College Loans and Human Capital Investment (Online Appendix)

Chao Fu*, Hsuan-Chih (Luke) Lin†, and Atsuko Tanaka‡

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C Model Solution

We solve the model numerically by backward induction. Individual heterogeneity at time t in the model is characterized by (a_t, k_t, X, χ). The variables are discretized as follows: in solving the model, the asset space (a_t) is discretized into 18 grid points, while in simulating the model, agents are allowed to choose from a finer grid with 30 asset points; the corresponding value functions are obtained by linear interpolation. The human capital levels (k_t) are discretized using five points. The amounts of unpaid loans and additional loans are both discretized using five points. With two unobserved types, this classification amounts to 4,500 possible state points that represent individual heterogeneity. With the state space discretized, we can solve the model for each individual who belongs to one of mutually exclusive groups defined by (a_t, k_t, X, χ).

Continuous choice variables (asset (a) and HK investment (i)) are discretized. An individual can choose the asset level in the next period a_{t+1} from the set $\{\underline{a},...,\overline{a}\}$, subject to the borrowing limit $\underline{b}_{t+1}$. We need to interpolate the value function since the HK level and/or the unpaid loan level in the next period could be at a value between the value functions evaluated on the grid. When the new level of HK associated with a chosen amount of investment is at a value between two grid points, we apply linear interpolation.

C.1 Further Details

Since the preference shocks follow an i.i.d. Type I extreme value distribution, the decision problem at time t, given $\{a_{t+1}, c_t, i_t, \eta_t\}$, can be written in recursive form as

$$V(\Omega_t, \epsilon \big| a_{t+1}, c_t, i_t, \eta_t) = \max_h \left(\tilde{v}(x_t, h \big| a_{t+1}, c_t, i_t, \eta_t) + \epsilon_{th} \right), \tag{C1}$$

where

$$\tilde{v}(x_t, h) = u\left(c_t, h_t, \epsilon_t; \chi\right) + \beta E[V_{t+1}\left(\Omega_{t+1}\right)]. \tag{C2}$$

*University of Wisconsin-Madison and NBER, cfu@ssc.wisc.edu
†National Taiwan University, hclin@ntu.edu.tw
‡University of Calgary, atanaka@ucalgary.ca

Denote $\bar{v}(x_t) = E_\epsilon[\tilde{v}(x, \epsilon)]$, where x consists of all the necessary state variables. Following McFadden (1974) and Rust (1987), we have

$$\bar{v}(x_t) = \bar{\gamma} + \log\left(\sum_{h=0}^{2} \exp\left(\tilde{v}(x_t, h)\right)\right) \tag{C3}$$

where $\bar{\gamma}$ is the Euler constant.

Using the above solution, the value function can now be expressed by

$$E[V_{t+1}(\Omega_{t+1}|a_{t+2}, c_{t+1}, i_{t+1})] = \int \left[\bar{v}(x_{t+1}|\eta_{t+1})\right] dF\left(\eta_{t+1}\right). \tag{C4}$$

The integrals over wage shocks η are calculated by approximation through Monte Carlo integration.

D Government Budget under Different Assumptions

We evaluate the impact of different counterfactual scenarios on the government budget under four alternative assumptions about the evolution of human capital and work status beyond T (age 45) until retirement (age 62). The results are presented in Table D1. The four cases are defined as follows:

- **Case 1 (the case used in the main text):** Individuals invest enough to maintain their human capital until age 55, then stop investing, and work full time until age 60 and part time for the final two years.
- **Case 2:** Individuals stop investing in human capital after age 45 and work full time until age 60 and part time for the final two years.
- **Case 3:** Individuals invest enough to maintain their human capital until age 50, then stop investing, and work full time until age 60 and part time for the final two years.
- **Case 4:** Individuals invest at a constant rate of 0.1 until age 55, then stop investing, and work full time until age 60 and part time for the final two years.

Table D1: Government Budget (PBL) – Other Scenarios (Present Value)

	SAVE			RAP		
	ΔTax Rev	ΔBudget	ΔCEV + ΔBudget	ΔTax Rev	ΔBudget	ΔCEV + ΔBudget
Case 1	2,320	1,805	11,306	1,012	1,109	8,473
Case 2	2,413	1,898	11,399	1,052	1,149	8,513
Case 3	2,379	1,865	11,365	1,036	1,133	8,497
Case 4	2,372	1,857	11,358	1,036	1,133	8,497

E Results for Natural Borrowing Limits (NBL)

In this section, we present results for the version of the model with natural borrowing limits (NBL), focusing on parameter estimates, model fit, and counterfactual outcomes.

