supply less of their time endowment to the market and employ more time investing in human capital. This acts in the opposite direction from the changing ability and human capital of college graduates and causes the average human capital profile of a college graduate to steepen.

Figure 9 shows that subsidizing tuition also leads to less sorting by income across college qualities. That is, the proportion of children attending college with parents in the first (fifth) quintile of the income distribution rises (falls). This contributes to both decreasing inequality and increasing intergenerational mobility.

Under the subsidization of tuition, the composition of abilities across colleges will also change. In particular, low-income, high-ability agents will now attend high-quality colleges. This will increase intergenerational mobility as these agents will more quickly move up the income distribution. However, it will also tend to put upwards pressure on the Gini coefficient. Together, these above forces cause intergenerational persistence and inequality to fall.

5.1.2 The Role of College Quality

One of the key contributions of this analysis was the explicit modeling of college qualities. Moreover, differences in college quality account for the majority of the inequality differences between the U.S. and Canada explained by the model. For these reasons, I further investigate the role of college quality in explaining the main counterfactual, and more generally lifetime inequality and intergenerational earnings persistence. To focus on the role of college quality, I omit a detailed discussion of other state variables.

Lifetime Inequality – When tightening the college quality distribution, inequality falls for three main reasons. First, holding all else fixed the productive technology available to agents is less unequal, and will directly act to compress lifetime earnings. High (low) ability and high (low) income agents disproportionately attend high (low) quality colleges. Hence, under this counterfactual, the agents that are typically high (low) income are now given a worse (better) technology for producing human capital. Second, investment in human capital is rising in college quality, and hence high-quality college agents will also reduce their investment in human capital production. Lastly, a higher quality q_1 and lower quality q_3 induces more low-ability, and less high-ability agents to attend college. These forces all act to unambiguously reduce inequality.

I now provide further evidence of the importance of college quality in determining lifetime income inequality. To begin, I follow what is standard in the literature and decompose the

Table 5: **Lifetime Wealth Variance Explained by States at Age 23-27**

	(q, a, b_2, h_2, d) (1)	(a, b_2, h_2, d) (2)	(q, b_2, h_2, d) (3)	(q, a, h_2, d) (4)	(q, a, b_2, d) (5)	(q, a, b_2, h_2) (6)
% Var	0.83	0.76	0.57	0.81	0.80	0.83

Notes: This table reports a decomposition of lifetime wealth (LTW) variance into contributions from initial states explained at age $j = 2$. The first column conditions on all state variables. Each subsequent column omits one state variable.

variance of lifetime wealth into the individual contributions from states at age 23.[33] That is, I determine how much of the differences in lifetime wealth can be explained at age $j = 2$. An agent's states at age 23 are (q, a, b_2, h_2, d): college quality, ability, assets, human capital, and student loans.

The variance decomposition is conducted using the law of total variance, which states that total variance can be written as the sum of the variance in the conditional mean plus the variance around the conditional mean. Following the method of Lee and Seshadri (2019) I begin by assigning each agent a tertile separately for each continuous state (b_2, h_2, d). I then compute conditional variances, which give the fraction of variance in lifetime wealth (LTW) that can be attributed to the different initial conditions.

Table 5 reports the decomposition results. Column (1) shows that 83% of lifetime variance can be explained by conditions at age 23. The remainder of lifecycle variance is explained by uncertainty in human capital shocks and future investments in children.[34]

When leaving out college attendance and college quality (column (2)), this share drops to 76%. This indicates that the effect of college is important for lifetime inequality even after conditioning on ability, human capital, and wealth. Put differently, the effects of college on lifetime outcomes are not driven exclusively by selection.

Column (3) shows that the largest portion of variance can be explained by ability. When leaving out ability from initial conditions, the share of variance explained drops to 57%. As typically found in similar models, initial wealth (column (4)) plays a small role in explaining lifetime wealth variance. Column (5) shows that human capital also plays a relatively small role in determining lifetime wealth. As it is entirely determined by other initial states, column (6) shows that student loan levels play almost no role in explaining LTW variance.

All state variables at age 23 are jointly correlated, and hence *Table 5* does not convey

[33] Lifetime wealth along some path of shocks ϵ^J from the initial condition $\mathbf{x_2} = (q, a, b_2, h_2, d)$ is given by, $\Sigma_{j=2}^{8} {}^{e_j(x_2, \epsilon^j)}/_{(1+r)^{j-2}} + b_2$.

[34] This number is in line with the similar analysis of Lee and Seshadri (2019) and Huggett et al. (2011) who compute it at 74% and 67%, respectively.

Table 6: **Average Lifetime Wealth Across Differing Demographics**

State	Compared to	Change in LTW Percentile
College, q	Attends	9.9
Ability, a	Low	-11.2
	High	24.0
Human capital, h_2	Low	-16.0
	High	14.2
Assets, b_2	Low	-9.1
	High	21.9

Notes: This table reports changes in lifetime wealth percentile rankings associated with changing one state variable, holding all others fixed at median levels.

the exact contribution of each state. Human capital and assets appear to play a small role, but in general they are both outcomes of an agent's ability through their own decisions, and decisions of their parents. To further investigate the importance of each state separately, I begin by calculating the average LTW percentile rank of non-college agents ($q_0 = 1$) with median levels of (a, h_2, b_2). I then compute the difference in the LTW percentile rank when raising or lowering one state variable, while holding all others fixed at the median. The results are reported in *Table 6*.

