College Financial Aid Application Frictions*

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Abstract

We show that 11 percent of recent US high school graduates did not apply for federal financial aid due to mistakenly believing themselves ineligible or finding applying too difficult. Not applying for aid due to these frictions negatively predicts bachelor's degree enrollment, even after controlling for other attributes. We embed aid application frictions into a structural model of college enrollment where federal financial aid is determined by the Expected Family Contribution formula. We find that the welfare costs of aid application frictions for affected non-enrollees amounts to 0.5 percent of lifetime consumption and leisure. General equilibrium effects magnify these losses.

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1 Introduction

In the United States, a complex federal financial aid system exists with the goal of making college more affordable. However, frictions in the financial aid application process may prevent some from utilizing the aid they are eligible for: young people may be mistaken about their own eligibility for financial aid and thus forego applying for it, or may face prohibitive costs of applying (e.g., due to complicated paper work). Policy makers are well aware that the federal student aid system could benefit from reform. For example, a recent Congressional Research Service report on the 2020 *FAFSA Simplification Act* (Collins and Dortch, 2022) states that:

> [This act] is intended principally to address several long-standing concerns with the HEA Title IV federal student aid application process. Specifically, the current process has been criticized for being too complicated to navigate, with the length and complexity of the Free Application for Federal Student Aid (FAFSA)—the instrument students use to apply for federal student aid—being consistent targets of the criticism. The student aid application and award process has also been criticized for lacking transparency and predictability for students and their families. This is because the methodology for calculating award amounts is opaque. In addition, students are not aware of how much federal aid they may be eligible for until an institution of higher education (IHE) to which they have been admitted provides an award letter. As a result, critics of the current system argue that students and their families may be discouraged from applying for aid and consequently may be discouraged from pursuing postsecondary education.

Despite policy-maker interest in simplification, recent government reports have highlighted that implementation of the *FAFSA Simplification Act* has been unsuccessful, characterized by rollout delays, difficulty with the new forms, and generally exacerbated confusion (Government Accountability Office, 2024b,a). Furthermore, even a successful reform's usefulness depends on the heretofore unknown aggregate extent of aid application frictions and their welfare costs prior to recent policy changes.

The main contribution of this paper is to empirically document the extent of aid application frictions faced by potential college enrollees, and then use a structural model to quantify the ensuing under-enrollment in college and resulting welfare cost.

Our main empirical results are established using the High School Longitudinal Study of 2009 (HSLS:09), a nationally representative panel survey of 9th graders from the United States Department of Education. Using directly reported reasons given by survey respondents for not applying for financial aid, we find that 11 percent of high school graduates did not apply due to reasons related to frictions. These reasons include believing themselves ineligible for aid (despite the fact that unsubsidized loans do not restrict eligibility), lack of awareness about federal financial aid, and finding the forms too difficult to complete. We provide a battery of probit regressions to demonstrate that not applying for federal aid due to frictions is associated with a lower likelihood of enrolling in a BA—both immediately and three years after high school graduation—even when we control for other attributes such as student skill, family income, and not filing for aid due to lack of intent to continue education. Furthermore, we find that not filing for aid due to frictions negatively predicts both applying to any BA and enrolling in a BA conditional on being accepted.

In order to quantify under-enrollment in college due to financial aid application frictions (and the resulting welfare costs) we embed these frictions into a structural model of college enrollment choice, where high school graduates also differ in skill, family transfers, and eligibility for need-based aid. In the model, a skill-specific share of high school graduates are affected by aid application frictions, while all others are not. Those affected anticipate that they will not receive federal college financial aid (that is, Pell grants and subsidized and unsubsidized Stafford loans) when making the college enrollment decision. This modeling choice parsimoniously captures those who believe they are not eligible for aid or are unaware of it, as well as those who find it too difficult to apply. Apart from incorporating aid application frictions, another novel feature of our framework is that the model approximates the way in which family attributes map into eligibility for need-based financial aid (that is, Pell grants and subsidized loans) via the Expected Family Contribution (EFC) formula.

After parameterizing our framework using the observed share of high school graduates who do not file a FAFSA due to aid application frictions in each skill bin as measured directly in the HSLS:09, we validate the model with three main exercises. First, we run a probit on enrollment likelihood with a flag for those who do not file a FAFSA due to aid application frictions along with other standard controls. The model produces a negative average marginal effect for the flag on frictions similar to that observed in the data. Second, we show that the enrollment rate response to a tuition subsidy in the model is similar to empirical estimates from Deming and Dynarski (2009). Third, we compare enrollment rates by skill and parental income terciles in the model baseline with empirical estimates. The model captures the pattern in the data that enrollment is increasing in both skill and parental income. In supplemental exercises, we also show that the model accounts for sorting of those affected by application frictions into enrollment and non-enrollment outcomes, decreasing Pell grant uptake by income, and increasing college premiums by skill.

While a sizable share of non-enrollees are affected by aid application frictions, not all of them would choose to enroll in college even if application frictions were removed. Therefore, we introduce the concept of "under-enrollment" in our model, whereby the under-enrolled are defined as non-enrollees who would enroll in college if they were not affected by aid application frictions. Indeed, in the initial equilibrium of our calibrated model we find that 2.3 percent of non-enrollees are under-enrolled, although (as in the data) roughly 14 percent of non-enrollees are affected by aid application frictions.

The usefulness of reducing frictions in the federal financial aid application process depends on the welfare costs of those frictions. Our structural model, which takes into account skill-specific lifetime returns to education and potential intergenerational and general equilibrium effects, allows us to quantify these welfare costs. We do so by computing the welfare gains from eliminating aid application frictions. In particular, we compute welfare for non-enrollees affected by aid application frictions in the initial equilibrium and for the average high school graduate. The welfare gains from eliminating aid application frictions for non-enrollees affected by those frictions amount to 0.5 percent of lifetime consumption and leisure, while the welfare gains to the average high school graduate amount to 0.15 percent of lifetime consumption. These welfare gains take into account intergenerational effects, in which inter vivos transfers increase. These gains also reflect general equilibrium effects, in which the low-education wage rate increases while the high-education wage rate decreases (providing insurance against a low skill draw), and the average income tax rate decreases. Without the integenerational and general equilibrium effects, the welfare gains are smaller, amounting to 0.04 percent of lifetime consumption and leisure for the average high school graduate. Overall, these results indicate that the presence of aid application frictions generates welfare costs in the baseline economy.

Over the last two decades, many papers have used structural models to analyze the implications of postsecondary education policy for the college enrollment decision; examples include Caucutt and Kumar (2003), Andolfatto and Gervais (2006), Ionescu (2009), Lochner and Monge-Naranjo (2011), Chatterjee and Ionescu (2012), Krueger and Ludwig (2016), Ionescu and Simpson (2016), Abbott, Gallipoli, Meghir, and Violante (2019), Caucutt and Lochner (2020), Matsuda (2020, 2022), Colas, Findeisen, and Sachs (2021), Kim and Kim (2023), Luo and Mongey (2024), Moschini, Raveendranathan, and Xu (2024), Vardishvili (2024), Krueger, Ludwig, and Popova (2024), and Hendricks, Koreshkova, and Leukhina (2024). These papers have emphasized various aspects of the topic, such as the substitutability between financial aid and family transfers or between federal and private student loans, dropout risk, and intergenerational effects. Our paper is the first to measure the extent of financial aid application frictions and to document their negative correlation with the likelihood of college enrollment after controlling for other attributes. We are also the first to incorporate aid application frictions into a structural model in which federal aid is determined by an EFC formula.

Previous work using small-scale randomized control trials has found that college enrollment rates increase when prospective students are provided with personalized information about grants, or when uncertainty about grants is eliminated by guaranteeing the grant amount before young people make the college application decision (Hoxby and Turner, 2015; Dynarski, Libassi, Michelmore, and Owen, 2021). These responses in enrollment rates are evidence of under-enrollment in college and under-utilization of college financial aid. Our paper contributes to this strand of the literature in two ways. First, we use nationally representative data to document the extent to which a single cohort of recent high school graduates was affected by aid application frictions. Second, we embed these frictions into a structural model that takes into account several factors including skill-specific lifetime returns to education, intergenerational effects, and general equilibrium effects to quantify the extent of under-utilization due to under-enrollment in college and the resulting welfare costs.

Finally, studying the potential general equilibrium and intergenerational effects of scaling up small scale interventions is a current topic of interest in several areas of macroeconomic research. For example, Donovan (2020), Bairoliya and McKiernan (2023), Daruich (2023), Adamopoulos (2023), and İmrohoroğlu and Zhao (2023) analyze the effects of scaling up interventions in agriculture, Social Security claiming decisions, early childhood development, spatial integration, and housing for the homeless, respectively. Our paper contributes to this growing body of literature by focusing on postsecondary education enrollment decisions in the presence of financial aid application frictions.

This paper proceeds as follows. Section 2 overviews the federal student aid system in the United States. Section 3 explains our main empirical results, and Section 4 outlines our structural model which is parameterized and validated in Section 5. We quantify the extent of under-enrollment and the resulting welfare costs in Section 6. Section 7 concludes.

2 Federal Student Aid in the United States

Federal student aid in the United States is a system of public financial support for those pursuing education after high school. In the period covered by our empirical analysis (the mid-2010s), filing the Free Application for Federal Student Aid (FAFSA) is necessary in order to qualify for federal aid (National Association of Student Financial Aid Administrators, 2014). Filers usually complete the FAFSA in the spring of their final year of high school, and re-submit before each academic year of postsecondary enrollment thereafter.[1] The FAFSA records information on parental income, wealth, tax liability, employment status, and number of dependents enrolled in college.[2] A formula then assigns the family an Expected Family Contribution (EFC), which is the estimated amount the family can afford to contribute towards the Cost of Attendance (COA). The difference between the COA and the EFC is "unmet need," the upper bound for total means-tested financial

[1] FAFSA filings determine aid from federal, state, and institution-level sources (non-federal sources may use additional information). Each source has a filing deadline; the federal deadline is last. Federal aid is distributed over several rounds during the academic year; FAFSA filings or updates within the academic year are reflected in the next round of aid.

[2] Here, we describe dependent FAFSA filers (the vast majority of first-year filers).

aid. Institutions that accept a FAFSA-filing applicant offer them a financial aid package; applicants then decide which program (if any) to enroll in.[3]

Financial aid packages are generated by the institution's Financial Aid Administrator (FAA); before proceeding, FAAs can invoke "professional judgment" to adjust FAFSA inputs if special circumstances for the FAFSA filer are documented. FAAs at any accredited institution may include Pell grants (the largest federal grant program) and Stafford loans (the largest federal loan program) in the aid package offerred to FAFSA filers who meet each aid program's eligibility criteria. Stafford loans may be unsubsidized (for which interest accrues on the loan balance during college) or subsidized (for which it does not). Eligibility for subsidized Stafford loans and Pell grants is means-tested while eligibility for unsubsidized Stafford loans is universal. Specifically, the Pell grants amount offerred to a student is determined by the difference between an upper bound and their EFC; the upper bound is the minimum of the maximum Pell grant amount and the COA. Subsidized Stafford loans are offered up to an annual borrowing limit, equal to the minimum of an annual limit and unmet need net of Pell grants; total Stafford loans (subsidized plus unsubsidized) are also subject to an annual limit. The FAA is expected to include any Pell grants the filer is eligible for in the aid package before turning to other sources of aid, such as Stafford loans.

3 Data

Our main data source is the High School Longitudinal Study of 2009, a nationally representative panel survey of 2009 9th graders in the United States (National Center for Education Statistics, U.S. Department of Education, 2020). A useful feature of the HSLS:09 is that the four main survey waves collect information on all sample members regardless of postsecondary education outcome. Each wave (with its academic timing for most sample members) is as follows: the Base year (2009), First follow-up (2012, 11th grade), 2013 Update (the summer after high school graduation), and Second follow-up (2016, three years after high school graduation). These waves are supplemented by Postsecondary Transcripts and Student Records collected from institutional sources up to the 2017 academic year for postsecondary enrollees. Financial aid records are pulled from the National Student Loan Database for the sample with a student record collection. In the Base year and First follow-up survey waves, the sample member and their parent are both interviewed, while the 2013

[3] Only accredited postsecondary institutions are eligible to distribute federal financial aid; accreditation requires that student outcomes after graduation meet certain criteria. Qualifying institutions may offer less than 2-year programs, 2-year or associate's degree programs, and 4-year or BA programs). Table A18 of Appendix A.1.5 reports the distribution of aggregate federal financial aid (defined as Pell grants and subsidized or unsubsidized Stafford loans) received by the HSLS:09 cohort in the 2014 academic year, both across and within postsecondary program types. Most federal financial aid is spent on BA enrollees, and each of these three sources of federal aid contributes a substantial amount to spending on that group. This partially motivates our focus on BA programs and all three sources of federal aid. The HSLS:09 is described further in Section 3.

Update is an abbreviated survey questionnaire completed by the sample member or their parent (in the latter case, survey questions are reframed to be about the respondent's child). Only the sample member is interviewed in the Second follow-up.

Sample cleaning and summary statistics We begin by restricting attention to high school graduates for whom we can construct a 2013 postsecondary enrollment outcome and for whom we observe family income, honors-weighted high school grade point average (GPA), and whether or not the respondent submitted a FAFSA in the 2013 Update.[4] We compare this cleaned sample with the raw data in Table 1. Appendix A.1.1 provides further details of our sample selection procedure as well as an extended description of how we assign observations to postsecondary outcomes by capitalizing on the various sources of information available in the HSLS:09.

Comparing the raw and cleaned samples in Table 1 indicates that the cleaned sample has fewer observations, which partially affects sample composition compared to the raw sample. Panel A reports demographic attributes: the cleaned sample exhibits a slightly higher average high school GPA, average family income, and parent education rate, but a similar share who are female, share with two parents present, and household size, compared to the raw sample. Panel B contains rates of postsecondary enrollment outcomes in the fall of 2013 (right after high school graduation), which we construct by combining information from several sources in the survey. In the cleaned sample, 43 percent of high school graduates enroll in a 4-year bachelor's degree, 27 percent in a 2-year or certificate program, and 30 percent of this cohort do not enroll in any postesecondary education. Table A1 of Appendix A.1.1 compares the BA enrollment rate computed in the HSLS:09 cleaned sample with national-level statistics for the 2013-2014 academic year reported by the NCES, which is 42 percent. This lends support to the accuracy of our postsecondary outcome assignment procedure.

Frictions in the financial aid application process How common is it to not apply for financial aid due to frictions in the financial aid application process? Here, application frictions refers to mistakenly believing oneself ineligible for aid or to filing costs due to difficult or confusing paperwork. To answer this question, we turn to the 2013 Update questionnaire. Regardless of postsecondary enrollment outcome, the 2013 Update asks the sample member (or their parent) whether or not they completed the FAFSA for themselves (or on behalf of the sample member) by that point in time. There are four possible replies: "Yes", "No", "Don't know what a FAFSA is", or "Not sure". If the answer to the FAFSA completion question is "No," then the questionnaire asks "Why not?" and provides a list of 7 possible reasons for not submitting the form. The survey asks

[4] Honors-weighting raises the total GPA of the individual if the difficulty of the course is higher (e.g., honors or college level). See the HSLS:09 2013 Update's Student file codebook and User Manual Appendix.

Table 1: Summary statistics

Category	Variable	Sample	
		Raw	Cleaned
Panel A: Demographic attributes	High school GPA	2.82	3.00
	Female	49.71	49.95
	Family income	76,106	83,125
	At least one parent BA+	35.48	40.19
	2-parent family	75.07	74.84
	Household size	4.27	4.23
Panel B: Enrollment outcome in fall 2013	Not enrolled		30.20
	2-year or certificate		27.17
	4-year Bachelor's		42.62
	Observations	13,283	7,145

Notes: Table 1 reports means of variables for the raw and cleaned samples from the HSLS:09. Dollar values are in 2012 USD. Weights are Second Follow-up student longitudinal weights. Source: HSLS:09.

the respondent to agree or disagree with each possible reason; respondents may agree with more than one reason or with none of them. This list is: believing themselves ineligible or unqualified, not knowing how to complete the FAFSA, not knowing that they could, because the forms were too much work, not wanting to go into debt, being able to afford college without financial aid, and not planning to continue their education. Appendix A.1.2 provides specific phrasing and additional details on these questions.

We group the 7 possible reasons for not filing a FAFSA into two categories, based on whether or not they are related to frictions in the FAFSA filing process. Reasons related to frictions are: “believing themselves ineligible or unqualified", "not knowing how to complete the FAFSA", "not knowing that they could”, and "because the forms were too much work". Believing oneself ineligible indicates not knowing that all aid applicants are eligible for unsubsidized Stafford loans—that is, information frictions. Information frictions can also broadly describe not knowing how to complete FAFSA forms or not knowing application was possible. Difficult forms reflect prohibitive costs of filing the FAFSA form.[5] Finally, reasons unrelated to frictions are: “being able to afford college without financial aid", “not planning to continue their education", and “because did not want to go into debt”. For each response grouping, we create a corresponding indicator equal to one if the respondent said that a FAFSA non-filing reason assigned to that grouping applied to them, and equal to zero otherwise.

In Table 2 we report statistics for all high school graduates and broken down by whether or not

[5]We do not include "Don't know what a FAFSA is" (one of the four possible replies to the question on FAFSA completion status) as reflecting a friction for two reasons. First, it is possible that the FAFSA form was filed without the knowledge of the respondent (e.g., we interpret this response as synonymous with "Not sure"). Second, this approach yields a lower-bound value for the percentage not filing for aid due to frictions.

the sample member enrolled in a Bachelor's degree in the 2014 academic year.[6] Those who do not enroll in a BA may have not enrolled in any postsecondary education or enrolled in a less-than 2-year or 2-year (sub-baccalaureate) program. Panel A reports the frequency of FAFSA filing statuses. Among all high school graduates, 69 percent report filing a FAFSA, while 21 percent specifically recall not filing one. The remaining respondents are uncertain: they either do not know what a FAFSA is or are not sure if one was completed on their behalf. Comparing across columns in Panel A, those who do not enroll in a BA are more likely to be a FAFSA nonfiler than enrollees.

In Panel B, FAFSA nonfilers are broken down into four mutually exclusive groupings for nonfiling reasons: only frictions, only not frictions, both, or no reason given. The frequencies of these four reasons add up to the total share of high school graduates who do not file a FAFSA in Panel A. Returning to Panel B, among all high school graduates, 4 percent do not apply for financial aid due to only frictions, while 6 percent do not apply due to only reasons unrelated to frictions, 7 percent due to both reasons, and 4 percent do not assent to any of the seven possible reasons suggested in the survey questionnaire. Compared to those who enroll in a BA, all of these reasons are cited more often among nonenrollees.[7]

Panel C reports that, overall, 11 percent of high school graduates cite frictions as a reason for not filing a FAFSA. Those who do not enroll in a BA are also more likely than enrollees to cite frictions as a reason for not filing: 14.3 percent of those who do not enroll in a BA fall into this group. In Table A6 of Appendix A.1.2 we show that this higher rate among BA nonenrollees is imperfectly correlated with postsecondary enrollment outcomes: 18 percent of those who do not enroll in any postsecondary education did not file a FAFSA due to frictions, while the corresponding rate is 10 percent of those who enroll in sub-baccalaureate programs. Table A7 in Appendix A.1.2 reports the frequency of not applying for aid due to frictions by skill tercile; for high school graduates, this frequency is highest in the lowest skill tercile (15 percent) and less common for those in the top skill tercile (8 percent). Among BA non-enrollees, however, a sizable share (12 percent) of the highest skill tercile cite frictions as a reason for not applying for aid. Returning to the second row of Panel C in Table 2, when asked their reason for not appying for financial aid, 13 percent of all high school graduates cite reasons unrelated to frictions (17 percent among non-enrollees).

Panel D offers a breakdown of the possible nonfiling reasons that we interpret as unrelated to

[6]In Table 2, the sample count for BA enrollees is higher than the sample count for nonenrollees despite the BA enrollment rate being less than 50 percent in Table 1. This is due to the use of survey weights.

[7]Table A5 of Appendix A.1.2 reports summary statistics of nonenrollees broken down by whether or not they are FAFSA nonfilers due to only frictions (Yes or No). Those in the "Yes" group are more likely to be female, have slightly lower income and parental education rates, and are less likely to enroll in a BA by 2016, compared to those in the "No" group.

frictions. Among the three reasons that we assign to the "non-frictions" group, not filing because they can afford college costs without aid is the most common response (7 percent), followed by not wanting to go into debt (6 percent). Not planning to enroll in postsecondary education is relatively rare, at 4 percent of all high school graduates; this response is strongly related to BA enrollment outcome, while the other two are relatively common among BA enrollees.

