Debt, Human Capital Accumulation, and the Allocation of Talent

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NBER Micro Data and Macro Models

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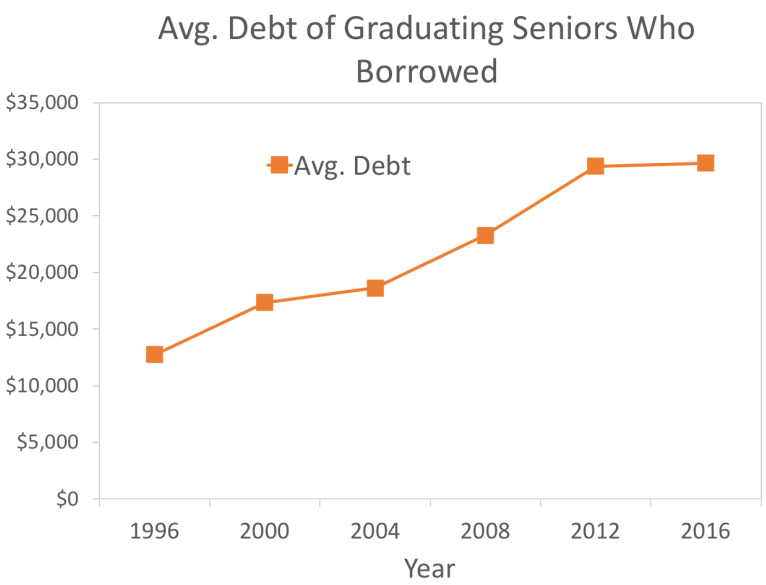
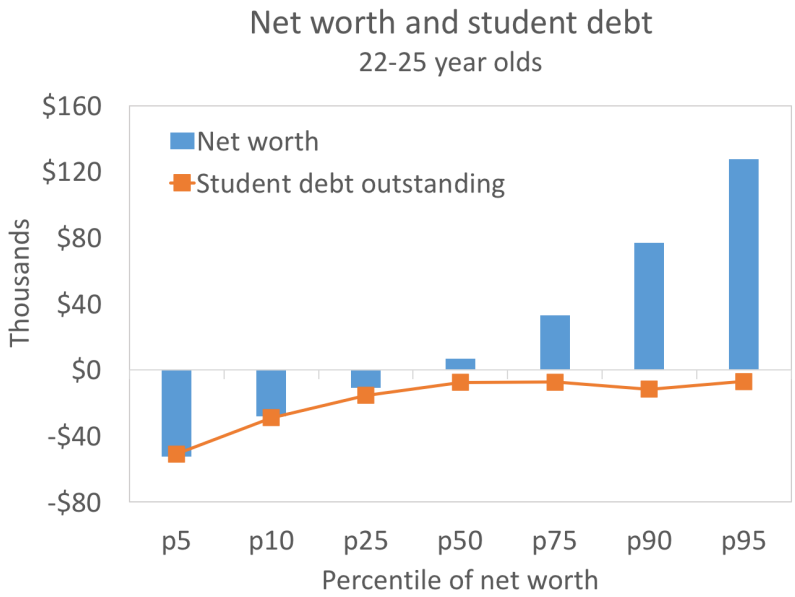
Motivation: Rise in student debt over time





- 69% graduate with student debt. Median debt \$8.9K, p90 is \$75K.
- Bottom half of the wealth distribution of young college graduates: student debt accounts for most of net worth.
- Typically takes 10-25 years to repay loans.

Our question

How do assets (debt) early in life affect the profile of labor earnings?

- Empirical evidence on initial earnings and returns to experience.
- Heterogeneous life-cycle model with college and occupation choice, and borrowing constraints.
- Quantitative effects of different grant schemes.

Key Empirical Findings

1. Individuals with higher levels of student debt have:
   - higher initial earnings, and
   - lower returns to experience (RTE) over the next 10-15 years.

2. Occupation heterogeneity relevant for understanding debt effects.
   - Suggestive evidence: Scope of ongoing training within the occupation correlated with initial earnings & RTE trade-off.

     (e.g. pilot vs. aeronautical engineer)

Model predictions

Explanation: Credit constraints interact with human capital decisions:

- Endogenously sort into occupations with less scope of human capital accumulation.
- Invest less in human capital on-the-job.

Implications for aggregate human capital: Depends on the joint distribution of credit constraints, talent, and occupational profiles.

- Larger distortions if constrained individuals are highly talented in occupations with scope for human capital accumulation.
- Occupation-based grants can reduce distortions.

Outline

1. Document empirical micro facts on earnings and student debt.
2. Heterogeneous life-cycle model with occupation choice and human capital investment.
3. Quantitative analysis of alternative grant schemes.

Data: NLSY 1997

- Individual-level panel dataset information on higher education, student debt, ability, occupational choice, and labor outcomes.
- Restrict analysis to college graduates.
- 5,976 individuals, surveyed annually between 1997-2015.
- Document how earnings and returns to experience varies with student debt.