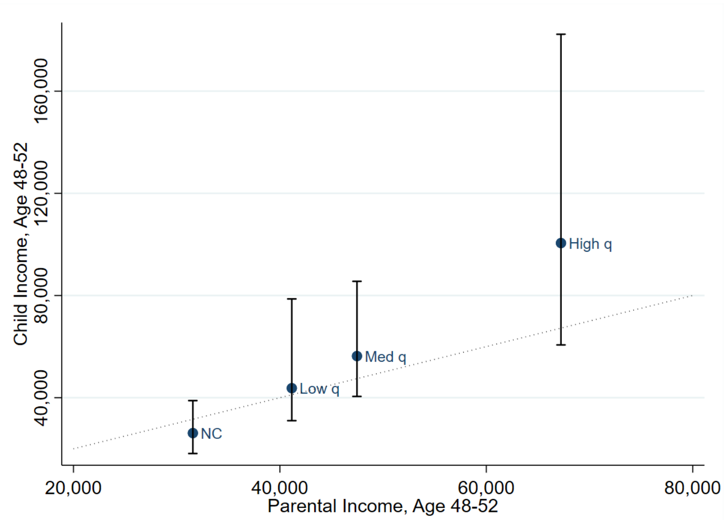
The effect of attending college remains significant (row (1) in *Table 6*). *Ceteris paribus*, attending college moves individuals up the lifetime wealth distribution by 9.9 percentile points. As in the variance decomposition analysis, ability has the largest role in explaining lifetime outcomes. Initial human capital and assets now play a more significant role.

Intergenerational Mobility – This section further decomposes the role college quality plays in determining intergenerational mobility. *Figure 10* plots median parental income against median child income at age $j = 7$, with each dot representing no college, or different college qualities.[35] This graph shows that those not attending college will typically earn less than their parents, whereas those attending college typically earn more than their parents, with agents attending the high-quality college earning significantly more.

However, *Figure 10* does not control for ability. To deal with this issue I perform an analysis similar to *Table 6*. I take the probability (at age $j = 7$) that a child has higher

[35]The moments in this graph were not calibrated and are the result of the benchmark U.S. economy calibration. Nonetheless, a surface level analysis suggests that these numbers are in line with what is observed in the data.

Figure 10: **Parental Income vs. Child Income by College Quality**



Notes: This figure plots median parental and child income with interquartile range, at ages 48-52, by no college and college quality. The dotted line represents the 45-degree line.

Table 7: **College Attendance and Probability Child Earns More than Parent**

	College	Probability
Low-ability	No	0.40
Low-ability	Yes	0.59
Med-ability	No	0.39
Med-ability	Yes	0.62
High-ability	No	0.24
High-ability	Yes	0.66

Notes: This table reports the probability of earning more than a parent by college attendance, holding ability fixed at different levels and all other states fixed at median levels.

income than their parent, *conditional on* ability level, and having not attended college. I then compare this probability to one where ability is held fixed, but the agent attends college.

Table 7 shows that conditional on ability, attending college greatly increases the probability of earning more than a parent. This increase is larger for high-ability agents. The reason this occurs is twofold. First, there are complementarities between college attendance and ability. Second, it is simply that more high-ability agents attend college, and so the probability of earning more than a high-ability parent is much lower if the child does not attend college.

This section shows that even contingent on all other states, college quality is a critical determinant of both inequality and intergenerational mobility. Hence, the omission of college quality when studying the effects of higher education leads to inaccurate predictions. Previous work will have underestimated the role that higher education plays in explaining across-country inequality and intergenerational earnings persistence.[36]

6 Conclusion

This paper investigates whether differences in tax policies, systems of higher education, and student loan systems can account for large differences in income inequality and intergenerational mobility across countries. I develop a model which incorporates lifecycle, intergenerational, and higher education components. The model captures all salient differences between the American and Canadian systems of higher education.

I find that approximately 22% of differences in income inequality and 11% of differences in intergenerational mobility between Canada and the United States can be accounted for by the system of higher education. The importance of explicitly considering the distribution of college qualities is evident from the results of the main counterfactual exercise. The distribution of qualities accounts for 57% of the differences in inequality explained by the model. This implies that existing models which do not consider the distribution of college qualities will underestimate the effects of the higher education sector on inequality.

This result also suggests that regardless of tuition subsidies in the United States, if the variance in college qualities remains large, inequality will persist. Education policy in the U.S. aimed at combating inequality would need to go beyond simply adopting a Canadian, or European style system. The effects of the quality distribution on IGE are small on net; however, they are subject to opposing forces.

[36]Empirical evidence suggests the returns to selective colleges are concentrated among low-income students. Consistent with this, in the model the mobility gains from quality access accrue to low-income, high-ability agents (*Section 5.1.1*).

References

Abbott, Brant, Giovanni Gallipoli, Costas Meghir, and Giovanni L. Violante, "Education Policy and Intergenerational Transfers in Equilibrium", *Journal of Political Economy* 127 (2019), 2569–2624.