Table 2: FAFSA filing status and reasons for not filing

			Enrolled in BA	
Category	**Variable**	**All**	**No**	**Yes**
Panel A: FAFSA filing rates	Filers	69.01	55.14	87.68
	Nonfilers	21.20	29.82	9.59
	Uncertain	9.80	15.04	2.74
	Total	100	100	100
Panel B: FAFSA nonfiler reasons (mutually exclusive)	Only frictions	4.37	6.50	1.50
	Only not frictions	6.25	9.19	2.30
	Both	6.79	7.82	5.40
	No reason given	3.79	6.32	0.39
	Total	21.20	29.82	9.59
Panel C: FAFSA nonfiler reasons (not mutually exclusive)	Frictions	11.16	14.32	6.90
	Not frictions	13.04	17.00	7.70
Panel D: FAFSA nonfiler not frictions breakdown	Can afford without aid	7.34	7.69	6.87
	Do not want debt	5.98	7.99	3.27
	Not planning to enroll	4.12	7.14	0.06
	Observations	7,145	3,386	3,759

Notes: Table 2 reports FAFSA filing status frequencies and reasons for not filing a FAFSA, for all high school graduates and broken down by 2013 BA enrollment outcome. Weights are Second follow-up student longitudinal weights. Source: HSLS:09.

FAFSA filing frictions and BA enrollment The findings of Table 2 indicate that not filing a FAFSA due to frictions is more common among those who do not enroll in a BA, but they do not establish whether this association is accounted for by other attributes that may be correlated with not filing for aid due to frictions (for example financial resources, skill, or intent to attend college).

Do FAFSA filing frictions predict BA enrollment, controlling for other attributes? To answer this question, Table 3 begins by reporting the Average Marginal Effects (AMEs) for four probit models which all include flags for FAFSA nonfiling reasons as well as a set of demographic controls (high school GPA, logged parental income, an indicator for whether at least one parent has a BA or more, and an indicator for being female). Regression coefficients for all exercises in Table 3 are presented in Table A9 of Appendix A.1.3.

In models (1) and (2) of Table 3, the dependent variable is an indicator for BA enrollment in the 2013-2014 academic year. Model (1) includes an indicator for not filing a FAFSA due to frictions (and potentially also other reasons). Not filing a FAFSA due to frictions is associated with being 14.3 percentage points less likely to enroll in a BA. Because citing reasons related to frictions may be correlated in the population with other reasons, including not wanting to enroll in any postsecondary education, model (2) includes a flag for citing *only* reasons related to frictions, and adds a flag for not intending to enroll in any postsecondary education. Being a FAFSA nonfiler due to only frictions is associated with a 16 percentage point drop in the likelihood of enrolling in a BA, while not applying for aid due to not intending to enroll in any postsecondary education is associated with a 50.1 percentage point drop in the likelihood of enrolling in a BA. This sizable AME lends credibility to the survey responses for questions related to FAFSA nonfiling reasons.

In models (3) and (4), the dependent variable is redefined as an indicator that takes a value of one if the respondent enrolled in a BA at some point by the spring of 2016 (and zero otherwise), and exercises of models (1) and (2) are repeated. This outcome incorporates potential learning about financial eligibility, or using strategies other than financial aid to finance later enrollment in a BA program (such as saving or attending a 2-year program before transferring). Although the AMEs of interest for (3) and (4) are slightly smaller in magnitude than their counterparts in models (1) and (2), they retain their qualitative properties and statistical significance.

Does being a FAFSA nonfiler due to frictions predict BA enrollment because it is associated with a lower likelihood of applying to college, being accepted conditional on applying, or enrolling conditional on being accepted? To answer this question, in models (5), (6), and (7), we examine the AME of not filing a FAFSA due to only frictions for three outcomes: applying to at least one BA program, being accepted to at least one BA program conditional on applying, and enrolling in a BA program conditional on being accepted. To construct indicators for these outcomes, we use the 2013 Update to identify survey respondents who say that they applied to at least one BA program and those who say that they were accepted to at least one BA program.

In model (5) we regress an indicator that takes a value of one if the respondent applied to at least one BA, and zero otherwise, on a standard set of controls that includes an indicator for being a FAFSA nonfiler due to only frictions. On average, being a nonfiler due to only frictions is associated with a 12.1 percentage point lower likelihood of applying to at least one BA program. This AME is statistically significant at the 5 percent level. In model (6), we regress an indicator for being accepted to at least one BA program on the same set of controls, for the sample of those who applied to at least one BA. Being a FAFSA nonfiler due to only frictions is associated with a statistically insignificant and small change in the likelihood of being accepted to a BA conditional on applying. Finally, in model (7), we regress an indicator that takes a value of one if the respondent enrolls in a BA program, and zero otherwise, on the same set of controls, for the sample accepted to at least one BA program. Being a FAFSA nonfiler due to financial aid application frictions is associated with a 14 percentage point drop in the probability of BA enrollment among those accepted to a BA program. This AME is statistically significant at the 10 percent level.

Table 3: The Average Marginal Effect of Aid Application Frictions on Outcomes

	BA enrollment by:				Fall 2013 BA outcome:		
	Fall 2013		Spring 2016		Applied	Accepted	Enrolled
Control variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Flag: nonfiler frictions	-0.143		-0.118				
	(0.0190)		(0.0223)				
Flag: nonfiler frictions only		-0.160		-0.129	-0.121	-0.027	-0.140
		(0.0381)		(0.0350)	(0.0380)	(0.0367)	(0.0734)
Flag: nonfiler no PSE		-0.501		-0.440			
		(0.0150)		(0.0674)			
Skill (HS GPA)	0.261	0.252	0.251	0.241	0.217	0.076	0.158
	(0.0086)	(0.0090)	(0.0082)	(0.0085)	(0.0089)	(0.0103)	(0.0141)
Log parental income	0.078	0.071	0.077	0.071	0.043	0.016	0.051
	(0.0117)	(0.0100)	(0.0112)	(0.0113)	(0.0119)	(0.0084)	(0.0126)
Flag: At least 1 parent BA+	0.138	0.127	0.147	0.136	0.127	0.036	0.084
	(0.0200)	(0.0195)	(0.0198)	(0.0194)	(0.0195)	(0.0134)	(0.0246)
Flag: Female	-0.003	-0.009	0.003	-0.005	0.022	-0.002	-0.015
	(0.0161)	(0.0155)	(0.0150)	(0.0147)	(0.0187)	(0.0130)	(0.0211)
Sample	HS grads	HS grads	HS grads	HS grads	HS grads	Applied	Accepted
Observations	7,145	7,145	7,145	7,145	7,145	4,779	4,422

Notes: Table 3 reports AME results from probit regressions of various outcomes on flags for FAFSA nonfiling due to frictions and a set of additional controls. The dependent variable for models (1), (2), and (7) have an indicator for enrolling in a BA in the fall of 2013; for models (3) and (4), the dependent variable is an indicator for enrolling in a BA by the spring of 2016; for model (5), the dependent variable is an indicator for applying to at least one BA program; and, for model (6), the dependent variable is an indicator for being accepted to at least one BA program. The estimation samples for models (1), (2), (3), (4), and (5) is all high school graduates; for model (6), the sample is high school graduates who also applied to at least one BA program; for model (7), the sample is high school students who also were accepted to at least one BA program. Bootstrapped standard errors are in parentheses. Weights are Second follow-up student longitudinal weights. Source: HSLS:09.

Counterfactual financial aid outcomes How much financial aid would non-enrolled nonfilers affected by frictions receive, were they to apply for aid and enroll full-time in a BA? Anyone who files a FAFSA and enrolls at least part-time is eligible for unsubsidized Stafford loans, so all nonfilers leave the option for this form of aid on the table. As for means-tested aid, we impute eligibility for Pell grants for the cleaned sample of Table 1 (given the financial aid system outlined in Section 2, Pell grants are relatively deterministic compared to subsidized Stafford loans). Our imputation assigns a dollar amount of Pell grant eligibility for observations regardless of FAFSA filing status, drawing on descriptions of the 2013-2014 FAFSA form available in the EFC formula guide for 2014 academic year, prepared by the Federal Student Aid Office, U.S. Department of Education (2014). To proceed, we use the estimated EFC to impute the level of Pell grants that the respond would be eligible for were they to enroll full-time in a BA program, using Pell grant descriptions from a Congressional Research Service report (Dortch, 2023). Details of our imputation procedure are provided in Table A16 of Appendix A.1.4, and Table A17 of Appendix A.1.4 compares imputed and realized Pell grants among 2013-2014 BA enrollees who file a FAFSA. The median difference is zero.

Our findings on counterfactual Pell grant eligibility are reported in Table A10 of Appendix A.1.3. We find that about 4 percent of high school graduates are FAFSA nonfilers who are eligible for sizable amounts of Pell grant aid. This frequency is much higher among non-enrollees (6.55 percent) compared to those who enroll in a BA (less than one percent). We also compute the same statistics computed for those who do not file a FAFSA due to *only* reasons related to frictions. This exercise reduces ambiguity about which category of reasons is the determining factor in the nonfiling decison. As one would expect, the more restrictive definition of being a nonfiler due to frictions lowers the frequency in each column, but leaves unchanged the magnitudes of Pell grant eligibility. Overall, the qualitative takeaways are maintained.

Summary We have shown here that 11 percent of all high school graduates do not file a FAFSA due to frictions in the aid application process. These frictions may stem from information frictions (believing oneself ineligible) and filing costs (difficult paperwork). Not applying for financial aid due to frictions is associated with a lower likelihood of enrolling in a BA immediately after completing high school; this does not seem to be driven by not filing due to frictions being correlated with not intendening to enroll in postsecondary education. These findings remain when we examine BA enrollment up to three years after high school completion. We find that responses to the questionnaire about reasons for not filing for aid have intuitive implications for BA enrollment likelihoods: those who respond they did not file for aid because they do not intend to enroll in postsecondary education are indeed substantially less likely to enroll. Being a FAFSA nonfiler due to only frictions is associated with a lower likelihood of both applying to at least one BA program and of enrolling in a BA conditional on being accepted.

Of course, not filing a FAFSA due to application frictions is one of multiple margins that affect the costs and benefits of college and differ across potential college enrollees. Other individual attributes also affect the college enrollment decision, for example skill (and the associated lifetime returns to education) and financial support from parents. The impact on BA enrollment of not applying for financial aid due to frictions is therefore heterogeneous because it interacts with other attributes in the population. These interactions, as well as potential general equilibrium effects, motivate our analysis of the impact of financial aid application frictions in a model which incorporates such a joint distribution of attributes.

4 Model

We build an overlapping generations general equilibrium model in which high school graduates differ in skill, initial assets (determined by family transfers), eligibility for need-based aid, labor market productivity, and whether or not they are affected by federal financial aid application frictions. Specifically, the model includes a fraction of high school graduates who mistakenly believe themselves to be ineligible or find it too difficult to apply for federal aid. Those affected by such frictions anticipate that, were they to enroll in college, they will not receive any federal aid, which consists of Pell grants and student loans (both subsidized and unsubsidized). Similar to our analysis of the data on application frictions, in the model, we do not distinguish between those affected by mistaken beliefs and those who find it too difficult to file for federal aid.[8] Furthermore, as a true counterpart to the key determinant of federal financial aid, we also include a model equivalent for the EFC formula that determines the amount of Pell grants and subsidized federal student loans.

In what follows Section 4.1 overviews the agent problems. Section 4.2 presents the set of consumer value functions during the college phase. The value functions for the phases after the college phase are provided in Appendix B.1. Additional functional forms as well as the equilibrium definition are provided in Appendix B.2. The computational algorithm is provided in Appendix B.3.

4.1 Overview

Time is discrete and runs forever; each period lasts one year. The economy contains a government, a final goods firm, and heterogeneous consumers.

4.1.1 Government

The government provides grants for college education (including Pell grants), runs the federal student loan program, funds Social Security, and faces an exogenous government consumption set as a fraction g of gross domestic product (GDP).

Pell grants provide an amount that is based on the EFC, f, and the cost of attendance, $\kappa + \bar{c}$, where κ denotes tuition and fees and $\bar{c}$ denotes an amount for room and board. The Pell grant has a maximum value of θ^{Pell}_{max}, and is decreasing in the EFC, with a function given by

$$\theta^{Pell}(f) = \max[\min[\kappa + \bar{c} - f, \theta^{Pell}_{max} - f], 0] \quad (1)$$

The federal student loan program is characterized by a cumulative student loan limit for subsidized and unsubsidized loans, $\bar{A}$, a cumulative student loan limit for subsidized loans, $\bar{A}_s$, and a student loan interest rate, $r_{SL} = r + \tau_{SL}$, where r is the risk-free interest rate on savings and τ_{SL} is an

[8]Merging the application frictions into one is not consequential for our analysis for the following reasons. First, in our model, the result of both mistaken beliefs and difficulty in filing is anticipated lack of access to federal aid when making the enrollment decision. Second, in our main experiment we completely eliminate aid application frictions rather than eliminating one type of friction at a time.

add-on set by the government. The subsidized loan amount is determined by the year of college (which also indexes the consumer's age), j, EFC, cost of attendance, and the cumulative limit. The subsidized loan function is given by

$$a_s(j, a', f) = -\mathbb{I}_{a'<0} \min[-a', \tfrac{j}{4}\bar{A}_s, j \max[\kappa + \bar{c} - f - \theta^{Pell}(f), 0]] \tag{2}$$

This function stipulates the amount of federal loans taken out by the student that are treated as subsidized. In this function, the object $\frac{j}{4}$ scales the cumulative limit with each year of college. The function implies that, subject to the borrowing limit $\frac{j}{4}A_s$, subsidized loans can be used to pay for at most the cost of attendance net of the EFC and the Pell grant.

The EFC, f, is determined by the formula $EFC(y, a, d_{pj})$, which depends on parental income, parental net assets, and whether the applicant qualifies for a professional judgment by the financial aid administrator. Qualification for professional judgment is an indicator variable where $d_{pj} = 0$ represents the case in which the applicant does not qualify for a professional judgment and $d_{pj} = 1$ represents the case in which the applicant qualifies for a professional judgment. In the latter case, the income used to determine the EFC is scaled down by $\tau_{AAI} < 1$. This professional judgment feature captures unmodeled special circumstances (e.g., recent unemployment of a family member, tuition expenses at an elementary or secondary school, and medical expenses not covered by insurance) in which the aid administrator may lower the income used to determine the EFC. The probability that $d_{pj} = 0$, so that the income used to determine EFC remains unchanged, depends on income and is given by $\pi_{AAI}(y)$. The functional form for $\pi_{AAI}(y)$ is chosen so that the probability of not qualifying for a professional judgment increases with income (see equation (16) in Appendix B.2).[9] The formula that determines the EFC is provided in equation (18) in Appendix B.2. The EFC formula is such that families with low income and assets will have a low EFC, and therefore be eligible for more need-based aid (that is, Pell grants and subsidized loans).

Government expenditure is financed with tax revenue collected from a flat consumption tax, τ_c, and a progressive income tax and transfer function, $T(y)$, levied on pretax income, y. The income tax and transfer function follows the specification of Heathcote, Storesletten, and Violante (2017) and is given by

$$T(y) = y - \gamma y^{1-\tau_p} \tag{3}$$

where τ_p governs the tax progressivity and γ is used to balance the government budget constraint

[9] Incorporating the professional judgment feature allows our model to account for the positive Pell grant uptake rates observed among students from families in middle or high income terciles, as documented in Appendix C.2. In Section 6.4, we consider a sensitivity analysis in which no one qualifies for a professional judgment. For more details about special circumstances and professional judgment, see Program Communications Division, Federal Student Aid (2013).

in every period as shown in equation (24) in Appendix B.2.

4.1.2 Final goods firm

Output is produced by a final goods firm using a production function that combines aggregate capital, K, and aggregate labor, L, is Cobb-Douglas with capital share α. Aggregate labor, in turn, is a CES aggregator of efficiency units of labor with low education, L_ℓ, and high education, L_h, with elasticity of substitution $1/(1-\iota)$ and share parameter ν. Specifically, the final goods production function is given by:

$$Y = K^\alpha \left(Z\left((\nu L_\ell^\iota + (1-\nu)L_h^\iota)^{1/\iota}\right)\right)^{1-\alpha} \tag{4}$$

where Z is aggregate labor productivity. The capital stock depreciates at rate δ.

4.1.3 Consumers

Here, we overview the utility and pretax income functions before discussing the consumer's life cycle.

The consumer's flow utility function is given by, $U(c, x, j, e, d_f)$, in which the inputs are household consumption, c, hours worked, x, adult age and college year for the first four years, j, education, $e \in \{h, \ell\}$, and federal student loan delinquency decision, $d_f \in \{0, 1\}$. Education recorded with $e = h$ indicates a college student for $j \leq 4$ and a college graduate with a high level of education for $j > 4$, whereas $e = \ell$ indicates a consumer with a low level of education because they never enrolled or dropped out of college. The utility function is given by

$$U(c, x, j, e, d_f) = \frac{\left[\left(\frac{c}{\zeta_j}\right)^\upsilon \left(1 - x - \lambda \mathbb{I}_{e=h \text{ and } j\leq 4}\right)^{1-\upsilon}\right]^{1-\sigma}}{1-\sigma} + CV\mathbb{I}_{e=h \text{ and } j\leq 4} - d_f \xi_D \tag{5}$$

where ζ_j is an adult equivalence parameter that determines child consumption, 1 is time endowment (normalized), λ is college effort cost, υ is consumption share, σ determines the relative risk aversion, CV is a utility shifter for the consumption value of college, and ξ_D is a stigma cost associated with student loan delinquency.[10]

Pretax income $y_{j,e,s,\eta,a,x}$ is determined by age, education, skill, stochastic earnings productivity,

[10] The choice to incorporate leisure in the utility function endogenizes labor supply, which allows the model to generate enough income inequality in the lower end of the income distribution to match Pell uptake rates observed in the data. Furthermore, this choice allows us to separately model the effort cost of college and the consumption value of college.

net assets, and hours worked, as summarized by the tuple (j, e, s, η, a, x), and is given by

$$y_{j,e,s,\eta,a,x} = [w_\ell \epsilon_{j,\ell,s} \mathbb{I}_{j \leq 4} \mathbb{I}_{e=h} + w_e \epsilon_{j,e,s} \mathbb{I}_{j>4 \text{ or } e=\ell} \mathbb{I}_{j<j_r}] \eta x + ss_{e,s} \mathbb{I}_{j \geq j_r} + r \left[a \mathbb{I}_{j>1} \mathbb{I}_{a>0} + Tr_j \right] \quad (6)$$

where w_e is the wage rate, $\epsilon_{j,e,s}$ is a deterministic life cycle component, j_r is retirement age, $ss_{e,s}$ is the Social Security transfer defined in equation (22) in Appendix B.2, r is the risk-free savings rate, and Tr_j is accidental bequests of the deceased.[11] Equation (21) implies that labor earnings as well as Social Security transfers are determined based on completed education.

Consumers start making decisions when they turn 18 at $j = 1$. Adults survive each period with probability ψ_j, and live for a maximum of J periods. Figure 1 illustrates the phases of the consumer's adult life cycle, which we discuss next.

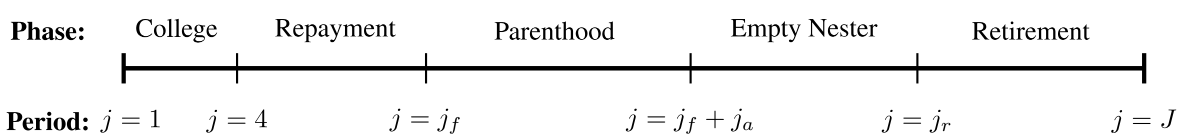


Figure 1: Phases of the consumer's life cycle

College phase At the start of adulthood, the consumer is indexed by skill, s, stochastic idiosyncratic earnings productivity, η, initial net assets, a, EFC, f, and an indicator of whether the consumer mistakenly believes themselves to be ineligible for federal financial aid or finds it too difficult to apply, b. The skill endowment of a new adult is drawn once from a uniform distribution; it indexes the college enrollment option shock, $q(s)$,[12] the exogenous probability of being allowed to continue in college conditional on being enrolled, $p(s)$, grants besides Pell, $\theta^{other}(s)$ and $\theta^{pr}(s)$, the deterministic life cycle component of earnings, $\epsilon_{j,e,s}$, and Social Security transfers, $ss_{e,s}$. The idiosyncratic stochastic component of earnings, η, follows an AR(1) process that depends on completed education. Net assets at the start of adulthood are determined by a one-time inter vivos transfer from the consumer's parent, and are recorded with $a \geq 0$. The EFC depends on the income and assets of each 18-year-old's parents, as well as on whether the enrollee qualifies for a professional judgment by the aid administrator, as described in more detail in Section 4.1.1. The indicator for being affected by aid application frictions, b, is a one-time draw at age 18 from a skill-specific binomial distribution. When $b = 1$, the consumer mistakenly believes themselves ineligible or finds it too difficult to file for federal aid (Pell grants and student loans), and therefore

[11] The indicator $\mathbb{I}_{j>1}\mathbb{I}_{a>0}$ implies that interest income on the inter vivos transfer accrues to the parents and not the newly emancipated child who has age $j = 1$.

[12] The shock captures unmodelled reasons that lead a consumer to not go to college such as personal preference and lack of acceptance by a college they would like to enroll in.

anticipates receiving no federal aid during college when making the college enrollment decision (the timing is clarified in the next paragraph). When $b = 0$, the consumer has the correct beliefs about eligibility and faces no difficulty in applying for federal aid.