E.1 Parameter Estimates (NBL)

Table E1 reports the main structural parameter estimates, with bootstrapped standard errors in parentheses. Panel A presents the parameters governing the human capital (HK) production function. The annual depreciation rate of human capital is approximately 1.6 percent. The elasticity of HK production with respect to investment is about 1.01, while the elasticity with respect to the existing HK stock is about 0.85. Moreover, Type-2 individuals are estimated to be more efficient at producing human capital than Type-1 individuals. Consistent with the PBL case, part-time employment reduces the productivity of human capital accumulation: production while working part-time is only about 78 percent as effective as under full-time employment. Panel B further shows that, for the same quantity of human capital supplied to the labor market, part-time workers earn only about 35 percent of the annual wage received by full-time workers.

Panel C of Table E1 reports estimates of disutility from work. Type-2 individuals face lower disutility relative to Type-1 individuals, both for part-time and full-time work. Panel D focuses on college preferences. The results indicate that individuals with higher AFQT scores and Type-2 individuals derive greater utility from attending college. College preferences decline with age, and four-year colleges are valued more highly, particularly among Type-2 individuals. Panel E presents the determinants of graduation probabilities. Higher AFQT and Type-2 individuals are more likely to complete college. On average, a four-year college education carries a higher risk of dropout relative to two-year programs, though this penalty is smaller for Type-2 individuals. Panel F summarizes human capital gains associated with college outcomes. Although partial completion of college modestly increases human capital (1.27 for two-year dropouts and 1.90 for four-year dropouts), the gains from completing college are substantially larger (3.81 for two-year completion and 4.54 for four-year completion). Finally, Panel G shows that annual parental transfers increase with tuition and family income, decrease with student age, and are somewhat larger for four-year college enrollees.

Table E2 presents additional parameter estimates for the NBL case. Two observations are worth noting. First, unlike in the PBL case—where the parameters governing borrowing constraints are estimated—borrowing constraints are endogenously determined under NBL. Consequently, Panel M does not appear in Table A2. Second, the signs of the coefficients in Panels H through L are identical to those in Table A2, and their magnitudes are very similar. This similarity suggests that behavioral responses are largely consistent across the two borrowing environments.

Finally, Table E3 summarizes the distribution of observed characteristics by unobserved type. Consistent with the PBL case, we find a strong positive correlation between being Type 2—interpreted as having unobserved advantages—and coming from a more favorable observable background, such as higher parental education or income. This pattern provides indirect evidence that early-life parental investment contributes to the development of unobserved traits. The persistence of this relationship across different credit environments supports the interpretation that type reflects a combination of innate ability and early inputs that shape long-run outcomes.

E.2 Model Fit (NBL)

Table E4 reports the targeted college-related moments. Overall, the model reproduces the main patterns in college enrollment, completion, student loan borrowing, and in-college labor supply. Nonetheless, it underpredicts four-year college completion rates and overpredicts the incidence of working while enrolled, particularly among high-AFQT students. The model also tends to underpredict the wage gains of two-year graduates relative to non-completers, while slightly overpredicting the corresponding gap for dropouts.

Table E1: Parameter Estimates for NBL

A. HK production: $k_{t+1} = (1-\delta)k_t + \alpha_{0h} A_\chi i_t^{\alpha_1} k_t^{\alpha_2}$		
Skill depreciation rate (δ)	0.016	(0.001)
Elasticity w.r.t. investment (α_1)	1.012	(0.020)
Elasticity w.r.t. human capital stock (α_2)	0.850	(0.008)
Type 1 factor (A_1)	0.097	(0.001)
Type 2 factor (A_2)	0.148	(0.007)
Part-time factor (α_{01})	0.782	(0.016)
B. Skill price for part-time jobs (p_1)		
	0.349	(0.006)
C. Disutility from Work		
Part-time work (Type 1) (λ_{11})	0.837	(0.023)
Part-time work (Type 2) (λ_{12})	0.086	(0.002)
Full-time work (Type 1) (λ_{21})	0.912	(0.014)
Full-time work (Type 2) (λ_{22})	0.488	(0.010)
Work during college (λ_e)	1.107	(0.075)
D. College Preference		
Constant term (ψ_0)	-39.163	(0.830)
AFQT score (ψ_1)	4.384	(0.081)
Type 2 (ψ_2)	10.774	(0.747)
Time (ψ_3)	-2.216	(0.063)
4-year college (ψ_4)	7.237	(0.079)
4-year college for Type 2 (ψ_5)	3.097	(0.048)
E. Graduation Probabilities		
Constant term (ρ_0)	-1.063	(0.019)
AFQT score (ρ_1)	2.635	(0.080)
Type 2 (ρ_2)	0.775	(0.033)
4-year college (ρ_3)	-0.848	(0.014)
4-year college for Type 2 (ρ_4)	0.524	(0.010)
F. Human capital gain upon leaving school: $\kappa(s_t^e)$		
Dropping Out from 2-year ($\kappa_0(s_t^e = 2)$)	1.270	(0.026)
Completing 2-year ($\kappa_1(s_t^e = 2)$)	3.809	(0.045)
Dropping Out from 4-year ($\kappa_0(s_t^e = 4)$)	1.894	(0.049)
Completing 4-year ($\kappa_1(s_t^e = 4)$)	4.537	(0.040)
G. Parental Transfer		
Constant term (ι_0)	1.032	(0.055)
Tuition (ι_1)	0.587	(0.016)
Age (ι_2)	-0.101	(0.003)
Parents' income (33–66 percentile) (ι_3)	0.203	(0.005)
Parents' income (67–100 percentile) (ι_4)	0.587	(0.052)
4-year college (ι_5)	0.153	(0.002)