Abraham, Katharine G. and Justine Mallatt, "Measuring Human Capital", *Journal of Economic Perspectives* 36 (2022), 103–130.

Athreya, Kartik, Christopher Herrington, Felicia Ionescu, and Urvi Neelakantan, "Student Loan Borrowing and Repayment Decisions: Risks and Contingencies", *The Routledge Handbook of the Economics of Education*, Routledge, 2021, pp. 458–511.

Becker, Gary S. and Nigel Tomes, "An Equilibrium Theory of the Distribution of Income and Intergenerational Mobility", *Journal of Political Economy* 87 (1979), 1153–1189.

Belley, Philippe, Marc Frenette, and Lance Lochner, "Post-Secondary Attendance by Parental Income in the US and Canada: Do Financial Aid Policies Explain the Differences?", *Canadian Journal of Economics* 47 (2014), 664–696.

Ben-Porath, Yoram, "The Production of Human Capital and the Life Cycle of Earnings", *Journal of Political Economy* 75 (1967), 352–365.

Brotherhood, Luiz, Bernard Herskovic, and João Ramos, "Income-Based Affirmative Action in College Admissions", *The Economic Journal* 133 (2023), 1810–1845.

Browning, Martin, Lars Peter Hansen, and James J. Heckman, "Micro Data and General Equilibrium Models", *Handbook of Macroeconomics*, vol. 1, Elsevier, 1999, pp. 543–633.

Cai, Zhifeng and Jonathan Heathcote, "College Tuition and Income Inequality", *American Economic Review* 112 (2022), 81–121.

Capelle, Damien and Kazushige Matsuda, "The Great Gatsby Goes to College: Tuition, Inequality and Intergenerational Mobility", *Manuscript* (2025).

Carneiro, Pedro, James J. Heckman, and Edward J. Vytlacil, "Estimating Marginal Returns to Education", *American Economic Review* 101 (2011), 2754–2781.

Caucutt, Elizabeth M. and Lance Lochner, "Early and Late Human Capital Investments, Borrowing Constraints, and the Family", *Journal of Political Economy* 128 (2020), 1065–1147.

Chetty, Raj, John N. Friedman, Emmanuel Saez, Nicholas Turner, and Danny Yagan, "Income Segregation and Intergenerational Mobility Across Colleges in the United States", *The Quarterly Journal of Economics* 135 (2020), 1567–1633.

Corak, Miles, "Income Inequality, Equality of Opportunity, and Intergenerational Mobility", *Journal of Economic Perspectives* 27 (2013), 79–102.

Cunha, Flavio, James J. Heckman, Lance Lochner, and Dimitriy V. Masterov, "Interpreting the Evidence on Life Cycle Skill Formation", *Handbook of the Economics of Education*, vol. 1, Elsevier, 2006, pp. 697–812.

Epple, Dennis, Richard Romano, Sinan Sarpça, and Holger Sieg, "A General Equilibrium Analysis of State and Private Colleges and Access to Higher Education in the U.S.", *Journal of Public Economics* 155 (2017), 164–178.

Guvenen, Fatih, Burhanettin Kuruscu, and Serdar Ozkan, "Taxation of Human Capital and Wage Inequality: A Cross-Country Analysis", *The Review of Economic Studies* 81 (2014), 818–850.

Hanushek, Eric A., Charles Ka Yui Leung, and Kuzey Yilmaz, "Borrowing Constraints, College Aid, and Intergenerational Mobility", *Journal of Human Capital* 8 (2014), 1–41.

Hendricks, Lutz, Tatyana Koreshkova, and Oksana Leukhina, "College Access and Intergenerational Mobility", *Manuscript* (2025).

Herrington, Christopher M., "Public Education Financing, Earnings Inequality, and Intergenerational Mobility", *Review of Economic Dynamics* 18 (2015), 822–842.

Holter, Hans A., "Accounting for Cross-Country Differences in Intergenerational Earnings Persistence: The Impact of Taxation and Public Education Expenditure", *Quantitative Economics* 6 (2015), 385–428.

Huggett, Mark, Gustavo Ventura, and Amir Yaron, "Sources of Lifetime Inequality", *American Economic Review* 101 (2011), 2923–2954.

Ionescu, Felicia, "Risky Human Capital and Alternative Bankruptcy Regimes for Student Loans", *Journal of Human Capital* 5 (2011), 153–206.

— "The Federal Student Loan Program: Quantitative Implications for College Enrollment and Default Rates", *Review of Economic Dynamics* 12 (2009), 205–231.

Ionescu, Felicia and Nicole Simpson, "Default Risk and Private Student Loans: Implications for Higher Education Policies", *Journal of Economic Dynamics and Control* 64 (2016), 119–147.

Kennan, John, "A Note on Discrete Approximations of Continuous Distributions", *Manuscript* (2006).

Krueger, Dirk and Alexander Ludwig, "On the Optimal Provision of Social Insurance: Progressive Taxation Versus Education Subsidies in General Equilibrium", *Journal of Monetary Economics* 77 (2016), 72–98.