The timing for aid application frictions is such that if consumers with $b = 1$ enroll in college despite their anticipation of no federal aid in college, upon enrollment these consumers apply and qualify for aid.[13] This timing assumption implies that the financial aid application frictions only affect the enrollment decision, which is focus of this paper, and not the dropout decision. One can interpret this timing assumption as follows: those who mistakenly believe themselves ineligible for aid update their beliefs upon enrollment, while those who found it too difficult to file for aid in fact realize that it is not too difficult to file for aid. In Section 6.4, we provide a sensitivity analysis in which the consumer with $b = 1$ maintains the anticipated lack of access to federal aid after enrollment.

While enrolled, college students incur a non-pecuniary effort cost, λ, but also benefit from a non-pecuniary consumption value of college, CV. Non-discretionary college expenses include only tuition and fees, κ; these expenses can be financed with federal student loans (the only form of debt in the model) where the stock of debt is recorded with $a < 0$, inter vivos transfers from parents, earnings from work while enrolled, Pell grants, other public grants, and private grants. College graduation leads to a high educational attainment, while all other consumers (non-enrollees, enrollees still in college, and dropouts) are considered to have a low educational attainment. Educational attainment indexes the return to labor supply, w_e, the deterministic component of life cycle earnings, $\epsilon_{j,e,s}$, the parameters for the AR(1) process for earnings, that is, the persistence, ρ_e, and the variance, σ_e^2, and Social Security transfers, $ss_{e,s}$.

Repayment phase Repayment of federal student loans begins after the college phase at age $j = 5$; subsidized federal loan balances have interest assessed starting at this age, whereas interest accrues on unsubsidized federal loan balances during college as well. During the repayment phase, consumers choose between making a full payment, $d_f = 0$, and delinquency, $d_f = 1$. A full payment implies that the consumer must make a payment of at least $\rho_R(j, a)$, whereas delinquency leads to a partial payment, $\rho_D(j, a, y)$, due to garnishment of disposable income above the amount $\bar{y}$ at the rate τ_g; additional costs of delinquency are a collection fee that is proportional to the missed payment, ϕ, and a utility cost, ξ_D. The payment functions are provided in Appendix B.2.

Parenthood and empty nester phase Upon paying off student loans, consumers solve a consumption-savings problem which at certain ages is affected by the presence of a child. Specifically, all consumers have a child at age j_f. At the beginning of age $j_f + j_a$, the family draws the child's skill

[13] Note that one can apply for federal financial aid by filing a FAFSA at any point before the end of the academic year (Chief Operating Officer for Federal Student Aid, 2013).

endowment, s_c, and the family's aid application frictions indicator, b. The parent then makes an inter vivos asset transfer to their child, altruistically taking into account both the child's skill and the family's aid application frictions indicator.

Retirement phase Consumers retire at age j_r and receive Social Security transfers until they die.

4.2 Consumer value functions during the college phase

Given their type, (s, η, a, f, b), the lifetime expected value to an 18-year-old (that is, $j = 1$ in the model) is given by

$$\begin{aligned} W(s,\eta,a,f,b) =& (1-q(s))V(j,\ell,s,\eta,a) \\ &+ q(s)[\max_{d_e\in\{0,1\}}(1-d_e)V(j,\ell,s,\eta,a) + d_e V(j,h,s,\eta,a,f,b)] \end{aligned} \tag{7}$$

where $V(j, \ell, s, \eta, a)$ is the value of not going to college and $V(j, h, s, \eta, a, f, b)$ is the value of college. The value of not going to college or dropping out for $j \in \{1, 2, 3, 4\}$ is given by

$$\begin{aligned} &V(j,\ell,s,\eta,a) = \max_{c\geq 0, a', x\in X} U(c,x,j,e=\ell,d_f=0) + \beta\psi_j E_{\eta'|\ell,\eta} V(j+1,\ell,s,\eta',a') \qquad (8) \\ &s.t. \\ &(1+\tau_c)c + a' = y_{j,\ell,s,\eta,a,x} + a + Tr_j - T(y_{j,\ell,s,\eta,a,x}) + \mathbb{I}_{a<0} r_{SL} a \\ &a' \geq \min[a,0] \end{aligned}$$

where a' is the stock of assets or federal student loans in the next period and β is the discount factor. The value of enrolling in college for the first three years, $j \in \{1, 2, 3\}$, is given by

$$\begin{aligned} &V(j,h,s,\eta,a,f,b) = \max_{c\geq 0, a', x\in X} U(c,x,j,e=h,d_f=0) + \qquad (9) \\ &\beta\psi_j E_{\eta'|\ell,\eta}\big[p(s)\max[V(j+1,h,s,\eta',a',f,b), V(j+1,\ell,s,\eta',a')] + (1-p(s))V(j+1,\ell,s,\eta',a')\big] \\ &s.t. \\ &(1+\tau_c)c + a' + \kappa = y_{j,h,s,\eta,a,x} + a + Tr_j - T(y_{j,h,s,\eta,a,x}) + \theta^{other}(s) + \theta^{pr}(s) \\ &+ (1-b)\theta^{Pell}(f) + r_{SL}(\mathbb{I}_{a<0} a - (1-b)a_s(j,a',f)) \\ &a' \geq -(1-b)\tfrac{j}{4}\bar{A} \end{aligned}$$

where $\theta^{Pell}(f)$ and $a_s(j, a', f)$ are functions that determine Pell grants and subsidized federal student loans, defined in equations (1) and (2), and $\frac{j}{4}\bar{A}$ determines by each year of college the cumulative limit for both subsidized and unsubsidized loans. Note that when $b = 1$, the constraints imply that the consumer anticipates no federal aid (that is, no Pell grants or student loans). The continuation value reflects that, apart from exogenously dropping out, consumers may also choose to drop out before the start of the next academic year if given the option to continue.

As mentioned above, for consumers with $b = 1$, we assume that they can freely access federal aid determined by the EFC immediately after enrolling in college. Therefore, for these consumers, only the enrollment choice is based on their mistaken beliefs (or the difficulty in filing for aid). However, conditional on enrollment, the consumption-savings and dropout decisions are based on the case in which $b = 0$. Of course, consumers with $b = 1$ do not foresee that they will update after enrollment when they are deciding whether or not to enroll. This lack of foresight is reflected in the continuation value of equation (9), where b remains fixed in expectation.

The value function at $j = 4$ is a slightly modified version of (9): as long as the consumer is allowed to continue and graduate, the AR(1) draw in the next period will be made from the distribution for the high-education labor and there will be no endogenous dropout decision.

5 Parameterization and Model Validation

Section 5.1 explains the model parameterization; Section 5.2 validates the model's calibrated baseline equilibrium.

5.1 Parameterization

We begin with Table 4, which reports the most important externally estimated parameters: the skill-specific shares of families with high school graduates affected by aid application frictions, $\pi_b(s)$. These values are set using estimates of those affected by aid application frictions in the HSLS:09, reported in Table A7 of Appendix A.1.2. The mapping of the model to the data is as follows. In the HSLS:09, we observe the skill-specific shares of high school graduates who cite aid application frictions as a reason to not file a FAFSA before the beginning of college. In the model, those with $b = 1$ are affected by aid application frictions and will not anticipate any federal aid when making the college enrollment decision. Therefore, this population can be interpreted as one that will not file a FAFSA before the beginning of college due to aid application frictions. The remaining externally estimated parameters are presented in Table 13 of the Appendix.

Table 4: Main externally estimated parameters: aid application frictions

Parameter	Description	Data	Value
$\pi_b(s)$	Shares with $b = 1$ by s	HSLS:09	$(0.149, 0.102, 0.083)$

Table 5 reports internally calibrated parameters. The first column contains the parameter symbol;

the second column, the parameter description; and the third column, the parameter value. Columns 4 through 6 contain the target moment's description, the moment in the data, and the moment in the calibrated model, respectively. Although parameters and moments are grouped using the most significant one-to-one relationship between each parameter and target moment, and are discussed accordingly, note that the parameters are calibrated jointly and each parameter can affect all target moments. In several rows within this table, we note that the moment is normalized by gross domestic product (GDP) per capita for those 18 and over. This value is computed by combining information on GDP from BEA (2022, T1.1.5) with population levels from the US Census Bureau (Census Bureau of the United States, 2020) for 2013-2015.

Panel A of Table 5 presents parameters governed by moments from the HSLS:09. Empirical moments are reported in Appendix A.1.3; the first three rows draw on Table A11, the fourth row Table A13, and the last two rows Table A15. The first row of Table 5 reports $p(s)$, which determines the skill-specific probability of being allowed to continue in college; these values are chosen to target rates of persistence to the end of the third academic year (Y3), given enrollment in a 4-year BA program (Y1). Next is the consumption value of college, CV, which is set to match the observed BA enrollment rate in the fall of 2013. The college option shock, $q(s)$, is chosen to target enrollment rates by skill for the top family income tercile; focusing on enrollment rates of young people from high-income families minimizes the role of financial constraints in the enrollment decision, so that the shock instead captures unmodeled reasons for non-enrollment such as personal preference and lower likelihood of acceptance into college. The college effort cost, λ, is set to match the average weekly hours worked while in college as a fraction of 40 hours (full-time work) for third-year college students. The next two rows contain ϕ_{AAI} and τ_{AAI}. Respectively, these are the parameters that govern the probability function in equation (16), which determines qualification likelihood for professional judgment, and the proportion by which income is scaled conditional on qualification for professional judgment in equation (17). These parameters are chosen to match uptake of Pell grants in the middle income tercile in both the extensive and intensive margin. The last two rows of the panel contain the vectors representing tuition and fees paid with grants and scholarships from public sources other than Pell grants, $\theta^{other}(s)$, and private sources, $\theta^{pr}(s)$, and are set to match the ratios of public grants net of Pell to tuition and private grants to tuition. These ratios are determined using data from the HSLS:09 and incorporating estimates from Krueger and Ludwig (2016); see Appendix A.1.1 for details and Table A12 for results.

Panel B of Table 5 reports parameters governed by moments from sources other than the HSLS:09. In the first row of Panel B, the degree of parental altruism, β_c, is set so that the model matches average parent-to-child transfers in the 1997 National Longitudinal Survey of Youth, reported in Table A22 of Appendix A.2.3. The discretionary cost of college (room and board), $\bar{c}$, targets

Table 5: Internally calibrated parameters

Symbol	Parameter description	Parameter value	Moment description	Data moment	Model moment
Panel A: Moments from the HSLS:09					
$p(s)$	Continuation prob. average	(0.793,0.890,0.958)	Persist to Y3 | Enrolled Y1	*(0.550,0.768,0.913)*	*(0.552, 0.768,0.913)*
CV	Consumption value	4.121	Enrolled fall 2013	*0.426*	*0.426*
$q(s)$	Enrollment option shock	(0.393,0.763,0.864)	Enr. fall 2013 | High income	*(0.212,0.606,0.836)*	*(0.212,0.605,0.836)*
λ	Net college effort cost	0.456	Average hours in Y3 / Full time hours	*0.350*	*0.350*
ϕ_{AAI}	AAI adjustment probability	0.979	Pell extensive margin | Middle income	*0.460*	*0.460*
τ_{AAI}	AAI adjustment scale	0.089	Pell intensive margin, normalized | Middle income	*0.058*	*0.058*
$\theta^{other}(s)$	Public grants net of Pell by s	(0.043,0.049,0.065)	Public grants net of Pell to tuition	*(0.204, 0.228, 0.305)*	*(0.204, 0.228, 0.305)*
$\theta^{pr}(s)$	Private grants by s	(0.028,0.029,0.034)	Private grants to tuition	*(0.133, 0.138, 0.158)*	*(0.133, 0.138, 0.158)*
Panel B: Moments from other sources					
β_c	Parent altruism toward child	0.113	Average transfer, normalized	*0.579*	*0.578*
$\bar{c}$	College room and board	0.146	Room + board, normalized	*0.146*	*0.146*
κ	Annual tuition	0.213	Net tuition + fees, normalized	*0.097*	*0.097*
$\bar{y}$	Garnishment-exempt income	0.152	Exempt earnings, normalized	*0.152*	*0.152*
ξ_D	Federal delinquency cost	0.087	Federal delinquency rate	*0.088*	*0.086*
ν	Low-education labor share	0.460	College wage premium | s_2	*1.420*	*1.422*
Z	Aggregate labor productivity	1.542	GDP per capita 18+	*1.000*	*1.000*
β	Discount factor	0.981	Capital-to-output ratio	*3.000*	*3.000*
χ	SS replacement rate	0.195	SS expenditure, fraction of GDP	*0.048*	*0.048*
υ	Consumption share utility	0.418	Average work hours = full time	*0.333*	*0.333*

average annual room and board; the non-discretionary cost (annual tuition), κ, targets average annual net tuition and fees. Both empirical moments are computed for bachelor's degree programs from 2013-2015 using data contained in a College Board report (Ma, Pender, and Libassi, 2020), supplemented with information from NCES (2019). The income exempt from garnishment in delinquency, $\bar{y}$, is set to 0.152 based on our calculations using results from Yannelis (2020). The parameter governing the costs of being delinquent on public loans, ξ_D, targets the average cohort delinquency rate 2013-2015 reported in FSA (2021b) (e.g., a delay in payment of 270 days or more). The parameter that determines the labor share for low-education labor, ν, is set so that the college wage premium for the middle skill tercile matches that observed in the data, reported in Table A21 of Appendix A.2.2. Aggregate labor productivity, Z, is set so that GDP per capita for the population aged 18 and over is one in the model. The discount factor, β, is calibrated to target a capital-to-output ratio of 3, consistent with Jones (2016). The Social Security replacement rate, χ, targets the average ratio of total Social Security expenditure to GDP, estimated using 2013-2015 data from BEA (2022, T2.1) and BEA (2022, T1.1.5). Lastly, the consumption share in the utility function, υ, is calibrated so that the average non-retiree works full time, ft, which is parameterized in Panel A of Table 13 in the Appendix.

5.2 Model validation

We validate the model's calibrated baseline with three main exercises. These exercises compare the model with the data in terms of the role of aid application frictions in driving enrollment, the response of the college enrollment rate to grants, and enrollment rates by skill and parental income terciles. Supplemental exercises, presented in Appendix C.1, show that the model also accounts for sorting of those affected by application frictions into enrollment and non-enrollment outcomes, decreasing Pell grant uptake by income, and increasing college wage premiums by skill level.

1. Probit on enrollment likelihood In Table 6, we report AME values for a probit on the sample of high school graduates. The dependent variable is an indicator for BA enrollment, and the independent variables include an indicator that takes a value of one for for those who, prior to college, do not file a FAFSA due to frictions. In the data this population is identified in survey responses, corresponding to column (1) in Table 3 of Section 3, while in the model this is the population for whom $b = 1$. Additional controls are described in the table notes. Not filing a FAFSA due to frictions is associated with a 14 percentage point reduction in the likelihood of enrollment in a BA in the data and a 17 percentage point lower likelihood in the model. This validation establishes that aid application frictions play a quantitatively plausible role in predicting college enrollment in the model.

Table 6: Probit on enrollment likelihood: Average Marginal Effect

Flag	**Data**	**Model**
Flag: Nonfiler, frictions	-0.14	-0.17

Notes: Table 6 reports the AME for the flag on FAFSA nonfilers affected by aid application frictions in the data and the model from a probit regression on enrollment likelihood. The sample for the probit is all high school graduates. Additional controls included in the probit are skill, parental income, parental education, and (in the data) gender. Data source: HSLS: 09.

2. Enrollment rate response to $1,000 subsidy Table 7 presents enrollment rate response estimates from a quasi-natural experiment in which prospective college students are given a $1,000 subsidy to attend college. The empirical estimate for the enrollment rate response, based on Deming and Dynarski (2009), is 4.00 percentage points. In the model, the analogous non-targeted estimate is 5.18 percentage points, close to its empirical counterpart.

Table 7: Enrollment rate response to $1,000 subsidy

Quasi-Natural Experiment	**Data**	**Model**
Enrollment change due to additional $1,000 tuition subsidy	4.00	5.18

Notes: Table 7 presents estimates for the enrollment rate response given a subsidy of $1,000 in the data and model. In the model, the enrollment rate response is computed in a partial equilibrium in which the distribution of 18-year-olds and general equilibrium prices, taxes, and transfers are held fixed at their initial steady state values. Data source: Deming and Dynarski (2009).

3. Enrollment rates by parental income and skill Figure 2 depicts enrollment rates of high school graduates, broken down by parental income and high school graduate skill tercile. Empirical values are drawn from Table A3 of Appendix A.1.3. Only enrollment rates by skill for the top parental income tercile are targeted in the model's calibration. The model generates the same broad qualitative pattern observed in the data: enrollment rates are increasing in parental income within each skill tercile, and increasing in skill within each parental income tercile.

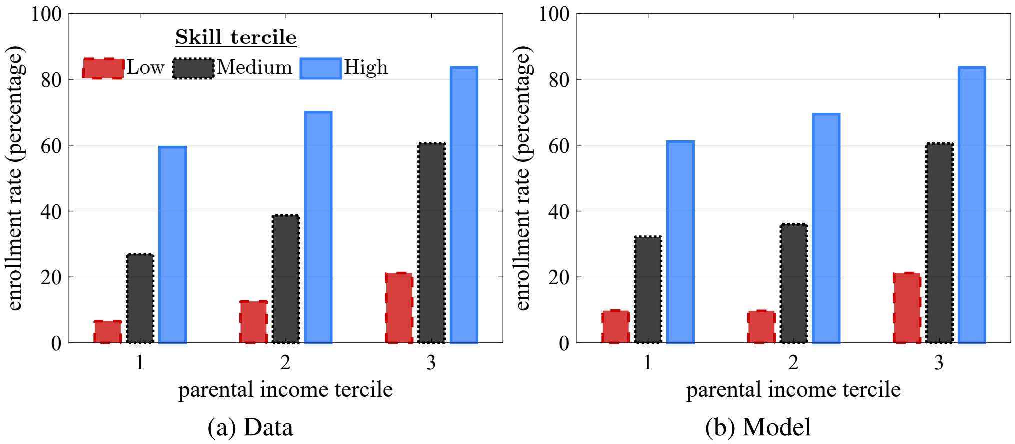


Figure 2: BA enrollment rates by parental income and high school graduate skill tercile

Notes: Figure 2 depicts bachelor's degree enrollment rates by parental income tercile and high school graduate skill tercile in the data and the model. Data source: HSLS:09.

6 Results

In both the model and the data, roughly 14 percent of high school graduates who do not enroll in college are affected by financial aid application frictions (Table A27 of Appendix C.1). Although this share is sizable, not all of these potential college enrollees would choose to enroll in college if application frictions were removed. This motivates Section 6.1, in which we quantify the extent of under-enrollment using our model framework. The under-enrolled are defined as those affected by aid application frictions $(b = 1)$ who do not enroll in college, but would otherwise $(b = 0)$. Subsequently, in Section 6.2, we analyze an experiment in which we eliminate all aid application frictions. This experiment allows us to quantify the welfare cost of aid application frictions, while taking into account skill-specific shares of high school graduates affected by aid application frictions, skill-specific lifetime returns to education, as well as potential intergenerational and general equilibrium effects. In Section 6.3, we quantify how the elimination of aid application frictions increases the value of the FSA program for the average 18-year-old. Finally, Section 6.4 provides sensitivity analyses.

6.1 Baseline equilibrium: Under-enrollment

Table 8 reports the extent of under-enrollment in the model's baseline equilibrium. Under-enrollment among all non-enrollees is 2.30 percent. Futhermore, the percentage who are under-enrolled is increasing in skill; this pattern is due to the model feature that lifetime returns to education are increasing in skill.[14]

Table 8: Under-enrollment in the baseline equilibrium

	Skill		
All	**Low**	**Medium**	**High**
2.30	1.05	2.27	6.33

Notes: Table 8 reports under-enrollment as a percentage of non-enrollees, overall and by skill. A high school graduate who has the option to enroll in college is defined to be an under-enrollee if they do not enroll because they are affected by aid application frictions ($b = 1$), but would enroll otherwise ($b = 0$). This exercise is performed for each individual and does not take into account intergenerational or general equilibrium effects.

If under-enrollment were equal to zero, eliminating aid application frictions essentially would have no effect on the model's equilibrium.[15] However, as indicated by Table 8, under-enrollment is sizable. This leads us to study the experiment in which we eliminate aid application frictions.

6.2 Experiment: Eliminating aid application frictions

In this section we eliminate aid application frictions by setting $b = 0$ for all consumers. Before examining the welfare implications, we analyze the effects on education and skill statistics, macroeconomic aggregates, and prices.

Aggregate changes across steady states The effects of eliminating aid application frictions on the model's steady state equilibrium are summarized in Table 9, which reports changes in education and skill statistics (Panel A), macroeconomic aggregates (Panel B), and prices, the income tax rate, and transfers (Panel C), compared to the baseline equilibrium.

The first row of Panel A indicates that enrollment rates increase for each skill level, but especially for medium- and high-skill young adults. The next row of Panel A indicates that the college graduation rate decreases; this happens because the skill composition of enrollees shifts towards the low- and medium-skill tercile. Nevertheless, on net in the new steady state the higher enrollment rate leads to more college graduates, as indicated in the last row of the panel.