Table E2: Parameter Estimates for NBL (cont.)

H. Type distribution		
Constant term (θ_0^χ)	-2.676	(0.073)
AFQT score (θ_1^χ)	0.009	(0.001)
Parent's education = HS (θ_2^χ)	0.083	(0.001)
Parent's education > HS (θ_3^χ)	1.981	(0.062)
Parents' income (33–66 percentile) (θ_4^χ)	0.603	(0.043)
Parents' income (67–100 percentile) (θ_5^χ)	1.649	(0.127)
I. Initial human capital (k_0)		
Constant term (θ_0^k)	1.615	(0.029)
Type 2 (θ_1^k)	0.219	(0.003)
AFQT (θ_2^k)	0.002	(0.001)
Parent's education = HS (θ_3^k)	0.378	(0.016)
Parent's education > HS (θ_4^k)	2.201	(0.075)
Parents' income (33–66 percentile) (θ_5^k)	1.078	(0.053)
Parents' income (67–100 percentile) (θ_6^k)	2.101	(0.079)
J. Variance of Preference Shocks		
Utility scale parameter (υ)	2.399	(0.032)
Std. Dev. of college preference shocks	1.229	(0.075)
Std. Dev. of in-college loan-work preference shocks	1.020	(0.133)
K. Terminal Value (at age 45)		
Asset (Type 1) (γ_1)	6.282	(0.153)
Asset^2 (Type 1) (γ_2)	-0.040	(0.001)
Asset (Type 2) (γ_3)	6.362	(0.293)
Asset^2 (Type 2) (γ_4)	-0.136	(0.002)
Human capital (Type 1) (γ_5)	3.503	(0.157)
Human capital^2 (Type 1) (γ_6)	-0.002	(0.001)
Human capital (Type 2) (γ_7)	10.581	(0.236)
Human capital^2 (Type 2) (γ_8)	-0.039	(0.001)
Asset × human capital (γ_9)	-0.034	(0.001)
L. Wage Distribution		
Shape of Gamma Distribution (a)	48.033	(2.703)
Scale of Gamma Distribution (b)	0.067	(0.002)

Table E5 reports the targeted moments for post-college wages, as estimated using the auxiliary wage regression. All model-predicted coefficients share the same sign as in the data regression, although some estimates lie outside the 95 percent confidence intervals of their empirical counterparts.

Taken together, the results indicate that the model fits the data well and captures most key empirical patterns. Despite the model's somewhat weaker performance in the wage regression, the model continues to replicate the core wage dynamics, including returns to labor market experience and education.

Table E3: Characteristics by Type (NBL)

	Type 1 (65%)	Type 2 (35%)
AFQT score	51.4	62.4
Pr(parent edu = HS)	56.1%	28.6%
Pr(parent edu > HS)	20.9%	64.2%
Pr(parent's income 33–66 percentile)	32.0%	26.0%
Pr(parent's income 67–100 percentile)	18.4%	45.5%

Table E4: Model Fit: College-Related Moments (NBL)