Krueger, Dirk, Alexander Ludwig, and Irina Popova, "Shaping Inequality and Intergenerational Persistence of Poverty: Free College or Better Schools?", *Journal of Monetary Economics* 150 (2025), 103694.

Lagakos, David, Benjamin Moll, Tommaso Porzio, Nancy Qian, and Todd Schoellman, "Life Cycle Wage Growth Across Countries", *Journal of Political Economy* 126 (2018), 797–849.

Lee, Sang Yoon and Ananth Seshadri, "On the Intergenerational Transmission of Economic Status", *Journal of Political Economy* 127 (2019), 855–921.

Liu, Gang and Barbara M. Fraumeni, "A Brief Introduction to Human Capital Measures", *NBER Working Papers* (2020).

Matsuda, Kazushige, “Optimal Timing of College Subsidies: Enrollment, Graduation, and the Skill Premium”, *European Economic Review* 129 (2020), 103549.

Matsuda, Kazushige and Karol Mazur, “College Education and Income Contingent Loans in Equilibrium”, *Journal of Monetary Economics* 132 (2022), 100–117.

Neill, Christine, “Reducing the Burden of Student Loan Repayment: A Canada-US Comparison”, *Oppressed by Debt*, Routledge, 2021, pp. 105–138.

OECD, *Education at a Glance 2023*, OECD Publishing, 2023.

Scherschel, Patricia M., “Student Indebtedness: Are Borrowers Pushing the Limits?”, *New Agenda Series* (1998).

Weber, Sylvain, “Human Capital Depreciation and Education Level”, *International Journal of Manpower* 35 (2014), 613–642.

Wright, Jacob, “On the Spatial Distribution of Colleges”, *Manuscript* (2025).

Wright, Jacob and Angela Zheng, “From Kindergarten to College: The Impact of Education Policies Over the Lifecycle”, *IZA Discussion Papers* (2025).

Online Appendix

Appendix A Data

This appendix provides additional details on data sources and empirical methods, as well as additional empirical results.

A.1 Financing Higher Education

This section presents a more in-depth contrast of the financing of higher education in Canada and the United States than was discussed in *Section 1*. *Table A.1* summarizes key differences in public funding of higher education between the U.S. and Canada. U.S. numbers are taken from the U.S. Census Bureau Annual Survey of State and Local Government Finances. Numbers for Canada are taken from Statistics Canada tables.

It is evident that the magnitude of public expenditures on higher education is large in both countries, and it is no surprise that higher education policy is consistently present in public debate. Of total expenditures, at all colleges in the United States, the government finances 34%. In Canada, this number is significantly larger at 58%. Higher education expenditures funded by the government are also much higher in Canada when expressed as a fraction of the government budget or GDP. Total public expenditures as a percentage of GDP are 1.2% in Canada, which is nearly double the 0.7% in the United States. Finally, when taking the total value of government expenditures on higher education and dividing by the number of full-time equivalent (FTE) students, each student costs the Canadian taxpayer approximately 40% more than the American taxpayer.

Table A.2 summarizes key differences in household expenditures on higher education between the U.S. and Canada. Numbers for total household education spending per FTE are taken from the OECD Education Statistics. Average sticker tuition in the United States

Table A.1: **Public Expenditures on Tertiary Education**

	Canada	**U.S.**
% Financed by gov.	58%	34%
% of total gov. expenditures	3.9%	2.9%
Total gov. expenditures as % of GDP	1.2%	0.7%
Average student cost to gov.	$15,100	$10,900

Notes: This table contrasts public tertiary education expenditures between the U.S. and Canada.

Table A.2: **Private Expenditures on Tertiary Education**

	Canada	**U.S.**
HH expenditures as % of GDP per capita	10.6%	24.9%
Average sticker tuition	\$5,775	\$20,880
Average debt of borrowers	\$11,900	\$30,800
% who borrow	43%	68%

Notes: This table contrasts private tertiary education expenditures between the U.S. and Canada.

comes from Integrated Postsecondary Education Data System (IPEDS). Average sticker tuition for Canada comes from Statistics Canada tables. Debt statistics for the U.S. come from the National Center for Education Statistics (NCES). Numbers on debt for Canada come from the National Graduates Survey (NGS) Public Use Microdata File.

The first row in *Table A.2* takes total household expenditures on higher education and then divides that number by the number of FTEs. This number is then expressed as a fraction of GDP per capita, to roughly account for income differences between the U.S. and Canada.[37] This suggests that contingent upon sending a child to college, average household expenditures on education are more than twice as high in the United States as in Canada. The average sticker tuition price in the United States is also nearly four times the level in Canada. Finally, significantly more Americans take on debt in order to attend college and accumulate much higher levels of debt. In particular, the average American student graduates with nearly three times more debt than the average Canadian graduate. The financial burden on households of attending college in the U.S. is higher than in Canada.

A.2 Linking IPEDS and College Earnings Data

The main challenge with merging the IPEDS data with the data found in Chetty et al. (2020), is that in the Chetty et al. (2020) dataset, colleges are defined at the "Super OPEID" level (Office of the Postsecondary Education Identification), and in the IPEDS dataset they are defined at the six-digit OPEID (henceforth OPEID) level. Super OPEIDs were defined in Chetty et al. (2020) and are in most part a consequence of relying on the names of the institutions on tax forms, which in some instances are not at the granularity of OPEIDs. In total, there are 96 super OPEIDs that cluster multiple OPEIDs. Therefore, to merge datasets, I take the FTE weighted average across OPEIDs to aggregate into super OPEIDs.