Moving to Panel B, the increase in the mass of college graduates increases the total efficiency units of labor, which increases total labor earnings. Higher earnings, in turn, increase both savings and aggregate capital. This rise in factor inputs increases output and, consequently, consumption

[14] Lifetime returns to education are increasing in skill for several reasons. First, those with higher skill face lower dropout risk (see the parameter estimates for $p(s)$ in Table 5 in Section 5.1). Second, those with higher skill have a higher college wage premium (see Table A29 of Appendix C.1).

[15] If under-enrollment were zero, there could still be a second order effect in which parents respond by changing their inter vivos transfer decision once aid application frictions are eliminated.

Table 9: Steady state changes after aid application frictions

Category	Variable	Changes from baseline equ.
Panel A: Education and skill statistics	College enrollment rate by s	(1.05,1.64,1.91)
Units: percentage point change	Graduation rate	-0.27
	Population share college graduates	0.97
Panel B: Macroeconomic aggregates	Low-education labor efficiency units	-1.38
Units: percentage change	High-education labor efficiency units	3.10
	Labor	0.46
	Capital	0.38
	Output	0.43
	Consumption	0.43
Panel C: Prices, income tax rate, transfers	Risk-free savings interest rate	0.01
Units: percentage point/percentage change	Wage rate for low-education	0.35
	Wage rate for high-education	-0.48
	Income tax rate ǀ Baseline mean income	-0.05
	Inter vivos transfers	0.40
	Accidental bequests	0.48
	$\mathrm{ss}_{\ell,s}$ by s	(0.39,0.40,0.41)
	$\mathrm{ss}_{h,s}$ by s	(-0.07,-0.11,-0.15)

Notes: Table 9 provides results from a steady state comparison of the baseline economy with an economy in which aid application frictions are eliminated. Panels A, B, and C report changes in education and skill statistics, macroeconomic aggregates, and prices, income tax rate, and transfers, respectively. Statistics that vary over s are presented as a tuple in the order (s_1, s_2, s_3).

increases.

Panel C of Table 9 indicates that the risk-free savings rate barely changes. The wage rate for those with low-education increases, whereas the wage rate for those with high-education decreases. This happens because of the fall and rise in the labor supply of each respective education group. The next row indicates that the income tax rate at the baseline equilibrium's average income decreases slightly; this happens because, in our model economy with progressive income taxation, a rise in the share of high income consumers allows the average tax rate γ to fall. Inter vivos transfers increase because the economy is richer due to the presence of more college graduates. The changes in Social Security are in the same direction as changes in the wage rate of the respective education groups.

To summarize, eliminating aid application frictions not only increases enrollment but also leads to sizable intergenerational effects (inter vivos transfers increase), and sizable general equilibrium effects (the wage rate increases for low-education workers and decreases for high-education workers). Together, these changes motivate us to quantify the welfare cost of aid application frictions in partial and general equilibrium.

Welfare changes We compute welfare changes for 18-year-olds, both for those affected by aid application frictions who do not enroll in college in the baseline equilibrium and for the unconditional average. Welfare is measured as the percent change in both lifetime consumption and leisure needed to make consumers indifferent across equilibria. The welfare estimate is computed from the perspective of a social planner who calculates expected lifetime utilities taking as given the policy functions of consumers, and who also understands that young adults with $b = 1$ update to $b = 0$ if they happen to enroll in college in the baseline equilibrium. Details of the welfare calculation are provided in Appendix B.4.

Table 10: Welfare gains for 18-year-old non-enrollees affected by aid application frictions

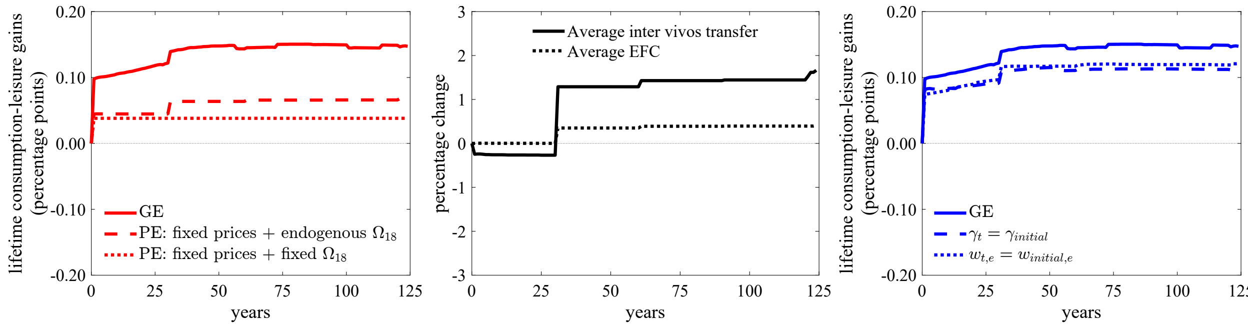
		Skill		
Equilibrium type	**All**	**Low**	**Medium**	**High**
Partial	0.36	0.05	0.22	1.56
General	0.50	0.19	0.36	1.66

Notes: Table 10 reports the welfare gains from eliminating financial aid frictions for non-enrollees affected by the friction in the baseline's initial equilibrium. The gains are reported in lifetime consumption and leisure units in both partial and general equilibrium.

The welfare gains from eliminating aid application frictions quantify the cost of aid application frictions in the baseline equilibrium. Table 10 reports the welfare gains from removing aid application frictions for 18-year-old non-enrollees affected by the frictions in the baseline initial equilibrium. The first row of the table indicates that, in partial equilibrium, the average gains amount to 0.36 percent of lifetime consumption and leisure. These gains are higher for those with higher skill. The second row indicates that general equilibrium effects amplify welfare gains from eliminating aid application frictions. We provide intuition for this general-equilibrium result in the discussion of the welfare effects for the average 18-year-old, which we turn to next.

Figure 3 provides a welfare analysis of the gains for the average 18-year-old from eliminating aid application frictions. Specifically, Figure 3a shows that the gains are magnified by both intergenerational and general equilibrium effects. In the partial equilibrium without intergenerational and general equilibrium effects, the dotted line of the figure (labeled "PE: fixed prices + fixed Ω_{18}") shows that the welfare gains are smallest. Once we allow for intergenerational effects, whereby the initial conditions of 18-year-olds change due to changes in inter vivos transfers and EFCs, the gains increase as indicated by the dashed line (labeled "PE: fixed prices + endogenous Ω_{18}"). Finally, once we take general equilibrium effects into account as indicated by the solid line (labeled "GE"), the welfare gains from eliminating frictions is highest.

Figures 3b and 3c provide intuition for why intergenerational and general equilibrium effects magnify the gains from eliminating aid application frictions. Figure 3b depicts the evolution of the average inter vivos transfer and the average EFC along the transition path, holding fixed general equilibrium objects at their initial steady state level. New 18-year-olds benefit from higher inter vivos transfers, but the effect is partially offset by higher initial EFCs (which lower eligibility for



(a) Welfare gains in PE and GE (b) EFC and Inter vivos transfer (c) Welfare gains GE decomposition

Figure 3: Welfare gains for average 18-year-old and partial and general equilibrium effects

Notes: Figure 3a depicts the welfare gains from eliminating aid application frictions to the average 18-year-old in each period of the transition under the following cases separately: (1) a partial equilibrium in which the income tax rate, prices, bequests, Social Security transfers, and the 18-year-old distribution are fixed at their initial steady state values; (2) a partial equilibrium in which the income tax rate, prices, bequests, and Social Security transfers are fixed at their initial steady state values, but the 18-year-old distribution is endogenous; and (3) general equilibrium. Figure 3b depicts the evolution of the averages of the inter vivos transfer and the EFC along the transition path holding fixed general equilibrium objects at their initial steady state level. Figure 3c depicts welfare gains for the average 18-year-old in each period of the transition under the following cases separately: (1) general equilibrium, (2) wage rates for each education level, $w_{t,e}$, fixed at their initial levels; and (3) income tax level parameter, γ_t, fixed at its initial level.

need-based aid). Figure 3c depicts the gains of eliminating aid application frictions in three cases: general equilibrium, when wage rates are fixed at their initial levels, and when the income tax rate is fixed at its initial level. In the latter two cases all other general equilibrium transition path values are fed into the model except the object that is being held fixed. In each of these cases, the gains are smaller than in general equilibrium, indicating that adjustments to these objects in general equilibrium act to magnify welfare gains. Intuition for this result comes from the results of Table 9, which indicate that the wage rate decreases for high-education workers and increases for low-education workers. This change is beneficial for the average 18-year-old because it provides insurance against having a low skill draw. A fall in the tax rate, as reported in Table 9, is beneficial because it increases disposable income.

6.3 Experiment: Value of the Federal Student Aid program

Thus far, our analysis quantified the welfare benefits of eliminating aid application frictions. Here, we consider how aid application frictions affect the value of the FSA program for the average 18-year-old. To begin, we compute the value of federal aid by removing it from both the baseline model with frictions and from the model without frictions. As shown in Table 11, when aid application frictions are present, the value of the federal aid program is 1.93 percent of lifetime consumption and leisure; without frictions, the value of the program rises to 2.08 percent of lifetime consumption and leisure. Therefore, the elimination of aid application frictions increases the value of the FSA program by nearly 8 percent.

Table 11: Value of FSA for average 18-year-old

Model economy	**Value**
Baseline (aid application frictions)	1.93
No aid application frictions	2.08
Percentage change in value of FSA	7.77

Notes: Table 11 reports the welfare loss from eliminating the FSA program for the average 18-year-old across steady states in general equilibrium in lifetime consumption and leisure units under two cases: (1) baseline economy, which has aid application frictions, and (2) baseline economy without aid application frictions.

6.4 Sensitivity analyses

In this section, we provide sensitivity analysis for our main experiment from Section 6.2 in which we compute the welfare gains from eliminating aid application frictions. Specifically, we found that in general equilibrium the gains amount to 0.5 percent of lifetime consumption and leisure for non-enrollees affected by the frictions in the initial equilibrium of the baseline calibration. We find that this estimate is robust to several alternative specifications. In the discussion that follows, we discuss the motivation for each sensitivity analysis and the details of the re-specified model. Each re-specification has been re-calibrated to target the same set of moments as the baseline calibration to the extent possible.

Table 12: Sensitivity: welfare for 18-year-old non-enrollees affected by aid application frictions

Model specification	**All**
Baseline	0.50
$b = 1$ do not update after enrollment	0.44
Flat income taxation	0.56
Skill | Parental education	0.44
Skill measure for earnings: ASVAB	0.42
Alternative EFC function	0.33

Notes: Table 12 reports the welfare gains from eliminating financial aid application frictions for non-enrollees affected by the friction in general equilibrium under the following cases: the baseline, flat income taxation ($\tau_p = 0$), consumers affected by aid application frictions, that is, those with $b = 1$, do not update to $b = 0$ if they enroll in college, child skill probabilities, $\pi_{s_c}(s_c)$, depend on parental education, earnings process is re-estimated using ASVAB instead of high school GPA as a measure of skill, and the EFC function is re-specified in which income from actual work hours rather than income assuming full time work hours is used as an input and there is no qualification for professional judgment. The gains are reported in lifetime consumption and leisure units.

In the baseline calibration, we assume that if consumers with $b = 1$ enroll in college, they apply and qualify for aid immediately after enrollment (despite anticipating no federal aid when making their enrollment decision). In the second row of Table 12, we consider a sensitivity analysis in which such an update does not happen.

Figure 3c indicates that the fall in the income tax rate makes a sizable contribution to welfare gains from eliminating aid application frictions in general equilibrium. In the third row of Table 12, we recompute the gains assuming flat income taxation.

In the baseline, child skill was assumed to be uniformly distributed and independent of parental education. In the data, child skill tends to be increasing in parental education as indicated by Table A14 of Appendix A.1.3. In the fourth row, we consider a sensitivity analysis in which the child skill probability distribution is a function of parental education and is parameterized using the estimates provided in Table A14.

Our measure of skill in the HSLS:09, the data set we use to document aid application frictions, is honors-weighted high school GPA. In the HSLS:09, there is no counterpart to ASVAB, which is the more commonly used measure of skill in the NLSY97. For the sake of consistency, in the baseline calibration we used high school GPA as the measure of skill when we estimated the skill shifters of the earnings process using data from the NLSY97 (Appendix A.2). In the fifth row of Table 12, we consider a sensitivity analysis in which the skill shifters for the earnings process are estimated using ASVAB as a measure of skill.

In the baseline model, the EFC was computed using income assuming full time work hours and included a shock for qualification for professional judgment. As Table A30 of Appendix C.2 indicates, these two features allow the model to better account for Pell uptake rates by income. In order to examine the consequences of not capturing these patterns for our main result, in the last row of Table 12, we consider a sensitivity analysis in which the input into the EFC is income from actual hours of work rather than income assuming full time work hours and there is no qualification for professional judgment. The somewhat lower welfare estimate in this sensitivity analysis highlights the importance of accounting for Pell uptake rates in the baseline model.

7 Conclusion

The federal student aid system of the United States has long been fraught with frictions in the process of applying for aid. The potential gains from reforming this financial aid system depend in part on the welfare costs that the presence of aid application frictions inflict on consumers. However, the extent of these frictions at the national level, as well as the ensuing under-enrollment in college and consequent welfare costs, have not previously been quantified. Our study fills this gap in the literature, using both empirical and structural analysis.

Using a public dataset covering high school students in the United States in the mid-2010s, we estimate that 11 percent of all high school graduates did not apply for aid due to frictions. These frictions may be due to lack of information, such as mistakenly believing themselves ineligible, or from difficult and lengthy application forms. We demonstrate that not applying for aid due to frictions predicts a lower likelihood of enrolling in a bachelor's degree program after high school graduation in the short- and medium-run, even after controlling for other attributes such as skill and parental income, or accounting for nonfilers who do not intend to enroll in postsecondary education. We then quantify the welfare costs of these aid application frictions by embedding them into a structural model of college enrollment choice. We parameterize the model using our empirical estimates of the mass affected by aid application frictions; after calibrating, we quantify the extent of under-enrollment that results from frictions in the aid application process. We then shut off aid application frictions and examine the welfare impact over the transition to the new steady state.

We find that non-enrollees who are affected by frictions suffer welfare losses in partial equilibrium due to frictions; these losses are sizable, especially for those with higher skill. General equilibrium adjustments act to magnify these losses. Our findings indicate that large-scale reforms of the financial aid application process which seek to reduce frictions can be beneficial, even more so once general equilibrium effects are taken into account.

Appendix

Table 13 presents the externally estimated parameters. Panel A governs demographics and hours, which we set by assumption; Panels B uses estimates from the literature to discipline preferences and technologies; Panel C draws on our earnings process estimations using the NLSY97 and PSID, which are explained in more detail in Appendix A.2; Panel D uses statutory values for government student aid policy for all parameters except in one case an estimate from the literature; and, finally, Panel E reports parameters related to government spending and tax policy.

In Panel A, the fertility period, j_f, is set to 13 so that consumers have a child when they turn 30; the age adulthood begins, j_a, is set to 18; j_r is chosen so that the retirement age is 65; and, finally, J sets maximum life span to 100 years. For $j < j_f + j_a$, we set survival probabilities ψ_j to one to rule out children without parents; ages $j \geq j_f + j_a$ use estimates from the 2010 Social Security Administration Life Tables presented in Bell and Miller (2020). We set full time hours, ft, to 1/3, which is equivalent to 8 hours of work per day, five days a week. The set of hours a consumer could work, X, consists of full time hours scaled by 0, 0.75, 1.00, 1.25, and 1.50.

Panel B reports parameters that govern preferences and the goods production technology. It begins with the parameter that governs the relative risk aversion, σ, which is set to $1/\upsilon + 1$ so that relative

Table 13: Externally estimated parameters

Parameter	Description	Data Target	Value
Panel A: Demographics and hours			
j_f	Child bearing age	30 years	13
j_a	Years for child to move out	18 years	18
j_r	Retirement age	65 years	48
J	Maximum life span	100 years	83
ψ_j	Survival probability	2010 SSA Life Tables	-
ft	Full time hours	8 hours per day	$1/3$
X	Set of hours	Percent of full time hours	$(0, 0.75, 1, 1.25, 1.5)ft$
Panel B: Preferences and technology			
σ	Risk aversion	Risk aversion $\upsilon = 2$, Chetty (2006)	$\frac{1}{\upsilon} + 1$
α	Capital share	Kydland and Prescott (1982)	0.360
δ	Depreciation rate	Krueger and Ludwig (2016)	0.076
ι	Elasticity of substitution	Card and Lemieux (2001)	0.800
ζ_j	Adult equivalence scale	OECD modified scale	$1 + 0.3\mathbb{I}_{j_f \leq j < j_f + j_a}$
Panel C: Life cycle earnings profile and hours worked in college			
$\epsilon_{j,e,s}$	Deterministic component	PSID and NLSY97	Table A20, App. A.2.1
ρ_e	AR(1) persistence for $e = (\ell, h)$		$(0.851, 0.886)$
σ_e^2	AR(1) variance for $e = (\ell, h)$		$(0.083, 0.072)$
Panel D: Government student aid policy and grants			
$y_{EFC=0}$	Income threshold 0 EFC, normalized	Statutory	0.345
$y_{f,i}$	AAI thresholds for EFC, normalized		(-∞,-0.049,0.220,0.276,0.332,0.389,0.445,∞)
f_i	Lower-bound for EFC, normalized		(0,0,0.048,0.062,0.079,0.098,0.120)
$\underline{y}_{f,i}$	Lower income bound for EFC marginal rate, normalized		(0,0,0.220,0.276,0.332,0.389,0.445)
a_{prot}	Asset protection allowance, normalized		0.521
$\bar{A}$	Subsidized and unsubsidized loan limit, normalized		0.377
$\bar{A}_s$	Subsidized loan limit, normalized		0.265
θ_{max}^{Pell}	Pell maximum, normalized		0.079
$\tau_{f,i}$	Marginal rate for EFC		(0,0.22,0.25,0.29,0.34,0.40,0.47)
τ_a	Asset conversion rate		0.120
τ_{SL}	Interest rate add-on		0.021
T_{SL}	Maximum years to repay		10
τ_g	Federal SL garnishment rate		0.150
ϕ_D	Student loan collection fee	Luo and Mongey (2024)	0.185
Panel E: Government spending and tax policy			
g	Government consumption	BEA	0.147
τ_p	Income tax progressivity	CBO	0.177
τ_c	Consumption tax rate	OECD	0.044

risk aversion is equal to 2 based Chetty (2006). The adult equivalence scale, ζ, is set to 0.3 following the Organization for Economic Co-operation and Development (OECD) modified scale. The capital share parameter, α, is set to 0.36 following Kydland and Prescott (1982). The depreciation rate of capital, δ, is set to 0.076, as in Krueger and Ludwig (2016). The parameter that dictates the elasticity of substitution between low- and high-education labor, ι, is set to 0.8, which implies an elasticity of substitution of 5. This value is in the middle of the range (between 4 and 6) reported in Card and Lemieux (2001) after controlling for imperfect substitutability across age groups.

The three rows of Panel C contain objects that determine the productivity components of earnings. First is the deterministic component of the life cycle earnings process, $\epsilon_{j,e,s}$; second, the persistence parameter of the AR(1) productivity shock, ρ_e; and, third, the variance of the AR(1) productivity shock, σ_e^2. These objects are estimated using data from both the PSID and NLSY97, with full results presented and explained in the discussion surrounding Table A20 of Appendix A.2.1.

Panel D reports government policy parameters related to student aid, as well as subsidy rates for grants other than Pell grants. The first eight rows of this panel are normalized by GDP per capita for those 18 and over, computed as explained in Section 5.1. In rows 1-5 and 9-10 we report parameters that govern the EFC in the model, which are drawn from the EFC formula guide for 2013-2014 prepared by the Federal Student Aid Office, U.S. Department of Education (2014). The first row reports the income threshold below which households are assigned an automatic zero EFC, $y_{EFC=0}$, which is set to 0.345. If the household does not qualify for an automatic zero EFC, then the EFC is computed after computing the adjusted available income using equation (17), an input into the EFC schedule provided in case 2 of equation (18). The various parameters of the adjusted available income function and the schedule are reported in rows 2-5 and rows 9-10. Rows 6, 7, and 8 report limits for federal aid: $\bar{A}$ is the net borrowing limit for any federal student loans which is set to 0.377, $\bar{A}_s$ is the net borrowing limit for subsidized loans which is set to 0.265, both determined using the limits for four years of college reported by the CRS (Smole, 2019), and θ^{Pell}_{max} is the maximum Pell amount an individual can be awarded, set to 0.079 using the amount from the Office of Postsecondary Education, Federal Student Aid (2013). The eleventh row contains τ_{SL}, the interest rate add-on, set to 0.021 as reported by the Chief Operating Officer for Federal Student Aid (FSA) in Chief Operating Officer for FSA (2021). Row 12 contains the number of years for repayment on a student loan, T_{SL}, which is set to 10 based on the standard repayment plan explained in Smole (2019), and the next row is the garnishment rate conditional on delinquency on student loans, τ_g, which is set as established by the 2005 Deficit Reduction Act (109th Congress of the United States of America, 2006). The last row contains the student loan collection fee, ϕ_D, which is set to 0.185 following Luo and Mongey (2024).