	Data	Model
2-year College Enrollees (%)	17.50	20.95
4-year College Enrollees (%)	41.50	42.03
2-year College Completion Rate (%)	26.70	28.58
4-year College Completion Rate (%)	58.60	47.51
2-year College On-time Completion Rate (%)	17.00	18.15
4-year College On-time Completion Rate (%)	33.10	33.16
College Loans|Enrollment in 2-year ($1,000)	1.32	1.18
College Loans|Enrollment in 4-year ($1,000)	6.16	5.75
College Loans (Std. Dev.)|Enrollment ($1,000)	8.33	4.07
Working While Enrolled (%)	67.20	89.13
Gap Years	0.90	0.62
Average Years in 2-Year College	2.39	1.64
Average Years in 4-Year College	4.98	4.44
Post- vs Pre-college Wage Diff. (2-year Dropouts)	4.82	7.84
Post- vs Pre-college Wage Diff. (2-year Graduates)	11.95	8.73
Post- vs Pre-college Wage Diff. (4-year Dropouts)	5.26	6.31
Post- vs Pre-college Wage Diff. (4-year Graduates)	14.78	18.60
Moments for High AFQT Subgroup		
2-year College Enrollees (%)	16.53	7.46
4-year College Enrollees (%)	63.83	66.34
College Completion Rate (%)	59.20	49.94
College Loans|Enrollment ($1,000)	4.57	3.57
Working While Enrolled (%)	69.00	85.70

E.3 Counterfactual Results (NBL)

This subsection presents counterfactual results under the natural borrowing limit (NBL). As in the PBL case, we first analyze the effects of an unexpected debt relief policy, followed by results for alternative income-driven repayment (IDR) schemes.

Table E5: Model Fit: Post-College Wage Regression (NBL)

	Data		Model
	Coefficient	95% CI	
Labor market experience (yrs)	4.25	(3.50, 5.00)	3.31
Labor market experience (yrs)^2	-0.11	(-0.14, -0.07)	-0.01
Labor market experience (yrs, full-time)	1.38	(1.00, 1.76)	1.27
Total amount of college loan	1.65	(-0.31, 3.61)	7.13
Experience × large loan	0.36	(-0.08, 0.81)	0.05
Experience × first 10 yrs	0.53	(0.08, 0.98)	0.87
Experience × first 10 yrs × loan	-1.04	(-1.97, -0.11)	-0.14
4-year college degree	16.62	(14.09, 19.14)	25.88
Full-time	20.67	(16.94, 24.39)	47.72

Notes: Other controls include dummy variables for individuals whose parental education is high school, those whose parental education exceeds high school, those whose parental income falls in the second tercile, those whose parental income is in the third tercile, and those with AFQT scores above the median.

Table E6: Model Fit: Post-College Asset Regression (Not Targeted) (NBL)

	Data		Model (NBL)
	Coefficient	95% CI	
Labor market experience (yrs)	0.46	(0.42, 0.49)	0.69
Total amount of college loan	-0.72	(-1.00, -0.44)	-0.78
Experience × loan	0.02	(-0.05, 0.10)	0.17
Experience × first 10 yrs	-0.03	(-0.09, 0.03)	-0.06
Experience × first 10 yrs × loan	-0.09	(-0.23, 0.05)	-0.18

Notes: This table compares coefficients from the data regression to those implied by the structural model (NBL specification). Additional controls include dummy variables for attending a four-year college, full-time employment, parental education at the high school level, parental education beyond high school, parental income in the second and third terciles, and AFQT scores above the median. The data coefficients are reported with 95% confidence intervals.

E.3.1 Unexpected Debt Relief

We begin by simulating an unexpected debt relief policy in which all outstanding student loans are forgiven upon labor market entry, while education and loan choices remain fixed at their baseline levels. The results are summarized in Table E7.

Table E7 shows the impact of this policy on borrowers with outstanding student debt—the only group directly affected. Debt forgiveness reduces their first-year labor income by about $1,470, increases their income at age 44 by $355, and raises their asset holdings at age 45 by $388, relative to the baseline repayment regime. These shifts primarily reflect higher investment in human capital: by age 45, average human capital rises by roughly $781. Put differently, the obligation to repay student debt distorts workers toward underinvesting in human capital during their careers. In addition, debt repayment induces slightly greater labor supply in the baseline, with affected individuals working about 0.02 more hours per week on average.