[37] These numbers are 8.6% and 28.5% for Canada and the United States, respectively, if expressed as percentages of average household expenditures.

A.3 Net Tuition Functions

A.3.1 United States

Data for needs-based aid and merit-based grants in the United States was obtained using the table creation tool from the National Center for Education Statistics Data Analysis System.[38] The sample is restricted to students aged 18 to 23 during the 2017-2018 academic year. Students considered to be "independent" from their parents are excluded from the sample. A student is independent if they meet one of the following criteria: married, a graduate or professional student, a veteran, a member of the armed forces, an orphan, a ward of the court, someone with legal dependents other than a spouse, an emancipated minor, or, someone who is homeless.

The variable used for total needs-based non-repayable aid is "NEEDAID" and includes federal Pell grants, federal SEOG grants, state needs-based grants, and institutional needs-based grants. The institutional and state grants are mainly needs-based; however, some do have a merit-based component. Private grants are not included, as it is not possible to determine if they are needs-based. Private financial aid represents a small fraction of funding, with less than 4% of students receiving financial aid originating from private sources.

The only measure of "quality" available in the NPSAS-AC dataset is a metric for the level of selectivity for 4-year institutions. The measure was developed using IPEDS data and follows three criteria: (1) whether the institution was open admission (no minimal requirements), (2) the ratio of admitted students to applicants, (3) the 25th and 75th percentiles of ACT and/or SAT scores. Four categories are then defined: very selective, moderately selective, minimally selective, and open admission. I then use the same IPEDS data with the sample of colleges used throughout to calculate the same selectivity score for each college quality. Given this, high-quality best fits the category "very selective", mid-quality is represented by an average of "moderately selective" and "minimally selective", and "open admission" best fits the low-quality colleges. The IPEDS dataset is not suitable for obtaining numbers of needs-based grants as it only includes Title IV federal financial aid. Institutional aid makes up a significant portion of financial aid.

The variable used to calculate total merit-only grants is "MERITAID". It includes, state merit-only grants and scholarships, and institutional merit-only grants and scholarships (including athletic scholarships).

[38] The data can be found at https://nces.ed.gov/datalab/.

A.3.2 Canada

The financial aid calculations for Canada (in both Ontario and Québec) depend on family specific factors. I make the following assumptions to best reflect a "typical" college student in Canada. It is assumed that students are registering for a full-time, full academic year of 34 weeks. Students are dependent on their parents. A student is defined as independent if one of the following holds: married, out of high school for at least six years, have been working full-time for at least two years (out of high school), are divorced or widowed, have dependent children, were ever in a permanent care foster agency, or both parents are deceased. Next, it is also assumed that the student lives with both parents and has a younger sibling that is not of college age.[39] It is also assumed that the child is non-Indigenous. Finally, I assume that there is a 60-40 income split between the child's parents.

[39] For a complete discussion of the implications for financial aid of a child living at home or away from home see Belley et al. (2014).

Appendix B Model

B.1 Effects of Pre-College Education

The model begins with individuals having just graduated high school, at a biological age of 18. In reality, a large portion of human capital and ability development occurs before college. This section analyzes what remaining differences in inequality and IGE between Canada and the United States can be explained by education prior to attending college. In the model environment, this involves varying the initial distribution of human capital and ability. To do so, I estimate the relative variances of ability and initial human capital in the data and calculate the relative variances for Canada, given the variances for the United States internally calibrated above and those in the data.

The first difficulty is determining which empirical objects correspond to initial human capital and ability. The empirical counterpart of human capital used throughout this paper has been wages. However, initial human capital refers to that of a child who has just graduated high school. In general, the literature estimates this using an index or expenditure measure.[40] Two issues arise with this. First, I do not have access to sufficient data to obtain a variance for Canada using expenditures data. Second, if one uses a test score-based index, it becomes difficult to distinguish human capital from ability.[41]

The model matches the data well for the variance of wages at age $j = 2$ (biological age 23–27), with a variance of 0.19 in the model and 0.21 in the data. The variance of wages at $j = 2$ reacts strongly to changes in the variance of initial human capital, $\sigma^2_{h_1}$. Given that the variance of initial human capital is a key parameter for matching this moment, I use the relative variance in wages at age 23 to distinguish differences in initial human capital between the U.S. and Canada.

Using Integrated Public Use Microdata Series (IPUMS) International data, relative variances for those aged 23–28 are calculated across the two countries. The sample used for the U.S. earnings analysis described in *Section 4.1* is replicated for Canada. The data are demeaned using sample averages for each country, and earnings variances are then computed. This yields a variance for Canada that is 19% lower than that of the United States. In general, this change in variance for the initial distribution of human capital translates into small changes in income inequality, less than 3%, for both the benchmark U.S. economy and the economy with the counterfactual Canadian objects.

[40] See Liu and Fraumeni (2020) or Abraham and Mallatt (2022) for a review of different measures used to compare the human capital of children across countries.