Panel E reports parameters related to government spending and tax policy. Government consumption as a share of GDP, g, is set to 0.147 using estimates of the numerator and denominator from the Bureau of Economic Analysis (BEA) in BEA (2022, T1.1.5) and BEA (2022, T3.1). The income tax progressivity, τ_p, is set to 0.177 following our estimation results using data from the Congressional Budget Office (CBO) provided in U.S. Congressional Budget Office (2018a,b), with the estimation procedure described in Appendix A.3 and point estimates presented in Table A24. Finally, we estimate the consumption tax rate τ_c to be 0.044 by applying the method of Mendoza, Razin, and Tesar (1994) to OECD data for the period 2013-2015 (OECD, 2024c,b,a); estimation results are presented in Table A26 of Appendix A.4.

References

109th Congress of the United States of America (2006). Deficit Reducation Act of 2005 (Public Law 109-171). (accessed 05.10.2024).

Abbott, B., G. Gallipoli, C. Meghir, and G. Violante (2019). Education Policy and Intergenerational Transfers in Equilibrium. *Journal of Political Economy 127*(6).

Adamopoulos, T. (2023). Spatial integration and agricultural productivity: quantifying the impact of new roads. *American Economic Journal: Macroeconomics, forthcoming*.

Andolfatto, D. and M. Gervais (2006). Human capital investments and debt constraints. *Review of Economic Dynamics 2*, 52–67.

Bairoliya, N. and K. McKiernan (2023). Revisiting retirement and social security claiming decisions. *Unpublished manuscript*.

Bell, F. C. and M. L. Miller (2020). Life Tables for the United States Social Security Area, 1900-2100, Actuarial Study No. 6, Table 6. (accessed 06.01.2022).

Board of Governors of the Federal Reserve System (2013). The 2013 Survey of Consumer Finances: Summary Extract Public Data. Found at: https://www.federalreserve.gov/econres/scf_2013.htm (accessed: 10.05.2024).

Bureau of Economic Analysis, U.S. Department of Commerce (2022a). Table 2.1. (accessed 05.15.2022).

Bureau of Economic Analysis, U.S. Department of Commerce (2022b). Table 1.1.5. (accessed 05.15.2022).

Bureau of Economic Analysis, U.S. Department of Commerce (2022c). Table 3.1. (accessed 05.15.2022).

Bureau of Labor Statistics, U.S. Department of Labor (2024). Consumer Price Index for All Urban Consumers: All items in U.S. city average, urban consumers, seasonally adjusted, annual average. (accessed 05.23.2024 via FRED).

Card, D. and T. Lemieux (2001). Can falling supply explain the rising return to college for younger men? A cohort-based analysis. *The Quarterly Journal of Economics 116*(2), 705–746.

Caucutt, E. and L. Lochner (2020). Early and Late Human Capital Investments, Borrowing Constraints, and the Family. *Journal of Political Economy 128*(3), 1065–1147.

Caucutt, E. M. and K. B. Kumar (2003). Higher education subsidies and heterogeneity: a dynamic analysis. *Journal of Economic Dynamics and Control 27*(3), 1459–1502.

Census Bureau of the United States (2000). National Intercensal Tables: 1990-2000. Produced by the Census Bureau of the United States. (accessed 05.23.2024).

Census Bureau of the United States (2010). National Intercensal Tables: 2000-2010. Produced by the Census Bureau of the United States. (accessed 05.23.2024).

Census Bureau of the United States (2020). National Population by Characteristics: 2010-2019. Produced by the Census Bureau of the United States. (accessed 05.23.2024).

Chatterjee, S. and F. Ionescu (2012). Insuring student loans against the financial risk of failing to complete college. *Quantitative Economics 3*, 393–420.

Chetty, R. (2006). A New Method of Estimating Risk Aversion. *The American Economic Review 96*(5), 1821–1834.

Chief Operating Officer for Federal Student Aid (2013). Deadline Dates for Reports and Other Records Associated With the Free Application for Federal Student Aid (FAFSA), the Federal Pell Grant Program, the William D. Ford Federal Direct Loan Program, the Teacher Education

Assistance for College and Higher Education (TEACH) Grant Program, and the Iraq and Afghanistan Service Grant Program for the 2013–2014 Award Year. *Federal Register 78*(130), 40731–40735. (accessed 10.05.2024).

Chief Operating Officer for Federal Student Aid (2021). Annual Notice of Interest Rates for Fixed-Rate Federal Student Loans Made Under the William D. Ford Federal Direct Loan Program. *Federal Register 86*(152), 44003–44005. (accessed 07.05.2022).

Colas, M., S. Findeisen, and D. Sachs (2021). Optimal need-based financial aid. *Journal of Political Economy 129*(2), 492–533.

Collins, B. and C. Dortch (2022). The FAFSA Simplification Act. (Congressional Research Service of the United States R46909).

Daruich, D. (2023). The macroeconomic consequences of early childhood development policies. *Unpublished manuscript*.

Deming, D. and S. Dynarski (2009). Into college, out of poverty? Policies to increase the postsecondary attainment of the poor. *NBER Working Paper 15387*.

Donovan, K. (2020). The equilibrium impact of agricultural risk on intermediate inputs and aggregate productivity. *Review of Economic Studies 88(5)*, 2275–2307.

Dortch, C. (2023). Federal Pell Grant Program of the Higher Education Act: Primer. (Congressional Research Service of the United States R45418).

Dynarski, S., C. Libassi, K. Michelmore, and S. Owen (2021). Closing the Gap: The Effect of Reducing Complexity and Uncertainty in College Pricing on the Choices of Low-Income Students. *American Economic Review 111*(6), 1721–1756.

Federal Student Aid Office, U.S. Department of Education (2014). 2013-2014 Expected Family Contribution (EFC) Formula Guide. (accessed 01.17.2024).

Flood, S., M. King, R. Rodgers, S. Ruggles, J. R. Warren, D. Backman, A. Chen, G. Cooper, S. Richards, M. Shouweiler, and W. Michael (2023). *IPUMS CPS: Version 11.0 Annual Socioeconomic Supplement (ASEC)*. IPUMS (Minneapolis, MN).

Government Accountability Office (2024a). Department of Education: Preliminary Results Show Strong Leadership Needed to Address Serious Student Aid System Weaknesses (Testimony of Marisol Cruz Cain Before the Subcommittee on Higher Education and Workforce Development, Committee on Education and the Workforce, House of Representatives). (Report GAO-24-107783).

Government Accountability Office (2024b). FAFSA: Education Needs to Improve Communications and Support around the Free Application for Federal Student Aid (Testimony of Melissa Emrey-Arras Before the Subcommittee on Higher Education and Workforce Development, Committee on Education and the Workforce, House of Representatives). (Report GAO-24-107407).

Heathcote, J., K. Storesletten, and G. L. Violante (2017). Optimal Tax Progressivity: An Analytical Framework. *Quarterly Journal of Economics 132*, 1693–1754.

Hendricks, L., T. Koreshkova, and O. Leukhina (2024). College access and intergenerational mobility. *Unpublished manuscript*.

Hoxby, C. M. and S. Turner (2015). What High-Achieving Low-Income Students Know About College. *American Economic Review: Papers and Proceedings 105*(5), 514–517.

İmrohoroğlu, A. and K. Zhao (2023). Homelessness. *Unpublished manuscript*.

Ionescu, F. (2009). The Federal Student Loan Program: Quantitative Implications for College Enrollment and Default Rates. *Review of Economic Dynamics 12(1)*, 205–231.

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

Jones, C. (2016). Facts About Economic Growth. *Handbook of Macroeconomics 2A*.

Kim, H. and J. H. Kim (2023). Sources of rising student debt in the U.S.: college costs, wage inequality, and delinquency. *Unpublished manuscript*.

Krueger, D. and A. Ludwig (2016). On the optimal provision of social insurance: Progressive taxation versus education subsidies in general equilibrium. *Journal of Monetary Economics 77*, 72–98.

Krueger, D., A. Ludwig, and I. Popova (2024). Shaping inequality and intergenerational persistence of poverty: free college or better schools. *Unpublished manuscript*.

Kydland, F. E. and E. C. Prescott (1982). Time to Build and Aggregate Fluctuations. *Econometrica 50(6)*, 1345–1370.

Lochner, L. J. and A. Monge-Naranjo (2011). The Nature of Credit Constraints and Human Capital. *The American Economic Review*, 2487–2529.

Luo, M. and S. Mongey (2024). Assets and job choice: Student debt, wages and amenities. *Review of Economic Studies, Conditionally Accepted*.

Ma, J., M. Pender, and C. Libassi (2020). Trends in College Pricing and Student Aid 2020. *College Board*.

Matsuda, K. (2020). Optimal timing of college subsidies: Enrollment, graduation, and the skill premium. *European Economic Review 129*, 103549.

Matsuda, K. (2022). Progressive Taxation versus College Subsidies with College Dropout. *Journal of Money, Credit and Banking* (available online).

Mendoza, E. G., A. Razin, and L. L. Tesar (1994). Effective tax rates in macroeconomics: Cross-country estimates of tax rates on factor incomes and consumption. *Journal of Monetary Economics 34*, 297–323.

Moschini, E. G., G. Raveendranathan, and M. Xu (2024). Optimism About Graduation and College Financial Aid. *Unpublished manuscript*.

NASFAA Monograph, 8th Edition (2023). Developing the cost of attendance: Practical information for student aid professionals. (accessed 1.26.2024).

National Association of Student Financial Aid Administrators (2014). National student aid profile: Overview of 2014 federal programs. (accessed 1.26.2024).

National Center for Education Statistics, U.S. Department of Education (2019). Table 330.10. Produced and distributed by the Institute of Education Sciences, National Center for Education Statistics (NCES). (accessed 01.04.2022).

National Center for Education Statistics, U.S. Department of Education (2020). High School Longitudinal Study of 2009 (public use data file). Produced and distributed by the Institute of Education Sciences, National Center for Education Statistics (NCES). (accessed 10.11.2022).

National Center for Education Statistics, U.S. Department of Education (2022). Table 302.10. Produced and distributed by the Institute of Education Sciences, National Center for Education Statistics (NCES) (accessed 01.03.2023).

OECD (2024a). Annual government expenditure by function (COFOG). Public use dataset, OECD.

OECD (2024b). Annual household final consumption expenditure on the territory and abroad. Public use dataset, OECD.

OECD (2024c). Details of Tax Revenue - United States. Public use dataset, OECD.

Office of Postsecondary Education, Federal Student Aid (2013). 2013-2014 Federal Pell Grant Payment and Disbursement Schedules. *Dear Colleague Letter GEN-13-06*. (accessed 1.26.2024).

O'Hara, A. (2006). Tax Variable Imputation in the Current Population Survey.

Program Communications Division, Federal Student Aid (2013). Federal Student Aid Handbook 2013-2014. Technical handbook, U.S. Department of Education.

Smole, D. P. (2019). Federal Student Loans Made Through the William D. Ford Federal Direct Loan Program: Terms and Conditions for Borrowers. (Congressional Research Service of the United States R45931).

U.S. Congressional Budget Office (2018a). The Distribution of Household Income, 2014.

U.S. Congressional Budget Office (2018b). The Distribution of Household Income, 2015.

U.S. Department of Commerce, Economics and Statistics Administration, Bureau of the Census (1993). Measuring the Effect of Benefits and Taxes on Income and Poverty: 1992 (Report P60-186RD).

U.S. Department of Education, Office of Federal Student Aid (2021). National Default Rate Briefing for FY 2018 Official Cohort Default Rates. (accessed 05.15.2022).

Vardishvili, O. (2024). The macroeconomic cost of college dropouts. *Unpublished manuscript*.

Yannelis, C. (2020). Strategic default on student loans. *Unpublished manuscript*.

Online Appendix for: "College Financial Aid Application Frictions"

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Contents

A Data Appendix

A.1 The HSLS:09

We use the the High School Longitudinal Study of 2009 (HSLS:09) as our main data source in this paper. Unless specified otherwise, throughout this paper we use "skill" to refer to honors-weighted high school GPA of the sample member in the HSLS:09, and "income" to refer to the household income of the sample member's parents. We use honors weighted high school GPA as our measure of skill in the HSLS:09 because it does not contain a standardized measure like the 1997 National Longitudinal Survey of Youth's ASVAB score.

A.1.1 Postsecondary outcomes

Assigning postsecondary outcomes to high school graduates As part of our sample cleaning procedure we assign postsecondary outcomes to the set of high school graduates and drop observations for whom this assignment is not possible or which have inconsistent records. To assign post-secondary outcomes for HSLS:09 cleaned sample members in the fall of 2013 and the second follow-up collected in 2016, we proceed as follows. First, we recognize that student records collected from postsecondary institutions are likely to be more reliable measures of postsecondary enrollment than survey responses. Because of this, we prioritize information on postsecondary outcomes collected from student records submitted by postsecondary institutions to the HSLS:09.

Specifically, we begin by identifying high school graduates who enroll in postsecondary education for the first time in the fall of 2013 (the 2014 academic year). We flag this group by identifying those who have a nonmissing value for at least one of the variables X4PS1START, X5PFYEAR, or X5POSTHSAY. The variable X4PS1START records the month and year of enrollment at the first postsecondary institution, collected in the second follow-up survey wave (the month of enrollment is suppressed in the public use data file). The variable X5PFYEAR records the first academic year of postsecondary enrollment as reported in the Student Records component of the Postsecondary Transcripts and Student Records (PETS-SR) data collection wave. The variable X5POSTHSAY reports the first known academic year of enrollment in postsecondary education as reported in the Postsecondary Transcript component of the PETS-SR wave. We require that each of these variables indicate enrollment in the academic year of interest if it is not missing; that is, we require that these variables do not contradict each other if more than one of them is nonmissing. For this group of enrollees, we use the variable X5PFYDEGREE (which records the degree program at the primary first-year institution the sample member enrolls in and is a variable from the Student Records component of the PETS-SR wave) to assign the individual to less than 2-year program or an associate's degree/2-year program (that is, sub-baccalaureate), or to a bachelor's degree/4-

year program. For observations that remain unassigned to a postsecondary outcome, we then use X4PS1DEGTYPE1 (which records the first degree or certificate pursued and is a variable from the second follow-up survey wave) to allocate observations to the relevant element of the set of possible postsecondary outcomes.

The last step is to clean out observations with inconsistencies. We keep only observations who receive either a high school diploma or a GED in the spring of 2013. We also drop those who are recorded as receiving financial aid before the 2014 academic year. Among those assigned to the "did not enroll" postsecondary outcome, we drop those with second follow up records that indicate enrollment in the fall of 2013 but have no record of what sort of degree they enrolled in. We discard nonenrollees who earned postsecondary credits while in high school and are therefore flagged as enrolling in postsecondary education before they graduate high school. Finally, we drop observations who have no postsecondary enrollment record after high school but whose student aid records indicate that they either attempted a positive number of academic credits or received federal financial aid.

Table A1 reports the bachelor's degree enrollment rate that result from this procedure and enrollment rate from the National Center for Education Statistics (NCES) for the same period for comparison (National Center for Education Statistics, U.S. Department of Education, 2022). The NCES tabulations draw on the Current Population Survey for the 2013 year of interest. Our procedure yields a BA enrollment rate in the cleaned sample that aligns well with the national NCES tabulation value computed using a different data source.

Table A1: Postsecondary education enrollment rates in the fall of 2013

	HSLS:09 cleaned sample	**NCES Table 302.10**
Enrollment in fall 2013	**HS graduates spring 2013**	**Recent HS completers**
4-year Bachelor's	0.426	0.421
Observations	7,145	

Notes: Table A1 reports enrollment rates in 4-year bachelor's degree programs for the cleaned HSLS:09 sample and postsecondary outcomes for recent high school graduates aged 16-24 from the NCES Table 302.10 for 2013. HSLS:09 weights: Second follow-up student longitudinal weights.

Descriptive statistics by BA enrollment outcome in the fall of 2013 Table A2 reports statistics overall for high school graduates (repeated from Table 1 of Section 3 in the main text) and conditional on post-secondary outcomes in the 2013-2014 academic year. Those who enroll in a BA in the fall of 2013 have higher high school GPA, are more likely to be female, and have higher family income than their non-enrollee peers. Additionally, those who immediately enroll in a BA after high school are more likely to have at least one parent with a BA or higher and to come from a 2-parent family. Household size is similar across fall 2013 enrollment outcomes. Finally, about 87 percent of those who do not enroll in a BA still have not enrolled by the spring of 2016, while 83 percent of BA enrollees are still enrolled in 2016 (their third academic year).

Table A2: Descriptive statistics overall and by fall 2013 BA enrollment outcome

Variable	All	BA: No	BA: Yes
High school GPA	3.00	2.62	3.53
Female	49.95	47.02	53.90
Family income	83,125	61,007	112,898
At least one parent BA+	40.19	24.20	61.71
2-parent family	74.84	70.94	80.11
Household size	4.23	4.24	4.22
Enr in BA 2016	43.11	13.16	83.43
Observations	7,145	3,386	3,759

Notes: Table A2 reports attributes for all high school graduates and and by BA enrollment outcome in the fall of 2013. Weights: Second follow-up student longitudinal weights. Source: HSLS:09.

Post-secondary enrollment breakdowns by skill and family income How do high school graduates sort into bachelor's degree programs by skill and family income? Table A3 breaks down enrollment in a bachelor's degree program in the fall of 2013 by terciles of family income and high school GPA. This table shows that BA enrollment is increasing in both skill and family income; for the highest skill tercile, the gap between the bottom and top family income tercile is more than 20 percentage points. Table A4 shows that this qualitative pattern persists when enrollment in sub-baccalaureate postsecondary education is included in the enrollment frequencies, although the gap between the lowest and the highest income terciles is narrowed for a given skill tercile once sub-baccalaureate programs are included, relative to Table A3. Note that the sample size in each skill bin differs in this table, because skill bins are assigned so that the weighted frequency of each bin is equal (not the number of observations). A similar pattern would be evident for skill terciles if their sample counts were reported.

Our analysis complements previous work in Lochner and Monge-Naranjo (2011) by documenting similar college attendance patterns by income and skill for a more recent cohort than that of the NLSY97. Our analysis also differs from Lochner and Monge-Naranjo (2011) in that we separately document enrollment rates for bachelor's degrees specifically, as well as enrollment rates for postsecondary education overall. We also use a different measure of skill (honor's weighted high school GPA).

A.1.2 FAFSA nonfiling: reasons and money left on the table

Data description: possible reasons for not filing a FAFSA The possible reasons that survey respondents may give in the HSLS:09 for not filing a FAFSA are:

Table A3: Enrollment in a bachelor's degree program by skill and parental income

	Skill tercile			
Income tercile	1	2	3	**All**
1	6.63	26.94	59.43	22.54
2	12.60	38.75	69.98	40.00
3	21.21	60.62	83.58	65.30
All	11.22	41.48	75.15	42.62
Observations	1,842	2,303	3,000	7,145

Notes: Table A3 reports the share of high school graduates who enroll in a bachelor's degree program in the fall of 2013, broken down by family income tercile (rows) and high school GPA tercile (columns). Weights: Second follow-up student longitudinal weights. Source: HSLS:09.

Table A4: Enrollment in any postsecondary education by skill and parental income

	Skill tercile			
Income tercile	1	2	3	**All**
1	37.87	63.42	84.65	54.52
2	43.00	73.05	89.15	68.25
3	59.85	85.75	96.50	86.60
All	43.52	73.70	92.15	69.80
Observations	1,842	2,303	3,000	7,145

Notes: Table A4 reports the share of high school graduates who enroll in a sub-baccalaureate or BA program in the fall of 2013, broken down by family income tercile (rows) and high school GPA tercile (columns). Weights: Second follow-up student longitudinal weights. Source: HSLS:09.

1. Because did not want to go into debt
2. Because can afford college without financial aid
3. Because thought ineligible or unqualified
4. Because did not know how
5. Because forms were too time-consuming or too much work
6. Because did not know could
7. Because teen does not plan to continue education

Respondents may respond yes/no for each reason to indicate that the reason applies; more than one reason may apply for the same survey respondent, or they may say "No" to all the reasons in the list. If they respond that they thought they were ineligible or unqualified, further questions are asked: why did you think you were ineligible? Options provided to respondents are:

3. Thought ineligible or unqualified...
   (a) Because other family member didn't qualify

(b) Because of concerns about credit score

(c) Because income too high

(d) Because grades/test scores too low

(e) Because of part-time enrollment

In the main text, we group these responses into two categories: first, responses 3 and 6 as related to beliefs about eligibility and responses 4 and 5 as related to filing costs, which together we consider as reasons related to frictions; and, second, responses 1, 2, and 7 as related to other reasons not related to frictions.

Attributes of nonenrollees affected by aid application frictions Table A5 compares the composition of those who did not enroll in a BA in the fall of 2013 by whether or not they were nonfilers due to only aid application frictions. Those nonfilers due to frictions, but not other reasons, have slightly lower skill, a higher percentage who are female, and have slightly lower family income. They are less likely to have at least one parent with a BA or higher, and have a similar composition of 2-parent families and household size, relative to their peers. Those who do not enroll in a BA in 2013, and do not file a FAFSA due to only FAFSA filing frictions, are slightly less likely to enroll in a BA by the spring of 2016 compared to other nonenrollees.