Table E7: Post-Schooling Effects of Debt Forgiveness for College Loan Borrowers (NBL)

Outcome	Forgiveness vs. Baseline
Δ Annual Earnings (First year of labor market) ($)	-1,470
Δ Annual Earnings (Age 44, last decision period) ($)	355
Δ Asset at Age 45 ($)	388
Δ Human Capital at Age 45 ($)	781
Δ Average Weekly Hours (First 10 years of labor market)	-0.024
Δ Average Weekly Hours (All Periods)	-0.022

Notes: This table summarizes simulated changes in key post-schooling outcomes under an unexpected loan forgiveness policy, announced upon labor market entry, relative to the baseline scenario. Reported values represent differences from the baseline and are limited to college loan borrowers. All dollar amounts are in 2012 USD. Human capital is measured in dollar terms, reflecting the earnings a worker would generate from full-time employment when devoting all available time to production rather than investment.

E.3.2 IDR plans

In the second set of counterfactual experiments, we study how alternative repayment policies influence individuals' education and career choices. We consider two policy environments. In each case, individuals are fully informed about the repayment regime when making education and borrowing decisions. Upon leaving college, a borrower chooses between the standard fixed repayment plan and the IDR option, as described in the main text.

Education and Loan Choices

Panel A of Table E8 compares enrollment, degree attainment, and graduation rates across repayment plans. Relative to the baseline, both SAVE and RAP modestly raise college attainment, with SAVE generating slightly larger increases. For example, the share of two-year (four-year) degree holders increases by 0.57 (0.71) percentage points under SAVE, compared to 0.19 (0.26) under RAP. Overall enrollment effects are small: two-year enrollment falls slightly under both plans, while four-year enrollment rises modestly, indicating a shift from two-year to four-year programs. Graduation rates (degrees conditional on enrollment) improve for two-year programs but decline slightly for four-year programs, mostly due to the selection of weaker students into 4-year colleges.

Panel B reports average loan amounts among enrollees and degree holders. The effects on borrowing are more pronounced than those on attainment. For example, from the baseline to SAVE, an average two-year (four-year) enrollee borrows $1,103 ($1,598) more. Panel C shows that these additional loans allow students to work fewer hours in college and consume more.

Earnings, Assets and Human Capital

Panel A of Table E9 reports average discounted lifetime earnings through age 44, assets at age 45, and human capital at age 45. Outcomes are consistently higher under SAVE than RAP. For instance, average discounted earnings increase by $9,744 under SAVE compared to only $4,995 under RAP. Similarly, assets at age 45 rise by $1,130 under SAVE versus $110 under RAP, while human capital at age 45 grows by $951 under SAVE and $539 under RAP.

Table E8: Education-Related Outcomes (NBL)

Panel A: College Enrollment and Attainment						
		2-year			4-year	
(ppts)	Enrollment	Degree	GradRate	Enrollment	Degree	GradRate
SAVE – Baseline	-0.14	0.57	2.93	1.68	0.71	-0.20
RAP – Baseline	-0.17	0.19	1.14	0.80	0.26	-0.29
Panel B: College Loan among Enrollees and Degree Holders						
		2-year			4-year	
($)	Enrollee	Degree Holder		Enrollee	Degree Holder	
SAVE – Baseline	1,103	1,660		1,598	2,471	
RAP – Baseline	383	805		840	1,325	
Panel C: Consumption and Work Hours During College Years						
	Annual Consumption ($)			Weekly Work Hours in College		
SAVE – Baseline	1,517			-0.21		
RAP – Baseline	775			-0.07		

Notes: This table shows changes in outcomes from the baseline to SAVE/RAP, as described in the text. Panel A reports changes in college enrollment and degree attainment outcomes. "Enrollment" is the proportion of the full sample who enroll in a 2-year or 4-year college. "Degree" is the proportion of the full sample who hold a 2-year or 4-year college degree. "GradRate" is the ratio of "Degree" to "Enrollment". Panel B reports changes in the average student loan amount among enrollees and degree holders. Panel C reports changes in the average in-college annual consumption and average weekly work hours while enrolled. All dollar values are reported in 2012 USD.

Table E9: Earnings, Assets, and Human Capital by Repayment Plan (Full Sample; NBL)

Panel A: Cumulative Earnings, Assets, and Human Capital			
($)	Earnings (post edu. to Age 44)	Assets (Age 45)	HK (Age 45)
SAVE - Baseline	9,744	1,130	951
RAP - Baseline	4,995	110	539

Panel B: HK at Market Entry, Hours, and On-the-Job HK Investment			
	HK at Market Entry ($)	Avg. Weekly Work Hrs	Avg. OTJ HK Inv. ($)
SAVE - Baseline	575	-0.07	318
RAP - Baseline	208	-0.03	342

Notes: Each row reports changes in the average outcomes under SAVE/RAP versus the baseline. Earnings refer to the discounted sum of earnings from labor market entry up to Age 44. Human capital (HK) is expressed in dollar terms and reflects the earnings a worker would obtain from full-time employment when allocating all time to production rather than investment. Labor market entry refers to the first year of work after completing schooling for college attendees and at age 18 for high school graduates. Average work hours represent weekly hours averaged over the labor market period; average OTJ investment is the annual average value of foregone earnings due to time spent on skill accumulation. All values are reported in 2012 USD.