[41] Looking at the variances of test score-based indexes (for example, the World Bank Human Capital Index), Canada and the United States are nearly identical.

To measure differences in ability, I use the Programme for the International Assessment of Adult Competencies (PIAAC), which provides internationally comparable measures of skills across countries. The PIAAC was developed by the OECD, and data were collected between 2011 and 2012. A representative sample of adults between the ages of 16 and 65 was interviewed and tested at home in the language of their country of residence. Cognitive skills were tested in the areas of literacy, numeracy, and problem solving. These three skills are measured on a 500-point scale.

The results are quite similar across the U.S. and Canada, with scores averaging 262 across literacy and numeracy in the U.S. and 270 in Canada. Moreover, the average variance is identical at 53 for both countries.[42] This suggests that the underlying distribution of abilities in Canada and the United States is quite similar. Hence, the initial distribution of abilities accounts for only a small portion (less than 1%) of the differences in inequality and intergenerational mobility.

Finally, I ask: if one were to explain all differences between Canada and the U.S. using only differences in initial abilities and human capital, how large would the changes to these distributions need to be? Given the benchmark model calibrated to the U.S. economy, I keep all parameters fixed but separately vary the parameters governing ability and initial human capital. There is no change in the variance or mean of the ability process or the human capital distribution that would explain all differences in IGE.[43] Moreover, shrinking the variance in the initial distribution of human capital by 80% would cause the Gini coefficient to fall by only 10.2%, and thus the initial distribution of human capital cannot explain all differences in income inequality. To explain all differences in income inequality using the variance of the ability process would require reducing the variance by roughly 45%, a magnitude entirely at odds with empirical evidence. Therefore, differences between Canada and the U.S. cannot be entirely explained by factors occurring prior to the start of college.

Additionally, these results are confirmed if Programme for International Student Assessment (PISA) scores are used instead, or if the American National Longitudinal Survey of Youth (NLSY) is compared to the Canadian Youth in Transition Survey as in Belley et al. (2014). Hence, it is highly unlikely that pre-college differences in ability or human capital are able to explain a significant portion of cross-country differences.

B.2 Welfare

In this section I analyze the welfare effects of the main counterfactual exercises presented in *Section 5.1*, for agents with differing initial states. *Table B.1* reports welfare changes for

[42] *Table C.5* in *Appendix C* reports more detailed results of PIAAC scores between the U.S. and Canada.

[43] Recall that the persistence of the AR(1) process governs IGE.

Table B.1: **Welfare Under Counterfactual Economies**

(a, b_1, h_1)	**Tuition** (1)	**Loans** (2)	**Quality** (3)
L, L, L	0.71	1.2	0.76
M, M, M	0.08	0.69	-0.22
H, H, H	-2.9	-2.7	-5.9
H, L, L	4.3	4.5	2.0
L, H, L	1.2	0.48	1.2
L, L, H	-1.1	-0.76	-1.54

Notes: This table reports welfare effects of Canadian higher education policies for select demographics. Welfare changes (percentage points) are relative to the benchmark U.S. economy. Welfare effects are reported by levels of initial states. H, M, and L stand for high, medium, and low values of initial states, respectively. These levels are defined by tertiles of initial state variables. Each column represents the *addition* of the Canadian policy.

agents of a selected set of demographics. Each column represents the addition of a given Canadian policy. Using consumption equivalent variation, welfare changes are reported as changes (in percentage points) relative to the benchmark U.S. economy.

I assume that the higher costs of the Canadian higher education system are financed through the higher progressive tax schedule in Canada.[44] The first policy change involves replacing the American tuition schedule with the Canadian counterpart. Taxes are held at the Canadian level, whereas the system of student loans and the college quality distribution are kept at the American level. See column (1) in *Table B.1*. High-ability, low-income agents go from not attending college to now attending the highest quality college and experience the largest net welfare gains. High-ability, high-income agents experience the largest welfare losses. Under the benchmark economy, these agents choose to attend the highest quality college, and under this counterfactual economy continue to do so. The key change is that they now pay a higher tax rate over their lifecycle. Low-ability, low-income, and high human capital agents also see net welfare losses, as their choice to not attend college is also unaffected under the Canadian tuition schedule.

The next policy change involves changing the student loan system to that of Canada, while keeping taxes and tuition at the Canadian level, and the quality distribution at the American level. See column (2) in *Table B.1*. Interestingly, the system of student loans plays

[44]Importantly, this implies that policy changes considered here need not be budget neutral.

a small role in explaining inequality and intergenerational mobility but plays a significant role in determining welfare of college attendees. The increase in welfare from this counterfactual arises from the higher income threshold for zero repayments under the Canadian system. From the perspective of an agent in period $j = 1$ this reduces the downside risk of taking on student loans to finance college, while leaving the upside benefit unchanged. Hence, for most agent demographics, welfare rises. Under the Canadian student loan system, higher income agents do not have access to student loans, which in general causes welfare to fall. On net, under these two opposing forces, welfare falls for select demographics with high levels of income, and low levels of human capital and ability.