Table A5: Summary statistics of those affected by only frictions among fall of 2013 nonenrollees

	Affected by only frictions	
Variable	**Yes**	**No**
High school GPA	2.56	2.62
Female	59.44	46.16
Family income	58,423	61,187
At least one parent BA+	20.01	24.49
2-parent family	73.06	70.79
Household size	4.35	4.24
Enr in BA 2016	10.61	13.34
Observations	224	3,162

Notes: Table A5 reports summary statistics for nonenrollees broken down by whether not they are FAFSA nonfilers due to only frictions (Yes or No). Weights: Second follow-up student longitudinal weights. Source: HSLS:09.

FAFSA nonfiling patterns among BA nonenrollees in the fall of 2013: no enrollment versus sub-baccalaureate enrollment Table A6 reports statistics on FAFSA filing status and nonfiling reasons among BA nonenrollees for those who did not enroll in any postsecondary education and those who enrolled in a sub-baccalaureate (less-than BA) program in the fall of 2013. Nonfiling respondents are concentrated among those who did not enroll in any postsecondary education, rather than those who enrolled in a sub-baccaulaureate program. Note that respondents who report not filing a FAFSA because they do not want to enroll in any postsecondary education make up less than one percent of those who enroll in less than a BA after high school.

Table A6: BA nonenrollees: FAFSA filing status and nonfiling reasons by postsecondary education outcome

Category	Variable	No enrollment	Sub-baccalaureate
Panel A: FAFSA filing rates	Filers	38.22	73.94
	Nonfilers	43.17	14.98
	Uncertain	18.61	11.07
	Total	100	100
Panel B: FAFSA nonfiler reasons (mutually exclusive)	Only frictions	9.01	3.71
	Only not frictions	14.64	3.13
	Both	9.06	6.44
	No reason given	10.46	1.71
	Total	43.17	14.98
Panel C: FAFSA nonfiler reasons (not mutually exclusive)	Frictions	18.07	10.14
	Not frictions	23.70	9.56
Panel D: FAFSA nonfiler not frictions breakdown	Can afford without aid	7.56	7.84
	Do not want debt	10.48	5.23
	Not planning to enroll	13.21	0.40
	Observations	1,745	1,641

Notes: Table A6 reports summary statistics for those who do not enroll in a BA after high school broken down by specific outcome: not enrolling in any postsecondary education, and enrolling in less than a BA. Weights: Second follow-up student longitudinal weights. Source: HSLS:09.

Share not filing a FAFSA affected by frictions by high school GPA tercile Table A7 reports the share witihin each skill tercile who are affected by FAFSA filing frictions, overall and by BA enrollment outcome in the fall of 2013.

Table A7: Nonfilers affected by frictions by skill tercile and fall 2013 BA enrollment

		Enrolled in a BA	
Skill tercile	**All**	**No**	**Yes**
1	14.91	15.93	6.85
2	10.23	12.74	6.68
3	8.33	12.28	7.03
Total	11.16	14.32	6.90
Observations	7,145	3,386	3,759

Notes: Weights: Second follow-up student longitudinal weights. Source: HSLS:09.

FAFSA filing rates among 2014 AY nonenrollee nonfilers Table A8 reports the percentage of FAFSA non-filers who did not enroll in a BA the fall of 2013 (the 2014 AY) and who later are observed in post-secondary institutional records as having submitted a FAFSA in either the 2015 or 2016 AY. This rate is positive but low. Note that this group includes those enrolled in a sub-baccalaureate program in 2013.

Table A8: FAFSA filing rates among 2013-2014 academic year nonenrollee nonfilers

Variable	**2015 AY**	**2016 AY**
FAFSA filer	12.66	10.38
Observations	1,522	1,522

Notes: Weights are Second follow-up student longitudinal weights. Source: HSLS:09.

A.1.3 Model motivation, parameterization, and validation tabulations

This section presents moments related to model motivation, model parameterization, and model validation.

Model motivation Table A9 presents regression coefficients corresponding to the AMEs presented in Section 3 of the main text.

Table A9: Coefficients of aid application frictions on outcomes

Control	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Flag: nonfiler frictions	-0.534		-0.469				
	(0.0720)		(0.0890)				
Flag: nonfiler frictions only		-0.602		-0.519	-0.423	-0.194	-0.491
		(0.1448)		(0.1376)	(0.1270)	(0.2429)	(0.2310)
Flag: nonfiler no PSE		-2.617		-1.811			
		(0.2025)		(0.3591)			
Skill (HS GPA)	0.981	0.965	1.035	1.017	0.804	0.622	0.641
	(0.0424)	(0.0477)	(0.0447)	(0.0454)	(0.0405)	(0.0914)	(0.0603)
Log parental income	0.294	0.272	0.316	0.302	0.158	0.134	0.205
	(0.0454)	(0.0398)	(0.0481)	(0.0496)	(0.0445)	(0.0681)	(0.0523)
Flag: At least 1 parent BA+	0.483	0.453	0.560	0.530	0.445	0.287	0.323
	(0.0664)	(0.0658)	(0.0722)	(0.0732)	(0.0656)	(0.1040)	(0.0909)
Flag: Female	-0.010	-0.035	0.011	-0.023	0.081	-0.015	-0.059
	(0.0604)	(0.0594)	(0.0617)	(0.0622)	(0.0687)	(0.1068)	(0.0857)
Constant	-6.529	-6.194	-6.641	-6.380	-4.002	-2.195	-3.828
	(0.4965)	(0.4529)	(0.5334)	(0.5453)	(0.4731)	(0.7669)	(0.5886)
Observations	7,145	7,145	7,145	7,145	7,145	4,779	4,422

Notes: Table A9 presents probit coefficients for the AME results presented in the main text. Bootstrapped standard errors are in parentheses. Source: HSLS:09.

Table A10 reports statistics related to imputed/counterfactual Pell grant eligibility. Our imputation assigns a dollar amount of Pell grant eligibility for observations regardless of FAFSA filing status, drawing on descriptions of the 2013-2014 FAFSA form available in the EFC formula guide for 2014 academic year, prepared by the Federal Student Aid Office, U.S. Department of Education (2014). To proceed, we use the estimated EFC to impute the level of Pell grants that the respond would be eligible for were they to enroll full-time in a BA program, using Pell grant descriptions from a Congressional Research Service report (Dortch, 2023). Details of our imputation procedure are provided in Table A16 of Appendix A.1.4. Table A17 of Appendix A.1.4 compares imputed and realized Pell grants among 2013-2014 BA enrollees who file a FAFSA. The median difference is zero.

The first two rows of Table A10 indicate that about 4 percent of high school graduates are FAFSA nonfilers who are eligible for sizable amounts of Pell grant aid. This frequency is much higher among non-enrollees (6.55 percent) compared to those who enroll in a BA (less than one percent). In the last two rows of Table 2 we report the same statistics computed for those who do not file a FAFSA due to *only* reasons related to frictions. This exercise reduces ambiguity about which category of reasons is the determining factor in the nonfiling decison. As one would expect, the more restrictive definition of being a nonfiler due to frictions lowers the frequency in each column, but leaves unchanged the magnitudes of Pell grant eligibility. Overall, the qualitative takeaways are maintained.

Table A10: Counterfactual Pell grant aid among FAFSA nonfilers due to frictions

		Enrolled in BA	
Variable	**All**	**No**	**Yes**
Nonfiler due to frictions and Pell>0	3.96	6.55	0.46
... Pell $	4,670	4,688	4,322
Nonfiler due to only frictions, Pell>0	2.07	3.34	0.36
... Pell $	4,897	4,945	4,288
Observations	7,145	3,386	3,759

Notes: Table A10 reports counterfactual Pell grant aid for FAFSA nonfilers due to frictions, both overall and broken down by 2013 BA enrollment outcome. Weights are Second follow-up student longitudinal weights. Source: HSLS:09.

Model parameterization Table A11 presents moments related to enrollment and persistence rates among high school graduates in the HSLS:09. These rates are broken down by skill tercile, where skill is measured with honors-weighted high school GPA. Table A12 reports, by skill tercile, total merit-based and means-tested grants received during the first year of enrollment as a share of tuition and fees overall, then allocated to private or public sources using shares from Krueger and Ludwig (2016), then total Pell grants as a share of tuition and fees. The last column in this table is the subsidy rate of public grants net of the subsidy rate of pell grants. Lastly, Table A13 reports the average hours worked by third-year BA enrollees, as a fraction of full time (40 hours a week). Table A14 reports the conditional skill distribution of young adults, for low- and high-education parents.

Model validation Table A15 reports the share receiving Pell grants, and the amount conditional on receipt, among 2013 BA enrollees for whom we have a student record with nonmissing infor-

Table A11: BA Enrollment and persistence by skill tercile

Skill tercile	Enr. in BA	Enr. in BA | Highest income tercile	Enr. Y3 | Enr. Y1
1	11.22	21.21	54.97
2	41.48	60.62	76.85
3	75.15	83.58	91.31
Total	42.62	65.30	83.43

Notes: BA enrollment rates and the condition for being enrolled in a BA in Y1 in the third column refer to enrollment in the fall of 2013. Weights: Second follow-up student longitudinal weights for the first two columns and PETS-SR student longitudinal weights for the third column. Source: HSLS:09.

Table A12: Grants subsidy rates by skill tercile

Skill tercile	Grants/TF	Prv Grants/TF	Pub Grants/TF	Pell grants/TF	Pub Grants net Pell/TF
1	0.445	0.133	0.311	0.108	0.204
2	0.461	0.138	0.323	0.095	0.228
3	0.526	0.158	0.368	0.064	0.305

Notes: Weights: PETS-SR longitudinal weights. Source: HSLS:09.

mation about student aid receipt (which includes those who receive no aid). These statistics are reported by income tercile and overall.

A.1.4 Imputation of means-tested financial aid eligibility

We use the HSLS:09 to impute the expected family contribution (EFC), which allows us to assign financial aid from the Pell grant to all high school graduates in our cleaned sample. With this information, we compare imputed values with realized values for students who enroll in a 4-year bachelor's degree program to validate our imputation. Our main source of discipline on how the attributes of FAFSA filers map into the EFC is the *Expected Family Contribution (EFC) Formula Guide* published by the US Department of Education's Federal Student Aid office for the 2013-2014 academic year (Federal Student Aid Office, U.S. Department of Education, 2014). In particular, we use Worksheet A for dependent students and the associated Tables A1-A7; whenever we cite Worksheet Table AX, where X is a number, we are referring to Tables recorded in Worksheet A. We construct HSLS:09 survey analogs for the inputs into Worksheet A and then operate on them using the parameters provided in Worksheet Tables A1-A7 of the *Expected Family Contribution (EFC) Formula Guide*. We abstract from FAFSAs expected student contribution for dependent students, so that the expected family contribution is equal to the parents' contribution. Table A16 summarizes the mapping from FAFSA formula inputs to observable counterparts that we use to impute financial aid eligibility (as opposed to realized aid receipt). Appendix A.1.6 describes how we compute income and tax liability values from the Current Population Survey's Annual Socioeconomic Supplement or CPS ASEC (Flood et al., 2023), which we then impute into

Table A13: Hours worked Y3 as a fraction of 40 hours

Ave. hours worked/40	0.350

Notes: Weights: Second follow-up student longitudinal weights. Source: HSLS:09.

Table A14: Young adult skill distribution by parent education

	At least one parent BA+	
Skill tercile	**No**	**Yes**
1	44.01	17.41
2	34.31	31.89
3	21.68	50.70
Observations	3,431	3,714

Notes: Table A14 reports the discretized skill distribution of young adults conditional on parent educational attainment. Weights: Second follow-up student longitudinal weights. Source: HSLS:09.

the HSLS:09; Appendix A.1.6 also describes how we compute net worth values from the 2013 Survey of Consumer Finances Extract Public Data (SCF).

Beginning with Category I of Table A16, we measure family income in the HSLS:09 using non-imputed values for the categorical variables X1FAMINCOME and X2FAMINCOME, which record discretized family income reported in the base year and first follow-up of the survey, respectively. For each wave's income variable, we assign 2012 dollar values for income, federal tax liability, and net worth as described in Appendix A.1.6. In our imputation of dollar values, we keep the values associated with the most recent income observed because we want an approximation of the input into the FAFSA form, which is the taxable and untaxable income from the previous year.

Moving to Category II of Table A16, we construct federal tax liability using the within-bin median for the most recent discretized income value, imputed from the CPS ASEC. We assign state and other tax allowance using the Worksheet Table A1 values for unobserved state of residence—because state of residence is unreported in the public HSLS:09—evaluated using observed family income constructed as explained in the previous paragraph. The Social Security tax allowance for each resident working parent is constructed using Worksheet Table A2 and observed income; the income protection allowance uses Worksheet Table A3 and the household size at the point of the first follow-up reported in the HSLS:09 with variable X2HHNUMBER. The employment expense allowance is constructed with information on the number of resident working parents from the HSLS:09 and parameters reported in the FAFSA formula worksheet. Total allowances against income are then defined as the sum of all allowances in Category II.

Category III of Table A16, available income, is the difference between total income and total

Table A15: Financial aid among 2013 BA enrollees - Pell grants by income tercile

Income tercile	% receiving	Ave amt. | receipt
1	79.95	4,776
2	45.98	4,050
3	6.22	4,033
Total	32.45	4,361
Observations	2,638	

Notes: Table A15 reports extensive and intensive margins of Pell receipt among 2013 BA enrollees, broken down by income tercile. Weights: Second follow-up longitudinal weights. Source: HSLS:09.

allowances against income.

Category IV of Table A16, parents' contribution from assets, sets the net worth to the value imputed using the SCF. The asset protection allowance is taken from Worksheet Table A5 evaluated using HSLS:09 information on the number of resident parents using the variable P2MARSTAT and the age of the oldest parent in the household. The parents' contribution from assets is the difference between net worth and the asset protection allowance, multiplied by the asset conversion rate of 0.12 taken from the *Expected Family Contribution (EFC) Formula Guide*.

Category V of Table A16, the adjusted available income (AAI) is the sum of the parents' available income and their contribution from assets. Their contribution from AAI is defined using Worksheet Table A6, assuming that the family has only one child enrolled in college in the 2013-2014 academic year. The result is the total contribution from parents. When contributions from the student are set to 0, as we assume in our approximation, the parent contribution is also equal to the expected family contribution (EFC) so that our imputation result for the EFC in Category VI of Table A16 is equal to the parent contribution in line # 28.

The Cost of Attendance (COA) affects eligibility for Pell grants only if the COA is less than the EFC. This is quite rare, especially for Bachelor's degrees such as we consider in our Pell grant imputation exercise. Because of this, we abstract from the role of COA in determining Pell grant eligibility.

Based on publications from the Federal Student Aid Office of the U.S. Department of Education and the National Association for Financial Aid Administrators, the Pell Grant is awarded first, and other sources of aid awarded subsequently, when financial aid administrators (FAAs) generate aid package offers for an applicant to their school (Program Communications Division, Federal Student Aid, 2013; NASFAA Monograph, 8th Edition, 2023; Office of Postsecondary Education, Federal Student Aid, 2013). In our imputation the amount of Pell grants that a high school grad-

Table A16: EFC formula inputs and construction of empirical counterparts

FAFSA category	FAFSA line number and description	Construction	Data source	Note
I. Parents' income in 2012	7. Total Income	[1]	HSLS:09	If negative, set to 0.
II. Allowances against parents' income	8. U.S. Income tax paid if tax filers	[2]	HSLS:09, CPS	Assume everyone files taxes.
	9. State and other tax allowance	WT A1		WT A1 value for blank state.
	10. Parent 1 Social Security tax allowance	WT A2		WT A2 value at #7.
	11. Parent 2 Social Security tax allowance	WT A2		WT A2 value at #7.
	12. Income protection allowance	WT A3 [3]	HSLS:09	
	13. Employment expense allowance	[4a,4b]	HSLS:09	
	14. Total allowances	# 8 to # 13		
III. Available income	15. Available income (AI)	#7 to #14		May be negative.
IV. Parents' contribution from assets	20. Net worth	[5]	SCF	#s 16 to 19 are not imputed.
	21. Ed. saving and asset protection allowance	WT A5 [6]	HSLS:09	
	22-24. Contribution from assets	[7]		If negative, set to 0.
V. Parents' contribution	25. Adjusted Available Income (AAI)	#15 + #24		
	26. Total parents' contribution from AAI	WT A6		Evaluate WT A6 using AAI.
	27. Number dep. in college in 2013-2014	[8]	HSLS:09	Set to 1.
	28. Parents' contribution	$\frac{\#26}{\#27}$		If negative, set to 0.
VI. EFC		Equal to #28		Set contributions from student to 0.

[1] HSLS:09 variables: X1FAMINCOME,X2FAMINCOME

[2] Tax liability $y - \hat{\lambda} y^{1-\hat{\tau}}$, $\hat{\lambda}$ and $\hat{\tau}$ estimated using CPS and y from [1].

[3] HSLS:09 variables: X2HHNUMBER.

[4a] HSLS:09 variables: P2MARSTAT,X2PAR1EMP, X2PAR2EMP.

[4b] FAFSA formula: $\min\{0.35y, 3900\}$ where y is lowest parent earned income.

[5] Source: see appendix text.

[6] HSLS:09 variables: P2MARSTAT

[7] FAFSA formula: 12 percent of # 20 - # 21.

[8] HSLS:09 variables: P2INCLG2013,P2SIBSTARTCLG, and P2SIBCLGGRAD

Notes: Table A16 summarizes our imputation of the EFC by mapping 2013 FAFSA formula inputs to empirical counterparts. The first column reports the FAFSA formula category; the second column provides the FAFSA line number and short description. The third column explains how the empirical counterpart is constructed; for explanations that are longer a table note number is provided in square brackets. The fourth column explains the data source for the empirical counterpart and the fifth column provides additional notes. Acronyms: WT refers to Worksheet Table, HSLS:09 refers to the High School Longitudinal Study of 2009, the CPS refers to the Current Population Survey Annual Socioeconomic Supplement, and SCF refers to the Survey of Consumer Finances.

uated is eligible for is assigned using the discretized table provided in Office of Postsecondary Education, Federal Student Aid (2013). The maximum Pell grant in the 2014 academic year was $5,645.

Validating imputed postsecondary financial aid eligibility We validate the imputed Pell grant amount that individuals in the HSLS:09 are eligible for by comparing imputed Pell grants with realized Pell grant amounts for 2013-2014 BA enrollees who apply for aid in the HSLS:09 in the 2014 academic year. The realized aid values are pulled from student records submitted by postsecondary institutions to the HSLS:09 data collectors and are therefore likely to be accurate. Note that we focus on Pell grants because by comparison the contribution of other components (e.g., subsidized Stafford loans) to the total aid package depends on the discretion of the individual FAA who is designing the aid package. Table A17 presents moments of the distribution the individual-level value of Realized − Imputed Pell grants in the population of 2013-2014 BA enrollees who submitted a FAFSA. The distribution of differences is largely centered at zero.

Table A17: Imputed Pell grants compared to realized values

	Mean	p10	p25	p50	p75	p90
Difference	333.9	-1,410	0	0	0	3,196
Observations	2,117					

Notes: Table A17 compares realized and imputed values for Pell grants received by 2013 BA enrollees who filed a FAFSA (Panel A) and those who are additionally eligible for Pell grants according to the imputation (Panel B). Values are current dollars. Sample: bachelor's degree enrollees who submitted a FAFSA. Weights are PETS-SR student longitudinal weights. Source: HSLS:09.

A.1.5 Financial aid accounting

Table A18 reports the distribution of different categories of postsecondary financial aid across postsecondary education program types (Panel A) and within program types (Panel B). These distributions are computed using the HSLS:09 cleaned sample, and they are useful for motivating our model specification in the main text. In Panel A, it is evident that most of each type of aid is spent on BA programs. This is the type of postsecondary education program that we model in our framework. In Panel B, within BA programs, the share of total financial aid dollars received by first year enrollees in the 2013-2014 academic year is similarly sourced from the three programs that we account for in our model specification of the main text: Pell grants and Stafford loans (subsidized or unsubsidized).

Table A18: Financial aid accounting: distribution of realized aid in the 2014 AY

		Postsecondary ed. type	
Distribution of aid	**Type of aid**	**Sub-BA**	**BA**
Panel A: across PSE types	Pell grants	45.35	54.65
	Subsidized Stafford loans	18.04	81.96
	Unsubsidized Stafford loans	20.14	79.86
Panel B: within PSE types	Pell grants	60.55	30.46
	Subsidized Stafford loans	17.56	33.31
	Unsubsidized Stafford loans	21.89	36.22
	Observations	3,552	

Notes: Table A18 reports distributions of financial aid by aid type both across postsecondary program types (Panel A) and within program types (Panel B). Rows in Panel A sum to 1; Columns in Panel B sum to 1. Sample count reflect valid observations of financial aid outcomes among each postsecondary outcome. Weights are PETS-SR student longitudinal weights. Source: HSLS:09.