Panel B highlights the mechanisms behind our findings. First, the human capital effect at labor market entry increases under SAVE and RAP, relative to the baseline, reflecting greater pre-market HK accumulation. Second, while IDR plans could in theory reduce work incentives, the effects on average weekly work hours are

negligible (-0.07 under SAVE and -0.03 under RAP). Third, by reducing repayment burdens when income is low, IDR plans, particularly SAVE, enable greater post-schooling investment in human capital, as reflected in higher average on-the-job HK investment per year.

Individual Welfare

To evaluate individual welfare, we compute the discounted consumption-equivalent variation (CEV) each person would require under the baseline to be as well off as under a given IDR policy. Table E10 summarizes the cross-sectional distribution of welfare changes relative to the baseline. Similar to the findings in the main text, both SAVE and RAP increase individual welfare.

Table E10: Changes in Individual Welfare (CEV; NBL)

($)	SAVE vs. Baseline	RAP vs. Baseline
25th Percentile	39	37
Median	2,640	1,204
75th Percentile	8,830	6,575
Mean	3,739	3,869

Notes: This table reports the distribution of changes in individual welfare under alternative repayment plans, relative to the baseline, at selected percentiles (25th, median, 75th) and the mean. Welfare changes are measured as the discounted sum of consumption equivalent variation (CEV). All values are expressed in 2012 USD.

Government Revenue and Social Welfare

Table E11 presents changes in discounted government revenue under alternative repayment plans relative to the baseline. Column 1 reports changes in tax revenue from lifetime earnings (up to age 62), Column 2 reports changes in net loan revenue, and Column 3 combines the two.

Table E11: Government Revenue and Social Welfare Changes (Full Sample; NBL)

($)	ΔTax Rev.	ΔLoan Rev.	ΔGov. Rev.	CEV	ΔWelfare
SAVE – Baseline	3,629	-356	3,273	3,739	7,011
RAP– Baseline	2,051	69	2,120	3,869	5,989

Notes: Each row shows changes in government revenue and individual welfare under alternative repayment plans, relative to the baseline; all numbers are discounted to the present value at $t = 1$. ΔTax Revenue is the change in total lifetime tax collection. ΔLoan Revenue is the discounted present value of loan repayment minus the amount lent (negative values indicate a loss). ΔGov. Revenue combines changes in tax and loan revenue. CEV refers to the consumption-equivalent variation, and ΔWelfare is the sum of ΔGov. Revenue and CEV. All values are expressed in 2012 USD.

To compute post-age-44 tax revenue, we assume that all individuals work full-time until age 60 and part-time until age 62, investing in human capital until age 55 just enough to offset depreciation. Under these assumptions, SAVE generates an average tax revenue gain of $3,629 per person but a loan revenue loss of $356, resulting in a net government revenue gain of $3,273. RAP produces a smaller increase in tax revenue

($2,051) but a small loan profit, yielding a net revenue gain of $2,120. Combining changes in government revenue with individual CEV provides a measure of social welfare (Column 5). SAVE raises social welfare by $7,011 per person, while RAP raises it by $5,989.

Overall, these results suggest that SAVE is fiscally unsustainable for a private lender, who would incur losses, whereas RAP would generate a small positive return. However, once income taxes are accounted for, both IDR schemes become fiscally viable and yield a "win-win" outcome: they facilitate human capital investment, improve individual welfare, and increase government revenue. The welfare and fiscal gains are larger under SAVE than under RAP.

F Simulating the Impact of High Tuition (PBL)

We apply our estimated PBL model to examine how higher tuition costs, similar to the costs faced by later cohorts such as the NLSY97 cohorts (born in 1980-1984), would affect educational attainment and post-education decisions.

To simulate the higher tuition environment, we adjust net tuition costs based on differences in tuition-to-income ratios between NLSY79 and NLSY97. To do so, we use net tuition and fee data from the College Board's Trends in College Pricing (2006),[1] as well as the information on the growth in real household income overtime from the Census.[2] Holding all other initial conditions (including parental income levels) fixed, these data allow us to calculate the counterfactual net tuition-to-income ratios (hence the net tuition costs) for two- and four-year colleges faced by each parental income group in our sample had they graduated from high school in 2002.[3] In particular, the original (low) net tuition and the counterfactual (high) net tuition for each parental income group by college type are given by Table F1.