For the final counterfactual, the distribution of college qualities is now changed to that of Canada, with all other systems now also at Canadian levels. See column (3) in *Table B.1*. Naturally this counterfactual causes welfare to fall for almost all types of agents. Most agents who remain in college now receive a less productive technology for human capital accumulation. Moreover, some agents on the margin are induced to not attend college. The largest drop in welfare is for high-ability agents. These agents see the largest loss in complementarities between their ability and college quality. One of the few exceptions is agents with low-ability, low human capital and high-income. These agents find it optimal to attend low-quality colleges under this economy and the previous economy with the American distribution of college qualities. This type of agent now receives a slightly more productive technology.

B.3 Computation

The dynamic programming problem is solved by backwards induction beginning with the terminal condition $V(j = 9, q, a, b, h) = 0$. Given that ability and college quality are static over an individual's lifecycle, the problem is broken apart and solved separately. This is done to easily facilitate parallelization of the computer code. The model is solved with four college qualities (including no college option). The model can be solved for a larger number of qualities, however distinguishing between many more college qualities in the data becomes difficult.

The AR(1) process for abilities is approximated using nine ability levels and the Rouwenhorst discretization method. The model solution is invariant to the number of abilities used. The ability cut offs for the high-quality and mid-quality college are set at ability 7 and above, and 5 and above, respectively. This places ability cut offs at the 85^{th} and 37^{th} percentiles of the ability distribution. The distributions for market luck shocks are discretized using the equal-mass approach of Kennan (2006).

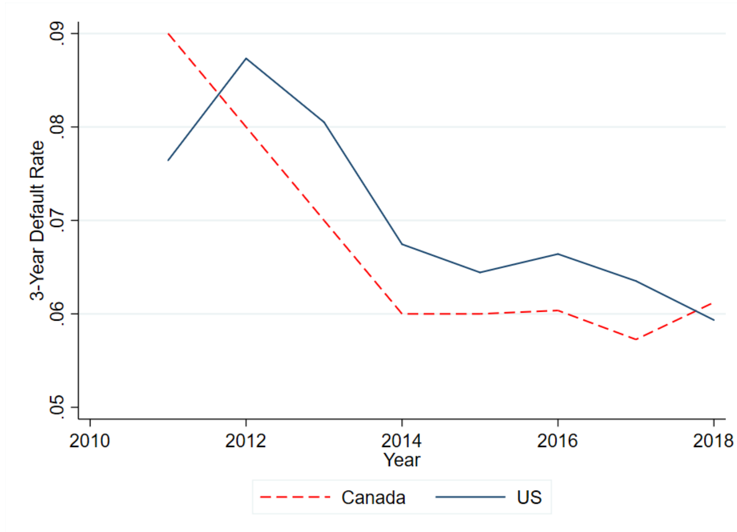
For all periods an expanding rectangular grid is set over continuous variables (h_j, b_j) and a uniform grid is set over discrete variables (a, q, d). During period $j = 5$ there is an additional continuous choice variable $\hat{b}_j$. During period $j = 1$, for the problem of someone who chooses to attend college, there are two continuous choice variables (d, b') and one discrete choice variable q. When solving for optimal policies I interpolate using cubic splines over next period's value functions. I solve for policy functions using a modified quasi-Newton method to allow for rectangular box constraints.

Given the altruistic motives of parents to children and the parameterization of the progressive tax function and tuition functions in terms of average income, a single round of backwards induction is insufficient to solve the model. I must solve for two fixed points. Thus, solving the model proceeds by guessing a value function V_1 and a mean income level $\bar{y}$. The model is then solved via backwards induction, obtaining a new guess for V_1. Once a convergence criterion is satisfied on V_1, I simulate the model to obtain a new guess for average income $\bar{y}$. The new guess for average income is then fed into the model, and the model is solved by backwards induction until once more achieving convergence on V_1. This process is repeated until I obtain convergence on $\bar{y}$.

To simulate moments from the model I take some arbitrary vector of parameters Θ and solve the model to obtain all decision rules. I then simulate $N = 200,000$ agents for $T = 20$ generations and discard all but the last two generations. The model converges to a steady state quickly and increasing the number of generations to $T = 100$ has no effect on results. Similarly, simulating $N = 1,000,000$ agents has negligible effects on results.

Appendix C Additional Figures and Tables

Figure C.1: **Student Loan Default Rates in Canada and the United States**



Notes: This figure plots average student loan default rates between Canada and the United States.

Table C.1: **Estimated Tax Function Parameters**

Parameter	United States	Canada
a_0	0.623	0.657
	(0.010)	(0.012)
a_1	-0.005	-0.002
	(0.0003)	(0.0004)
a_2	-0.516	-0.492
	(0.010)	(0.011)
ϕ	-0.448	-0.525
	(0.010)	(0.013)
R^2	0.998	0.996

Notes: This table reports the results of the estimated progressive tax schedules for the United States and Canada. I follow closely Guvenen et al. (2014) and Herrington (2015). Data is taken from the OECD.

Table C.2: **Average (College & Non-college) Earnings Profiles**

Age	Data	Model
23-27	1.00	1.00
28-32	1.39	1.32
33-37	1.67	1.69
38-42	1.83	2.03
43-47	1.91	2.13
48-52	1.91	2.32
53-57	1.90	2.37

Notes: This table reports aggregate earnings profiles for the model and data. Earnings profiles are calculated by obtaining average wages for each age group bin, and indexing by first bin. Earnings profiles in the data are also calculated using the ACS. I follow closely the method of Lagakos et al. (2018).