A.1.6 Assigning continuous values to income, federal tax liability, and net worth

Household income is a relevant attribute for the decision of whether to enroll in college. In addition, income, federal tax liability, and net worth are inputs into the synthetic FAFSA formula used to impute the EFC and Pell grant eligibility. Household income in the HSLS:09 is reported in the base year and the first follow-up, and records the previous year's income in current dollars (2008 for the base year, and 2011 for the first follow-up). The income is reported as a discretized variable where bin thresholds are in current dollars and are the same across the two waves. For each tax year (2008 and 2011) we use this discretized income to impute continuous values for income and federal tax liability from the CPS ASEC and for net worth from the SCF.

Specifically, we use 2009 and 2012 CPS ASEC data; these waves contain information on income earned and federal taxes on that income in the previous year. We assigning individuals to tax units and then aggregate total individual income to the tax unit level. Federal tax liability is reported at the tax unit level by the CPS ASEC and is computed using TAXSIM (U.S. Department of Commerce, Economics and Statistics Administration, Bureau of the Census, 1993; O'Hara, 2006). We restrict attention to tax units where the head of household is between 35 and 70 in a given year, and they have at least one child living with them who is between 13 and 14 in 2009 or 16 and 17 in 2012. For each year of the CPS ASEC, we assign observations in that year to an income bin using thresholds in current dollars, where the bin cutoffs are drawn from the HSLS:09. Within each income bin, we then compute the median value of income and federal tax liability and convert to 2012 USD using the CPI (Bureau of Labor Statistics, U.S. Department of Labor, 2024). The results are reported in the first four columns of Table A19.

We use the 2013 SCF Summary Extract Public Data (2013 SCF) to compute median net worth within each income bin (Board of Governors of the Federal Reserve System, 2013). We define net worth as the sum of the value of: saving, checking, nonresidential real estate, trusts, money market deposit accounts, money market mutual funds, certificates of deposit, stocks, and bonds. Lastly, we include net worth from farm or business after passing it through the function provided in Table A4 from the EFC formula sheet. The Summary Extract Public Data is made available in real dollars for the most recent wave of the SCF, which was 2022 when we downloaded the data. To proceed, we first select a tax year (2008 or 2011) and then convert family-level income reported in the SCF to that tax years' dollars using the CPI. With that value, we assign each family to the income bin they would have been in in that tax year using current-dollar income bin cutoffs from the HSLS:09. After restricting attention to the sample of families with children living at home and household heads between 35 and 70, we compute the within-bin median of net worth for that sample. These within-bin median values, expressed in 2012 dollars, are reported in the last two columns of Table A19.

For the base year and first follow-up household income values in the HSLS:09, we impute the continuous dollar values for income, federal tax liability, and net worth. This yields one set of imputed dollar variables per discretized household income observation in the HSLS:09. We keep values associated with the most recent observation of discretized household income as our dollar amounts for household income, federal tax liability, and net worth at the household level in the HSLS:09.

Table A19: Income, federal tax liability (CPS ASEC) and net worth (SCF) by income bin

	Income		Tax liability		Net worth	
Income bin	**2008**	**2011**	**2008**	**2011**	**2008**	**2011**
1	9,093	8,590	0	0	50	50
2	26,665	25,547	0	0	399	350
3	47,996	45,459	568	315	1,997	1,997
4	69,274	66,329	2,514	2,397	6,291	5,692
5	89,642	85,814	4,382	4,582	9,487	9,487
6	110,462	105,764	6,855	6,906	15,379	13,282
7	131,864	126,571	10,523	9,743	45,810	48,135
8	154,134	148,174	13,941	12,279	53,927	51,940
9	175,026	167,808	18,731	16,485	78,466	55,225
10	195,559	187,339	15,729	18,625	159,436	112,747
11	217,222	207,419	23,758	24,916	74,899	80,890
12	237,512	228,722	11,662	24,845	141,808	74,899
13	419,805	315,814	40,471	40,484	628,346	628,346

Notes: Table A19 reports median income, federal tax liability, and net worth by income bin from the 2009 and 2012 CPS ASEC (first four columns) and the 2013 SCF (last two columns) in 2012 USD rounded to the nearest dollar. Sources: 2009 and 2012 CPS ASEC and 2013 SCF.

A.2 The PSID and NLSY97

We use the Panel Study of Income Dynamics (PSID) and the 1997 National Longitudinal Survey of Youth (NLSY97) to estimate the deterministic and stochastic components of the life cycle earnings process. Our estimation approach follows Moschini, Raveendranathan, and Xu (2024) (which in turn builds on the method of Abbott, Gallipoli, Meghir, and Violante (2019)), with the modification that skill is measured in the NLSY97 using high school GPA rather than the ASVAB. Specifically, our PSID estimation sample is identical to Moschini et al. (2024); the NLSY97 estimation sample cleaning procedure is identical in most respects, but requires that we observe high school GPA, which slightly affects estimation sample counts.

A.2.1 Life cycle earnings process functional forms and estimation results

The deterministic component $\epsilon_{j,e,s}$ depends on the consumer's age, j, their education, e, and their skill endowment, s:

$$\epsilon_{j,e,s} = \exp\left(\beta^A_{e,1} j + \beta^A_{e,2} j^2 + \beta^A_{e,3} j^3 + \beta^s_{e,s}\right)$$

The stochastic component is an AR(1) process where the persistence parameter ρ_e depends on the consumer's educational attainment, as does the variance σ^2_e of the Normal distribution from which the error term is drawn:

$$\eta' = \rho_e \eta + \nu_e, \quad \nu_e \sim \mathbb{N}\left(0, \sigma_e^2\right)$$

For each education group e, we use the Panel Study of Income Dynamics (PSID) to estimate how logged real wages are related to a third-order polynomial of age within each education group. This identifies $\beta_{e,1}^A$, $\beta_{e,2}^A$, and $\beta_{e,3}^A$. The longer panel dimension of the PSID makes it better suited to this task than the NLSY97. We then clean logged hourly real wages in the NLSY97 of age effects with the PSID estimation results. We regress the resulting age-free log hourly real wages on indicators for skill terciles; the estimated coefficients on skill tercile indicators, $\beta_{e,s}^s$, are the factor loadings on skill s. The fact that high school GPA is observed in the NLSY97 but not the PSID makes the NLSY97 suited to this task. The residuals from the NLSY97 regression are then used to jointly estimate ρ_e and σ_e^2. Point estimates are reported in Table A20.

Table A20: Earnings process estimation results

		Value given education e	
Parameter	**Description**	$e = \ell$	$e = h$
$\beta_{e,1}^A$	Age third-order polynomial	0.106	0.186
$\beta_{e,2}^A$		-0.00176	-0.00319
$\beta_{e,3}^A$		0.00000897	0.0000174
$\beta_{e,1}^s$	Skill endowment tercile shifter	-0.0396	-0.201
$\beta_{e,2}^s$		-0.0329	-0.122
ρ_e	Persistence AR(1)	0.851214	0.886269
σ_e^2	Variance AR(1)	0.082873	0.072023

Notes: Table A20 summarizes the results from the earnings process estimation. Sources: PSID and NLSY97.

A.2.2 College wage premium by skill tercile

Table A21 reports the college wage premium for those aged 25-39 in the NLSY97.

Table A21: Bachelor's degree wage premium by skill tercile: ratio of median wages

	High school		**Bachelor's**		
Skill	**Wage**	**Obs**	**Wage**	**Obs**	**Wage premium**
1	14.12	6854	18.63	870	1.32
2	14.67	5546	20.85	2402	1.42
3	14.92	2687	23.41	5350	1.57

Notes: Table A21 tabulates the median wage within each skill tercile by education attainment status for those not currently enrolled in post-secondary education and aged 25-39; the last column is the ratio of median wages in the two educational attainment categories, the college wage premium. Observation counts are at the individual-year level. Source: NLSY97.

A.2.3 Inter-vivos transfers

To estimate average inter vivos transfers from parents to their college-aged children in the NLSY97, we use the earnings process estimation sample with four modifications involving requirements on respondent age, education status, independence status, and whether the observation has been assigned a family/parent income tercile. First, we allow individuals to be enrolled in an education program in a given year; second, we restrict attention to individuals classified as independent by the NLSY97 in a given year; third, we keep individuals between the ages of 18 and 23 during the years from 1997 to 2003; and, fourth, we require that we observe family income tercile. This leaves 8,291 individual-year observations (3,063 individuals).

To account for an implicit transfer from parents to their children who cohabit with them and do not pay rent, we flag those cohabiting with their parents and paying no monthly rent, then impute the average monthly rent paid by sample members with the same family income tercile, college enrollment status, and observation year who are not cohabiting. Next, we transform monthly rent to yearly rent, and add it to yearly net income received from parents (if both parents are present) or from both the mother and father (if both parents are not present). We also add any yearly allowances received. The resulting quantity is the yearly nominal transfers from parents to their child. Within each year, we then multiply the quantity by 6 and divide by nominal GDP per capita in that year (for those over 18) to find a unitless implied ratio of transfers received to per capita income for each individual while they are young adults of college age. To compute GDP per capita for those 18 and over in these years, we use we normalize by GDP per capita for those 18 and over, which is computed by combining information on GDP from 1997-2003 from BEA (2022, T1.1.5) and population levels from the US Census Bureau found in Census Bureau of the United States (2000, 2010). We then average this ratio across invididuals and years to find the value reported in the first row of Table A22. The average real values of the components of transfers are also reported. To convert current dollars to 2012 US dollars, we use the Consumer Price Index (CPI).

Table A22: Inter vivos transfers

Variable	**Mean**
Transfer ratio	0.579
Transfers	6,281
Transfers not allowance	721
Allowance	188
Imputed rent	6,227
Observations (invidual-year)	8,291
Observations (inviduals)	3,063

Notes: Table A22 reports average transfers for the sample used to estimate inter vivos transfers. Sample: independents between 18 and 23 observed during 1997-2003. Units for transfer amounts: year 2012 USD. Data are at the individual-year level. Source: NLSY97.

A.3 Income tax progressivity τ_p: estimation data from the CBO and results

In order to estimate the progressivity of the income tax and transfer system, we use data unerlying figures from the CBO reports on the distribution of household income (U.S. Congressional Budget Office, 2018a,b), following the robustness exercise of Heathcote, Storesletten, and Violante (2017). Note that, although we parameterize to the period 2013-2015, in this estimation we omit 2013 because the CBO report for that year does not include the components necessary to implement the estimation procedure described below.

Qualitatively, the income tax progressivity parameter, τ_p, represents the progressivity of the federal tax system including transfers from Temporary Aid for Needy Families (TANF), SNAP (Supplemental Nutrition Assistance Program), and SSI (Supplemental Security Income). This is in contrast to the estimation in Appendix A.1.6 which only computes median federal tax liability within each income bracket for the purposes of imputing the EFC and Pell grant eligibility.

Table A23 reports the baseline federal tax rate, as well as the transfer rates from Temporary Assistance to Needy Families (TANF), Supplemental Nutrition Assistance Program (SNAP), and Supplemental Security Income (SSI) shown in columns (1), (2), (3), and (4), respectively. We compute the empirical equivalent of the net tax rate for our model as the federal tax rate (which includes refundable credits as reported in column 1) minus the transfer rates from TANF, SNAP, and SSI and report this net tax rate in column (5). Average pretax income in column (6) is logged in column (7); logged after-tax income reported in column (8), where after-tax income is computed by taking the log of the net tax rate in column (5) applied to the pretax income of column (6).

Table A23: CBO data by year

	Percentiles		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Year	Min	Max	Fed. tax	TANF	SNAP	SSI	Net tax	Ave. Y	$\log(Y)$	$\log(Y_{AT})$
2014	99	100	33.6				33.6	1.776	0.249	0.071
	96	99	26.8				26.8	0.251	-0.466	-0.601
	91	95	23.4				23.4	0.158	-0.685	-0.801
	81	90	21.2				21.2	0.119	-0.820	-0.924
	60	80	17.8				17.8	0.104	-0.981	-1.066
	40	60	14.0				14.0	0.059	-1.163	-1.229
	20	40	9.1	1.6	1.6	1.1	4.8	0.040	-1.376	-1.397
	0	20	1.9	6.6	9.7	7.0	-21.4	0.023	-1.717	-1.632
2015	99	100	33.3				31.3	1.237	0.268	0.092
	96	99	26.7				26.7	0.261	-0.449	-0.583
	91	95	23.6				23.6	0.163	-0.670	-0.786
	81	90	21.3				21.3	0.124	-0.804	-0.908
	60	80	17.9				17.9	0.089	-0.967	-1.052
	40	60	14.0	0.5			13.5	0.061	-1.149	-1.212
	20	40	9.2	1.6	1.4	0.9	5.3	0.042	-1.357	-1.380
	0	20	1.5	6.5	9.0	6.7	-20.7	0.024	-1.699	-1.617

Notes: Table A23 reports the components for the estimation of the income tax progressivity parameter τ_y. Data is from 2014 and 2015, and dollar values in column (6) are in millions of current USD. After-tax income is defined as $Y_{AT} \equiv \left(1 - \frac{\text{Net tax}}{100}\right) Y$, where the net tax rate is defined as $(5) \equiv (1) - (2) - (3) - (4)$.

Table A24 reports the estimation results using CBO data presented in Table A23.

Table A24: Income tax progressivity estimation results by year and overall

Coefficient	**2014**	**2015**
β_1	0.822 (0.0314)	0.824 (0.0311)
β_0	-0.251 (0.0332)	-0.246 (0.0323)
Implied $\hat{\tau}_{p,t}$	0.178	0.176
Average 2014-2015 $\hat{\tau}_p$	0.177	

Notes: Table A24 reports estimation results. Standard errors in parentheses.

A.4 Consumption tax τ_c: estimation data from the OECD and results

In order to estimate the consumption tax rate, τ_c, we apply equation (5) from Mendoza, Razin, and Tesar (1994) to updated data for our parameterization time period. This equation is:

$$\tau_{c,t} = 100 \times \frac{5110_t + 5121_t}{C_t + G_t - GW_t - 5110_t - 5121_t} \tag{10}$$

Specifically, we use values for the United States from three data series (OECD, 2024c,b,a) to populate the 2013, 2014, and 2015 entries of Panels A, B, and C in Table A25.

Table A25: OECD data by year

Variable	**Description**	**2013**	**2014**	**2015**	**Source**
Panel A: Total tax revenue (all levels of government)					
5110	General taxes on goods and services	343,853	361,685	374,173	OECD (2024c)
5121	Excises	154,390	155,976	156,902	
Panel B: Final consumption expenditure					
C	Private	11,040,849	11,521,194	11,933,651	OECD (2024b)
G	Government	2,530,745	2,562,276	2,603,988	OECD (2024a)
Panel C: Compensation of employees by source					
GW	Paid by producers of gov't services	1,665,524	1,706,888	1,758,064	OECD (2024a)

Notes: Table A25 reports OECD data used in the consumption tax rate estimation method of Mendoza, Razin, and Tesar (1994). Dollar values are in millions of current USD for that year, rounded to the nearest dollar.

Results are presented in Table A26. The average rate across the 2013-2015 time period is 0.044, which is the number we assign to τ_c.

Table A26: Consumption tax rate estimation results by year and overall

Variable	**Description**	**2013**	**2014**	**2015**
$\hat{\tau}_{c,t}$	Annual rate (share)	0.044	0.044	0.043
$\hat{\tau}_c$	Average rate 2013-2015 (share)	0.044		

B Model Appendix

B.1 Value functions after college phase

This section presents the value functions for the lifecyle phases after the college phase.

Consumers are required to begin student loan payments the year after college graduation age, regardless of whether or not they complete college. The idiosyncratic state of a consumer while $j > 4$ and $j \neq j_f + j_a$ is given by the tuple (j, e, s, η, a). The consumer's value function is given by

$$V(j, e, s, \eta, a) = \max_{d_f \in \{0,1\}} (1 - d_f)V^R(j, e, s, \eta, a) + d_f V^D(j, e, s, \eta, a) \tag{11}$$

where d_f denotes the student loan delinquency decision. The objects $V^R(\cdot)$ and $V^D(\cdot)$ denote the value of repayment and the value of delinquency, respectively. The value of repayment for $j > 4$ and $j \neq j_f + j_a$ is given by

$$V^R(j, e, s, \eta, a) = \max_{c \geq 0, a', x \in X} U(c, x, j, e, d_f = 0) + \beta\psi_j E_{\eta'|e,\eta} V(j + 1, e, s, \eta', a') \tag{12}$$

$$s.t.$$

$$(1 + \tau_c)c + a' = y_{j,e,s,\eta,a,x} + a + \mathbb{I}_{\{a<0\}} r_{SL} a + Tr_j - T(y_{j,e,s,\eta,a,x})$$

$$a' \geq \min[(1 + r_{SL})a + \rho_R(j, a), 0]$$

The constraint on a' is the loan repayment constraint, which requires that if the consumer has outstanding federal loans, then the consumer must repay at least $\rho_R(j, a)$ of the outstanding principal plus interest.

Alternatively, these consumers can choose delinquency. The value function for $j > 4$ and $j \neq j_f + j_a$ is given by

$$V^D(j, e, s, \eta, a) = \max_{c \geq 0, x \in X} U(c, x, j, e, d_f = 1) + \beta\psi_j E_{\eta'|e,\eta} V(j + 1, e, s, \eta', a') \tag{13}$$

$$s.t.$$

$$(1 + \tau_c)c = y_{j,e,s,\eta,a,x} + Tr_j - T(y_{j,e,s,\eta,a,x}) - \rho_D(j, a, y_{j,e,s,\eta,a,x})$$

$$a' = (1 + r_{SL})a + \rho_D(j, a, y_{j,e,s,\eta,a,x}) - \phi_D[\rho_R(j, a) - \rho_D(j, a, y_{j,e,s,\eta,a,x})]$$

In the case of delinquency, consumers do not make a consumption-savings decision. Instead, they have their wage garnished to make a partial payment of $\rho_D(j, a, y_{j,e,s,\eta,a,x})$. Therefore, they consume whatever remains from their disposable income, plus accidental bequests, after making the partial payment. The parameter ϕ_D is the fraction of the missed payment, the difference between full payment and partial payment, that is charged as a collection fee. The outstanding principal plus interest is then augmented by the missed payment plus the collection fee (net of any partial payment). During delinquency the consumer also faces a stigma cost, which is represented in the utility function in equation (5) by ξ_D.

When $j = j_f + j_a$, in addition to the choices described above, the parent chooses an inter vivos transfer to their child, who will become an independent agent in that period. At the start of age $j_f + j_a$, the parent draws their child's skill type and the family's indicator for aid application frictions and then chooses whether or not to be delinquent on any student debt payments; the EFC of the child, f, is determined based on parental income, parental net assets, and the respective probabilities of qualifying for a professional judgment. The value function before the draw of child skill type and the indicator for aid application frictions is given by

$$V(j,e,s,\eta,a) = \sum_{s_c} \pi_{s_c}(s_c) \sum_b \pi_b(b|s_c) \left[\max_{d_f \in \{0,1\}} (1-d_f) V^R(j,e,s,\eta,a,s_c,b) \right. \quad (14)$$
$$\left. + d_f V^D(j,e,s,\eta,a,s_c,b) \right]$$

where $\pi_{s_c}(s_c)$ is the probability over child skill and $\pi_b(b|s_c)$ is the child skill-specific probability over the indicator about aid application frictions. The value of repayment for $j = j_f + j_a$ is given by

$$V^R(j,e,s,\eta,a,s_c,b) = \max_{c \geq 0, a', x \in X, a_c} U(c,x,j,e,d_f=0) + \beta\psi_j E_{\eta'|e,\eta} V(j+1,e,s,\eta',a') + \quad (15)$$
$$\beta_c E_{\eta'|\ell} \left[\pi_{AAI}(\tilde{y}) W(s_c,\eta',a_c,EFC(\tilde{y},a,0),b) + (1-\pi_{AAI}(\tilde{y})) W(s_c,\eta',a_c,EFC(\tilde{y},a,1),b) \right]$$
$$s.t.$$
$$(1+\tau_c)c + a' + a_c = y_{j,e,s,\eta,a,x} + a + r_{SL} a \mathbb{I}_{a<0} + Tr_j - T(y_{j,e,s,\eta,a,x})$$
$$a' \geq \min[(1+r_{SL})a + \rho_R(j,a), 0]$$
$$a_c \geq 0$$
$$\tilde{y} = y_{j,e,s,\eta,a,x=ft}$$

where $EFC(\cdot)$ is the EFC formula defined in equation (18), a_c is the inter vivos transfer to the child, $W(\cdot)$ is the child's value function, β_c disciplines the intensity of parental altruism toward the child, $\pi_{AAI}(\cdot)$ is the probability with which the child does not qualify for a professional judgment by the aid administrator, and $\tilde{y}$ is income at full time work hours, $x = ft$. Because the parent uses $W(\cdot)$ for their child's lifetime utility with the same b as the child, the parent also has the same indicator as the child about aid application frictions. When computing the EFC, parental income assuming full time work hours is used to avoid moral hazard incentives with respect to hours worked; otherwise, the parent may have an incentive to work fewer hours to lower the EFC so that the child qualifies for more need-based aid.[16]

When $j = j_f + j_a$ and the consumer chooses delinquency, we assume for simplicity that those consumers cannot make an inter vivos transfer to their child. Therefore, the value functions for delinquency are the same as in equation (13), with the difference that the parent has a term reflecting altruistic utility toward their child in their objective function.