Table F1: Net Tuition (2012 USD)

	Original (Low Tuition)		Counterfactual (High Tuition)	
Parental Income Tercile	2-year	4-year	2-year	4-year
1 (lowest)	55	2,352	747	5,022
2 (middle)	470	3,475	1,303	7,373
3 (highest)	990	4,007	1,737	10,297

Notes: The counterfactual (high tuition) values are constructed by scaling net tuition using tuition–to–income ratios from the College Board's *Trends in College Pricing* (2006) and observed income growth from the Census. All amounts are in 2012 USD.

[1] Trends in College Pricing (2006) (`https://research.collegeboard.org/trends`) reports net tuition by parental income quartile. Since our model is based on terciles, we re-map quartiles into terciles using weighted averages. The report also distinguishes among 4-year public, private nonprofit, and for-profit institutions; we aggregate these into a single 4-year category using enrollment-share weighted averages.

[2] U.S. Census Bureau, Real Median Household Income in the United States [MEHOINUSA672N], FRED, Federal Reserve Bank of St. Louis; `https://fred.stlouisfed.org/series/MEHOINUSA672N`.

[3] The net tuition-to-income ratio for 2-year colleges for the low/middle/high parental income group rises from 0.21/0.70/0.90% to 2.40/1.73/1.58%. For 4-year colleges, the corresponding increase is from 9.00/5.50/3.70% to 16.16/9.76/7.89%.

F.1 Impacts of Tuition Increase under the Standard Repayment Plan

Table F2 reports differences in outcomes between the counterfactual high-tuition environment and the baseline low-tuition environment, both under the standard repayment plan regime. When tuition increases, Panel A shows a substantial reallocation away from four-year colleges: Four-year enrollment falls by 8.8 percentage points (ppts) and degree attainment by 2.17 ppts. Although two-year college enrollment rises by 1.75 ppts and degree completion increases by 0.28 ppts, these increases are minor relative to the corresponding decreases in the four-year college sector, leading to overall lower college enrollment and attainment. These findings are consistent with prior evidence that higher tuition reduces college participation (Leslie and Brinkman, 1988; Cameron and Heckman, 2001).

Table F2: Education-Related and Economic Outcomes (High vs. Low Tuition)

Panel A: College Enrollment and Attainment

	2-year			4-year		
(ppts)	Enroll	Degree	GradRate	Enroll	Degree	GradRate
High – Low	1.75	0.28	-0.78	-8.80	-2.17	7.45

Panel B: College Loan among Enrollees and Degree Holders

	2-year		4-year	
($)	Enroll	Degree	Enroll	Degree
High – Low	89	105	398	-5

Panel C: Consumption and Work Hours During College Years

	Annual Consumption ($)	Work Hours (per week)
High – Low	-3,464	0.59

Panel D: Cumulative Earnings, Assets, and Human Capital

($)	Discounted Earnings (to Age 44)	Assets (Age 45)	Human Capital (Age 45)
High – Low	-19,341	-3,594	-3,142

Panel E: Human Capital at Entry, Hours, and HK Investment on the Job

	Human Capital ($ Entry)	Avg. Work Hours	Avg. HK Investment ($)
High – Low	-1,794	0.25	-1,029

Notes: This table reports the differences in education-related and economic outcomes between high- and low-tuition environments under the baseline repayment plan. Panel A shows differences in college enrollment, degree attainment, and graduation rates (in percentage points). "Enroll" is the proportion of the full sample who enroll in a 2-year or 4-year college, "Degree" is the proportion who attain a degree, and "GradRate" is the ratio of degrees to enrollment. Panel B shows the difference in average student loan amounts (in dollars) among enrollees and degree holders. Panel C reports the difference in average annual consumption (in dollars) during college and average weekly work hours while enrolled. Panel D reports differences in discounted lifetime earnings up to age 44, as well as assets and human capital at age 45 (all in dollars). Panel E reports differences in human capital at college entry, average weekly work hours, and average annual human capital investment on the job (in dollars). All entries are expressed as the difference between high-tuition and low-tuition environments (High – Low).

Panel B of Table F2 shows that higher tuition increases student loan balances among enrollees: by $398 for four-year students and by $89–$105 for two-year students. Panel C shows that when placed in the high-

tuition environment, college students reduce annual consumption by $3,464 and increase weekly work hours by 0.6. Panel D shows that discounted lifetime earnings (up to Age 44) decline by $19,341 and that at Age 45, assets fall by $3,594 and human capital by $3,142. Panel E shows that the increase in tuition lowers HK upon market entry and on-the-job HK investment, while increasing post-education work hours.