Table C.3: **Non-college Earnings Profiles**

Age	Data	Model
23-27	1.00	1.00
28-32	1.26	1.16
33-37	1.43	1.31
38-42	1.55	1.42
43-47	1.63	1.44
48-52	1.67	1.49
53-57	1.67	1.47

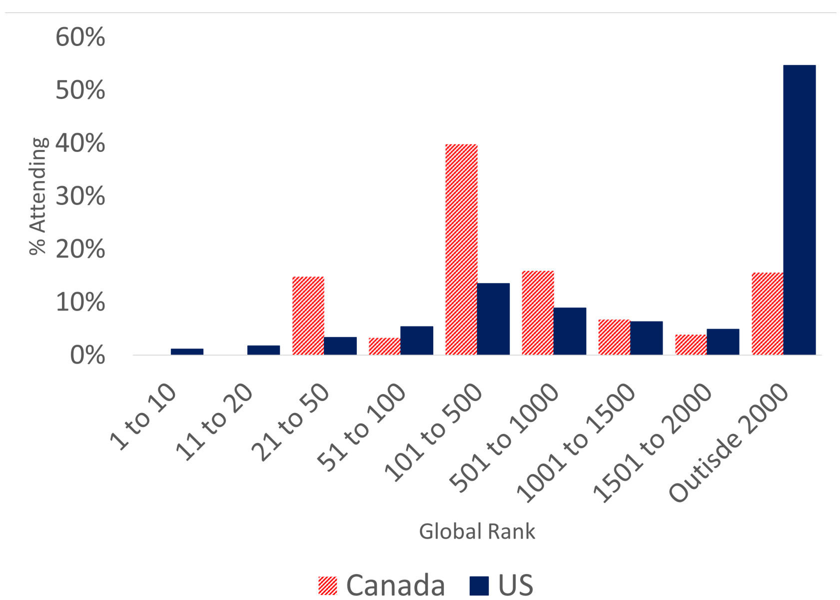
Notes: This table reports earnings profiles for those without a college degree, in the model and in the data. Earnings profiles are calculated by obtaining average wages for each age group bin, and indexing by first bin. Earnings profiles in the data are also calculated using the ACS. I follow closely the method of Lagakos et al. (2018).

Table C.4: **Wages by College Quality, and No College, Relative to Average Wage**

	q_1 **College**		q_2 **College**		q_3 **College**		**No College**	
Age	Data	Model	Data	Model	Data	Model	Data	Model
23-27	0.84	0.92	1.01	1.43	1.09	2.05	0.84	0.85
28-32	0.90	0.95	1.21	1.56	1.62	2.81	0.76	0.76
33-37	1.00	0.97	1.41	1.82	2.09	3.34	0.72	0.69

Notes: This table compares earnings profiles in the model and data by college quality.

Figure C.2: **College Attendance by Global Rank and Country**



Notes: This figure plots college student masses by international college rankings, for the U.S. and Canada.

Table C.5: **PIAAC Scores Between the United States and Canada**

	SD	**5%**	**10%**	**25%**	**75%**	**90%**	**95%**
U.S.							
Literacy	49	182	204	238	305	330	344
Numeracy	57	152	178	217	293	323	340
Canada							
Literacy	50	185	208	243	309	334	348
Numeracy	56	169	194	231	304	332	349

Notes: This table compares PIAAC scores for high school students between Canada and the United States.

Table C.6: **Externally Calibrated Parameters**

Parameter	**Description**	**Value**	**Source**
Preferences			
J	Model periods	8	Biological life age 18-57
β	Discount factor	0.98	Risk free rate = 0.02
σ	Relative risk aversion	1.0	Ln utility
Prices			
r	Risk free rate	0.02	Risk free rate in 2019
ι	Student loan premium	0.02	Standard student loan
w	Wage rate	1.0	Normalization
Human capital			
δ	Depreciation	0.015	Weber (2014)
γ	Production elasticity	0.55	Browning et al. (1999)
Colleges			
ξ	Loan haircut	0.50	Matsuda and Mazur (2022)
ζ	Human capital haircut	0.75	Some-college premium
π_1	Dropout rate – low-q college	0.47	IPEDS
π_2	Dropout rate – mid-q college	0.31	IPEDS
π_3	Dropout rate – high-q college	0.23	IPEDS

Notes: This table gives model parameters, a brief description of their role, the externally calibrated value, and the source. β, r, ι, and δ are annualized.

Table C.7: **Internally Calibrated Parameters**

Parameter	**Value**	**Description**
θ	0.70	Altruism motives
σ_ϵ^2	0.17	Market luck shock variance
ρ_a	0.65	Ability AR(1) persistence
σ_a^2	0.45	Ability AR(1) variance
$\sigma_{h_1}^2$	0.20	Initial human capital variance
q_1	1.27	Low-quality college productivity
q_2	1.33	Mid-quality college productivity
q_3	1.55	High-quality college productivity

Notes: This table gives model parameters, the internally calibrated value, and a brief description of their role.