B.2 Additional functional forms and equilibrium definition

This section presents functional forms not provided in the main text in Section 4.1 and the equilibrium definition.

Professional judgment probability function. With probability $\pi_{AAI}(y)$, an 18-year-old does not qualify for a professional judgment by the aid administrator. This probability function is given by

$$\pi_{AAI}(y) = 1 - \exp(-\phi_{AAI} y) \tag{16}$$

where ϕ_{AAI} governs the rate at which the probability function is increasing in y.

Adjusted available income function. When the applicant does not qualify for an automatic zero EFC, the EFC is determined using a schedule provided in the second case of the EFC formula in equation (18). The input into the schedule is adjusted available income, which is computed using the function given by

$$y_{adj}(y, a, d_{pj}) = [(1 - d_{pj}) + d_{pj}\tau_{AAI}][y - T(y) + \tau_a \max(-a - a_{prot}, 0)] \tag{17}$$

where τ_a and a_{prot} denote the asset conversion rate and the asset protection allowance, respectively.

Expected family contribution function. The function to determine the EFC is given by

$$EFC(y, a, d_{pj}) = \begin{cases} 0 & \text{if } y \leq y_{EFC=0} \text{ or } T(y) \leq 0 \\ \bar{f}_i + \tau_{f,i}[y_{adj}(y, a, d_{pj}) - \underline{y}_{f,i}] & \text{else, } y_{f,i} < y_{adj} \leq y_{f,i+1} \end{cases} \tag{18}$$

for $i = 1, ..., n_f$. If parental income is less than or equal to the zero EFC income threshold,

[16] In reality, this moral hazard incentive is most likely not big because the EFC is updated for every academic year of college. In our model, for the purposes of tractability, the EFC is determined in the first academic year and stays constant thereafter. Furthermore, Appendix C.2 shows that using full-time income allows the baseline model to account for uptake of Pell grants among first year enrollees from the lowest family income tercile. In Section 6.4, we provide a sensitivity analysis in which realized income is used as the EFC input.

$y_{EFC=0}$, or income tax is less than 0 (i.e., positive transfers), then the expected family contribution is an automatic 0. Otherwise, the EFC is determined using the EFC schedule after computing the adjusted available income using equation (17).

Full payment function. Federal student loan repayment leads to a full payment given by the function

$$\rho_R(j,a) = \begin{cases} -\left[\frac{r_{SL}}{1-(1+r_{SL})^{-(T_{SL}+5-j)}}\mathbb{I}_{j\in(4,T_{SL}+4]} + (1+r_{SL})\mathbb{I}_{j>T_{SL}+4}\right]a & \text{if } a<0 \\ 0 & \text{otherwise} \end{cases} \tag{19}$$

If there is an outstanding balance and j is still within T_{SL} periods of the college phase, then the loan is amortized with an interest rate of r_{SL}; otherwise, the outstanding principal plus interest is due. If there is no outstanding loan balance, the payment amount is zero.

Partial payment function. Federal student loan delinquency leads to a partial payment given by the function

$$\rho_D(j,a,y) = \min[\tau_g \max[y - T(y) - \bar{y}, 0], \rho_R(j,a)] \tag{20}$$

To present the function for Social Security transfers and then define the equilibrium, we must first discuss notation. Let $\overrightarrow{\omega}$ denote the idiosyncratic state of a consumer. This state depends on age and enrollment status in the following way:

$$\overrightarrow{\omega} = \begin{cases} (s,\eta,a,f,b) & \text{for 18-year-olds, before making the college entrance decision} \\ (j,h,s,\eta,a,f,b) & \text{for consumers in college} \\ (j,e,s,\eta,a) & \text{for consumers not enrolled, dropouts, or graduates, if } j \neq j_f + j_a \\ (j,e,s,\eta,a,s_c,b) & \text{if } j = j_f + j_a \end{cases} \tag{21}$$

Furthermore, let $d_{d,t}(\overrightarrow{\omega})$ denote the dropout decisions that solve the endogenous discrete dropout problems in the continuation values of equation (9).

Social Security transfer function. Social Security transfers are set equal to a fraction χ of the average labor earnings for the 30 years before retirement (conditional on education and skill), plus the average unconditional labor earnings for the 30 years before retirement, divided by two. The transfer function is given by

$$ss_{e,s} = \frac{\chi}{2}\left[\frac{\int w_e \eta \epsilon_{j,e,s} x(\overrightarrow{\omega})\Omega_t d(\overrightarrow{\omega}|18 \le j < j_r, e, s)}{\int \Omega_t d(\overrightarrow{\omega}|18 \le j < j_r, e, s)} + \frac{\int w_e \eta \epsilon_{j,e,s} x(\overrightarrow{\omega})\Omega_t d(\overrightarrow{\omega}|18 \le j < j_r)}{\int \Omega_t d(\overrightarrow{\omega}|18 \le j < j_r)}\right] \tag{22}$$

Although we compute the transition path in our analysis, thus far we omitted time subscripts for the ease of exposition. For the definition of equilibrium, we include a time subscript, t, to indicate which variables may change along a transition path.

Equilibrium definition. Given an initial level of capital stock K_0 and an initial distribution over idiosyncratic states $\Omega_0\left(\overrightarrow{\omega}\right)$, a competitive equilibrium consists sequences of household value functions $\{W_t(\overrightarrow{\omega}),\ V_t(\overrightarrow{\omega}),\ V_t^R(\overrightarrow{\omega}), V_t^D(\overrightarrow{\omega})\}$, household college entrance and dropout policy functions $\{d_{e,t}(\overrightarrow{\omega}),\ d_{d,t}(\overrightarrow{\omega})\}$, household consumption, hours worked, and next period asset policy functions $\{c_t(\overrightarrow{\omega}),\ x_t(\overrightarrow{\omega}), a_t'(\overrightarrow{\omega})\}$, household delinquency policy functions $\{d_{f,t}(\overrightarrow{\omega})\}$, household inter vivos transfer policy function $\{a_{c,t}(\overrightarrow{\omega})\}$, production plans $\{Y_t, K_t, L_t, L_{\ell,t}, L_{h,t}\}$, tax policies $\{\gamma_t\}$, prices $\{r_t, w_{\ell,t}, w_{h,t}\}$, Social Security transfers $\{ss_{t,e,s}\}$, accidental bequests $\{Tr_{t,j}\}$, and measures $\{\Omega_t\left(\overrightarrow{\omega}\right)\}$ such that:

(i) Given prices, transfers, and policies, the value functions and household policy functions solve the consumer problems in equations (7)-(9) and (11)-(15);
(ii) The saving interest rate and wage rates satisfy firm first order conditions;
(iii) Social Security transfers satisfy equation (22);
(iv) Accidental bequests are transferred to households between ages 50 and 60 $(33 \leq j \leq 43)$ after deducting expenditure on private education subsidies[17]

$$Tr_{t+1,j} = \frac{\int (1-\psi_j)a_t'(\overrightarrow{\omega})\Omega_t d(\overrightarrow{\omega}) - \int \theta^{pr}(s)\mathbb{I}_{e=h \text{ and } j\in\{1,2,3,4\}}\Omega_{t+1}d(\overrightarrow{\omega})}{\sum_{j=33}^{43} N_{t+1,j}} \tag{23}$$

where $N_{t,j}$ denotes the mass of population of age j at time t;
(v) Government budget constraint balances as follows, by adjusting γ:

$$\int [\tau_c c_t(\overrightarrow{\omega}) + T(y_{t,j,e,s,\eta,a})]\Omega_t d(\overrightarrow{\omega}) = G_t + E_t + D_t + SS_t \tag{24}$$

where G_t, E_t, D_t, and SS_t are government consumption, total public education subsidy, federal student loan program expenditure, and Social Security expenditure;
(vi) Labor, capital, and goods markets clear in every period t; and
(vii) $\Omega_{t+1} = \Pi_t\Big(\Omega_t\Big)$, where Π_t is the law of motion that is consistent with consumer household policy functions and the exogenous processes for population, labor productivities, skill, indicator for aid application frictions, and the probabilities of being allowed to continue college.

Note that in the stationary equilibrium, the the equilibrium distribution will be stationary, and all

[17] In our baseline calibration and in all of the counterfactual exercises, accidental bequests are always positive because the assets of those who die exceed the expenditure on private subsidies to education costs. If they did not exceed private subsidies, then bequests would be negative, which is equivalent to a lump-sum tax.

aggregates, prices, taxes, and transfers will be constant, and all value functions and policy functions will be time invariant.

B.3 Computational algorithm

This section presents the computational algorithm to solve for the stationary equilibrium. The algorithm for the transition path is analogous except that the value functions, policy functions, prices, taxes, transfers, and distributions are indexed by a time subscript.

1. Guess interest rate, r_{guess}, wage rates, $w_{\ell,\text{guess}}$ and $w_{h,\text{guess}}$, the level parameter for the income tax rate, γ_{guess}, Social Security transfers, $ss_{e,s,\text{guess}}$, and accidental bequests, $Tr_{j,\text{guess}}$
2. Use backward induction to solve consumer problems during the empty nester and retirement phases from $j = j_f + j_a + 1, \dots, J$ (equations (11)-(13))
3. Guess value function before college, $W_{\text{guess}}(s, \eta, a, f, b)$ (equation (7))
4. Use backward induction to solve consumer problem for college, parenthood, and loan repayment phases from $j = 1, \dots, j_f + j_a$ (equations (7)-(15)
   - In solving the consumer problem at $j = j_f + j_a$, use $W_{\text{guess}}(s, \eta, a, f, b)$ for the altruism term
5. Use new value before college to update $W_{\text{guess}}(s, \eta, a, f, b)$; repeat 4.-5. until convergence
6. Guess initial distribution of 18-year-old consumers $\Omega(j = 1, s, \eta, a, f, b)_{\text{guess}}$
7. Simulate and solve for distribution of Ω for $j = 2, \dots, J$
8. Use distribution of Ω for $j = j_f + j_a$, exogenous processes for child skill, indicator for aid application frictions, productivity, and qualification for professional judgment, and inter vivos transfers policy function to compute new estimates for distribution of initial 18-year-old consumers $\Omega(j = 1, s, \eta, a, f, b)$
9. Update $\Omega(j = 1, s, \eta, a, f, b)_{\text{guess}}$ and repeat 7.-9. until convergence
10. Given the stationary distribution of Ω for $j = 1, \dots, J$, solve for new guesses:
    - Compute interest and wage rates from the firm's first order conditions
    - Compute the level parameter for the income tax rate using the government budget constraint (equation (24))
    - Compute Social Security transfers and accidental bequests (equations (22) and (23))
11. Update guesses in 1., and repeat steps 2.-11. until convergence

B.4 Welfare computation

To measure welfare, we use expected lifetime utilities computed by a planner. Although consumer decisions are taken as given, the planner's expected lifetime utilities could differ from those computed by the consumer for the following reason. Suppose a consumer affected by aid application frictions (that is $b = 1$) enrolls in college. After enrollment, in our model timing, the consumer is no longer affected by aid application frictions and solves their problem like a consumer with $b = 0$. This update is not foreseen due to irrational expectations by the 18-year-old consumer making the enrollment decision nor the parent of the child (whose decisions leading up to the period in which the child leaves the household are also potentially affected). However, the planner foresees this update for enrollees with $b = 0$ and takes it into account in computing welfare.

Let value functions with a hat denote expected lifetime utilities computed by the planner. For $j = j_f + j_a + 1, \ldots, J$, the values computed by the planner are equal to that of the consumer (i.e., $\hat{V}(\overrightarrow{\omega}) = V(\overrightarrow{\omega})$) because for the empty nester and retirement phases the consumer has rational expectations.

For $j = j_f + j_a$, the age at which the consumer makes the inter vivos transfer decision, the planner's value function is given by

$$\hat{V}(j,e,s,\eta,a) = \sum_{s_c} \pi_{s_c}(s_c) \sum_{b} \pi_b(b|s_c)[(1-d_f)\hat{V}^R(j,e,s,\eta,a,s_c,b) \\ + d_f \hat{V}^D(j,e,s,\eta,a,s_c,b)] \tag{25}$$

In computing $\hat{V}(\cdot)$, the planner takes as given the delinquency decision $d_f(\cdot)$, which solves equation (14). The values for $\hat{V}^R(\cdot)$ and $\hat{V}^D(\cdot)$ are given by

$$\hat{V}^R(j,e,s,\eta,a,s_c,b) = U(c,x,j,e,d_f=0) + \beta\psi_j E_{\eta'|e,\eta}\hat{V}(j+1,e,s,\eta',a')+ \\ \beta_c E_{\eta'|\ell}\big[\pi_{AAI}(\tilde{y})\hat{W}(s_c,\eta',a_c,EFC(\tilde{y},a,0),b) + (1-\pi_{AAI}(\tilde{y}))\hat{W}(s_c,\eta',a_c,EFC(\tilde{y},a,1),b)\big]$$

$$\hat{V}^D(j,e,e,\eta,a,s,s_c,b) = U(c,x,j,e,d_f=1) + \beta\psi_j E_{\eta'|e,\eta}\hat{V}(j+1,e,s,\eta',a')+ \\ \beta_c E_{\eta'|\ell}\big[\pi_{AAI}(\tilde{y})\hat{W}(s_c,\eta',0,EFC(\tilde{y},a,0),b) + (1-\pi_{AAI}(\tilde{y}))\hat{W}(s_c,\eta',0,EFC(\tilde{y},a,1),b)\big]$$

where $\hat{W}(\cdot)$ is the value before college computed by the planner (given below) and policy functions $\{c(\cdot),\ x(\cdot),\ a'(\cdot),\ a_c(\cdot)\}$, taken as given, solve equation (15) and the parent's delinquency value function at age $j = j_f + j_a$. For $j = 1, \ldots, j_f + j_a - 1$, the planner's value function is computed analogously. Finally, the planner's value before college is given by

$$\hat{W}(s,\eta,a,f,b) = q(s)[(1-d_e)\hat{V}(1,\ell,s,\eta,a) + d_e\hat{V}(1,h,s,\eta,a,f,0)] \\ + (1-q(s))\hat{V}(1,\ell,s,\eta,a) \tag{26}$$

where the planner takes as given the enrollment decision $d_e(\cdot)$, which solves equation (7). In this value function, as the last element of $\hat{V}(1, h, s, \eta, a, f, 0)$ indicates, the planner internalizes that all enrollees will update to $b = 0$ after enrollment.

To measure welfare changes for the 18-year-old consumer, we use consumption-leisure equivalent variation. We measure consumption-leisure equivalence units relative to the value of not going to college in the initial stationary equilibrium. We do this because the value of not going to college does not include any utility fixed costs or benefits. This approach is similar to that of Abbott, Gallipoli, Meghir, and Violante (2019) and Moschini, Raveendranathan, and Xu (2024). For the average 18-year-old in period t of the transition to the new stationary steady state, the consumption-leisure equivalent variation, $g_{cx,t}$, is computed using the following equation

$$(1 + g_{cx,t})^{1-\sigma} \int \hat{V}_{\text{initial}}(1, \ell, s, \eta, a)\Omega_{\text{initial}} d(\overrightarrow{\omega}) = \int \hat{W}_t(s, \eta, a, f, b)\Omega_t d(\overrightarrow{\omega}) \tag{27}$$

where on the left-hand side of the equation, "initial" refers to the initial stationary equilibrium. To compute the resulting gains or losses from a policy change in consumption-leisure equivalent units, we report the difference between period t and the initial stationary equilibrium: $100 \times (g_{cx,t} - g_{cx,\text{initial}})$. When measuring welfare holding the distribution of 18-year-old consumers fixed to that from the initial stationary equilibrium, we use the distribution Ω_{initial} instead of Ω_{t} for the right-hand side of equation (27).

C Results Appendix

C.1 Supplemental model validation exercises

This section contains three model validation exercises that supplement those of the main text.

Non-filer due to application frictions by enrollment Table A27 reports the share of high school graduates who do not file a FAFSA before college due to aid application frictions, broken down by enrollment outcome. The shares are reported within each enrollment outcome, both overall and by skill tercile. Empirical moments are drawn from Table A7 of Appendix A.1.3. In both the data and the model, FAFSA nonfilers due to frictions sort into enrollment and non-enrollment to a similar extent, both overall and by skill bin.

Uptake of Pell grants Table A28 reports by parental income tercile the share of first-year enrollees receiving Pell grants (extensive margin) and the average grant amount conditional on receipt (intensive margin), in both the data and model. Empirical moments are drawn from Table A15 of

Table A27: Non-filers before college due to application frictions given enrollment status

			Skill Tercile		
Enrolled in BA	**Category**	**All**	**Low**	**Medium**	**High**
No	Data	14.32	15.93	12.74	12.28
No	Model	15.00	15.90	13.05	16.16
Yes	Data	6.90	6.85	6.68	7.03
Yes	Model	5.93	8.40	6.43	5.17

Notes: Table A27 presents the share of high school graduates who not file a FAFSA due to aid application frictions prior to college by enrollment status, both overall and by skill tercile, in the data and model. Data source: HSLS:09.

Appendix A.1.3. In the data, Pell uptake decreases with income both in the extensive and intensive margin, and the model accounts for this pattern.[18]

Table A28: Pell grant uptake by parental income in data and model

Parental income tercile	Margin	Unit	Data	Model
1	Extensive	Share of 1st year enrollees	80.0	75.7
2			*46.0*	*46.0*
3			6.2	20.5
1	Intensive	Dollars | Pell grant > 0	$4,776	$4,757
2			*$4,050*	*$4,051*
3			$4,033	$3,371

Notes: Table A28 presents Pell uptake along the extensive and intensive margin for first-year enrollees, broken down by parental income tercile, for both the data and model. Data source: HSLS:09. The second income tercile estimates are in italics because they are targeted in the calibration.

College wage premiums by skill Table A29 presents the college wage premium by skill tercile in the model and the data. In both the model and the data, the college wage premium is computed as the median hourly earnings of individuals with a four-year college degree divided by the median hourly earnings of those without such a degree, for workers aged 25 to 39, within a given respective skill tercile. The age range is chosen to match the available NLSY97 sample used for empirical estimates, which are reported in Table A21 of Appendix A.2.2. The model captures the fact that the college wage premium increases with skill.

C.2 Pell grant uptake and EFC ingredients

Table A30 reports the share of first year enrollees with positive Pell grant uptake by income tercile in the data, the baseline model, and three alternative re-specifications of the model. The baseline model aligns with the data in that it generates Pell uptake rates that are decreasing in income;

[18]The model overstates the extensive margin of Pell uptake in the highest income tercile. A sensitivity analysis is provided in Section 6.4.

Table A29: College wage premium by skill tercile

Skill tercile	Data	Model
Low	1.32	1.40
Medium	*1.42*	*1.42*
High	1.57	1.54

Notes: Table A29 presents the college wage premium by skill tercile, in the data and model. Data source: NLSY97. The middle row estimates are reported in italics because they are targeted in the calibration.

however, the top income tercile's uptake rate is higher in the model than in the data. The Pell uptake rates in the alternative re-specifications highlight the role of two model ingredients. The first ingredient is the "professional judgment" feature, in which a family may qualify for a lower EFC with a probability that is decreasing in their income. The second ingredient is the EFC income input in the baseline model being set to the full-time income of parents (instead of realized income). Without the professional judgment feature, columns (3) and (5) of Table A30 show that uptake of Pell is zero for the middle and high income terciles; in the data, these uptake rates are substantially greater than zero. If we allow the EFC formula to use realized income instead of full-time income, columns (4) and (5) indicate that Pell uptake in the first income tercile becomes substantially higher than in the data. Altogether, the exercises of Table A30 show that the baseline model's professional judgment feature generates positive Pell uptake rates in the middle and high income terciles, while evaluating the EFC formula at full-time income prevents the model from over-estimating uptake in the lowest income tercile.

Table A30: Extensive margin of Pell grant uptake by parental income

	Data	**Baseline model**	**Re-specified model**		
Income tercile	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
1	80.0	75.7	29.0	94.4	96.7
2	*46.0*	*46.0*	0	*46.0*	0
3	6.2	20.5	0	12.2	0
Professional judgment		Yes	No	Yes	No
Full-time income		Yes	Yes	No	No

Notes: Table A30 presents Pell uptake along the extensive margin for first-year enrollees, broken down by parental income tercile in: (1) the HSLS:09 data, (2) the baseline model, (3) re-specification of the model in which there is no qualification for professional judgment, (4) re-specification of the model in which income from actual work hours (realized income) is used as the input for the EFC formula instead of income assuming full time work hours (full-time income), and (5) re-specification of the model in which there is no qualification for professional judgment and realized-income is used as the input for the EFC formula instead of full-time income. All three re-specified models are re-calibrated. The second income tercile estimates in columns (1), (2), and (4) are in italics because they are targeted in the calibration of the respective models; in columns (3) and (5), Pell uptake in the middle income tercile is not targeted.