In sum, higher tuition (i) shifts enrollment away from four-year colleges and reduces overall educational attainment, (ii) increases borrowing among college enrollees, and (iii) reduces earnings, wealth, and human capital while increasing work hours. That is, the increase in tuition suppresses both education and on-the-job human capital investment and imposes lasting economic consequences.

Remark 1 *Notice that the simulation does not capture the observed increase in college enrollment that coincided with higher tuition and greater student debt. This arises because this exercise isolates the effects of tuition increases, while the observed data patterns are also driven by changes in the labor market returns to college education.*

F.2 The Role of IDRs in the High Tuition Environment

Now we investigate the role of income-driven repayment (IDR) plans–SAVE and RAP described in the main text–in the high tuition environment. We present changes in various outcomes when the baseline repayment regime switches to SAVE/RAP.

Table F3 presents the impact of SAVE on various outcomes in the low-tuition environment (the first row in each panel) and in the high-tuition environment (the second row in each panel). Table F4 is the RAP counterpart of Table F3. Both tables show that IDRs' impacts tend to be larger when tuition is higher.

For example, Panel A of Table F3 shows that SAVE has a larger impact on educational achievement when tuition is high: The fraction of four-year college degree holders increases by 1.4 (0.95) ppts and that of any college degree holders increases by 2.1 (1.8) ppts in the high-tuition (low-tuition) case.[4] Panel B shows that SAVE increases in-college consumption and reduces in-college work hours more when tuition is high. Panel C shows that SAVE leads to higher earnings and assets, and this effect is larger when tuition is high: The discounted lifetime earnings increase by $4,497 and assets at age 45 by $1,383 in the high-tuition case, while the corresponding numbers in the low-tuition case are $3,669 and $701, respectively.

References

Cameron, S. V. and Heckman, J. J. (2001). The Dynamics of Educational Attainment for Black, Hispanic, and White Males. *Journal of Political Economy*, 109(3):455–499.

Leslie, L. and Brinkman, P. (1988). *The Economic Value of Higher Education*. American Council on Education/Macmillan Series on Higher Education. American Council on Education.

[4]The fraction of any degree holders refers to the sum of the second and the fourth columns, e.g., $2.1 = 0.69 + 1.4$.

Table F3: Differences in Outcomes under SAVE compared to the baseline (Low vs. High Tuition)

Panel A: College Enrollment and Attainment						
	2-year			4-year		
(ppts)	Enroll	Degree	GradRate	Enroll	Degree	GradRate
Low Tuition	0.70	0.84	3.00	0.69	0.95	1.33
High Tuition	0.32	0.69	2.63	1.17	1.40	2.40

Panel B: Consumption and Work Hours During College Years		
	Annual Consumption ($)	Work Hours (per week)
Low Tuition	874	-0.68
High Tuition	973	-0.73

Panel C: Cumulative Earnings, Assets, and Human Capital		
($)	Discounted Earnings (to Age 44)	Assets (Age 45)
Low Tuition	3,669	701
High Tuition	4,497	1,383

Notes: Each panel reports the effects of SAVE relative to the baseline under two tuition regimes. Panels A–B cover enrollment, attainment, and in-college outcomes. Panel C shows lifetime earnings and assets. All outcomes are differences from the baseline, reported in 2012 USD.

Table F4: Differences in Outcomes under RAP compared to the baseline (Low vs. High Tuition)

Panel A: College Enrollment and Attainment						
	2-year			4-year		
(ppts)	Enroll	Degree	GradRate	Enroll	Degree	GradRate
Low Tuition	0.06	0.57	2.62	0.36	0.62	1.01
High Tuition	-0.06	0.46	2.07	0.50	0.80	1.45

Panel B: Consumption and Work Hours During College Years		
	Annual Consumption ($)	Work Hours (per week)
Low Tuition	609	-0.60
High Tuition	681	-0.60

Panel C: Cumulative Earnings, Assets, and Human Capital		
($)	Discounted Earnings (to Age 44)	Assets (Age 45)
Low Tuition	2,317	128
High Tuition	2,595	480

Notes: Each panel reports the effects of RAP relative to the baseline under two tuition regimes. Panels A–B cover enrollment, attainment, and in-college outcomes. Panel C shows lifetime earnings and assets. All outcomes are differences from the baseline, reported in 2012 USD.