Estimating Wage Profiles

Estimating equation for individual i in year t:

$$y_{it} = \underbrace{\alpha_0 + X_{it}\beta}_{\text{initial (log) wage if no student debt}} + \underbrace{\alpha_1 \text{Exp}_{it}}_{\text{returns to experience if no debt}} +$$

$$\underbrace{\alpha_2 \text{D}_{it}}_{\text{effect of debt on initial (log) wage}} + \underbrace{\alpha_3 \text{D}_{it} \times \text{Exp}_{it}}_{\text{effect of debt on returns to experience}} + \epsilon_{it}$$

y_{it}	Log wage or log earnings
D_{it}	Total borrowing from all student loan sources
X_{it}	Age, gender, race, cohort, test score
Exp_{it}	Years of experience
ϵ_{it}	Standard errors.

Potential endogeneity: Correlated ϵ_{it} and D_{it}.

- Existing studies use variation in college grants and loans across cohorts.

IV for student debt

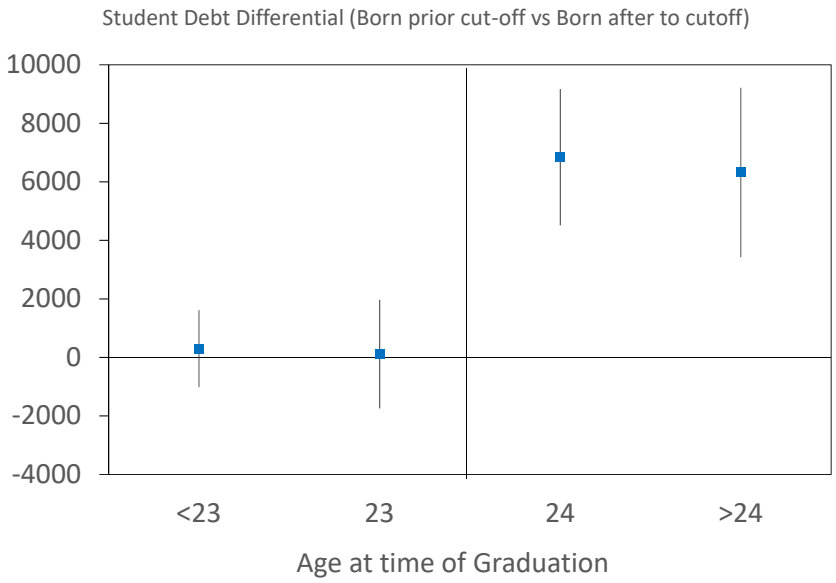
Source of variation: Calendar month of birth

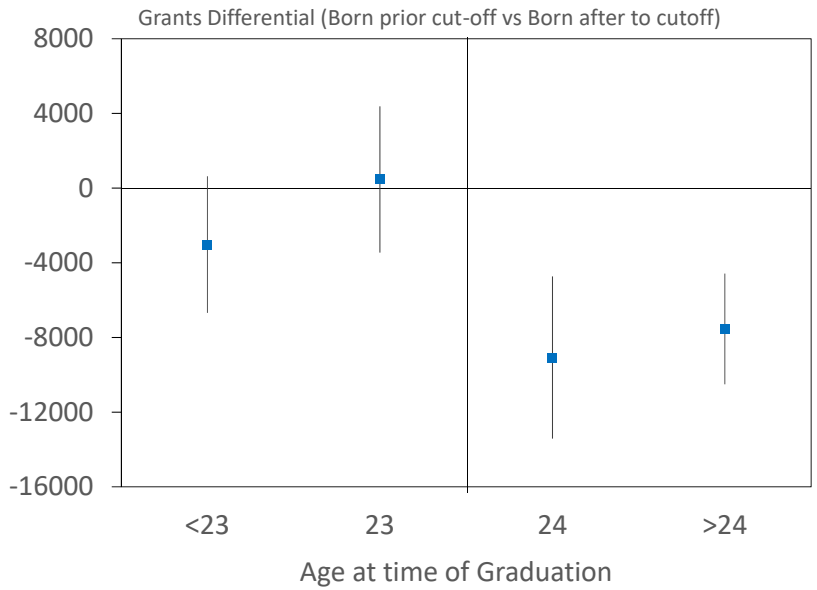
- Higher loan limits when student classified as independent (turn 24).
- Determined end-calendar yr. Cf. those born Q4 vs. those born Q1.

Why is it a plausible IV:

- Exogenous change in loan limits are accompanied by a 1-to-1 offsetting decline in institutional grants.
- Students have less grants, and more debt. I.e. rise in net debt.
- "Bennett hypothesis": Lucca, Nadauld, Shen (2015).
- Goodman, Isen and Yannelis (2018) use IV to examine household formation.

Student debt differential prior and after age cut-off





- Individuals who turn 24 during college: Higher student debt and lower grants for those born 3-months prior December cut-off.
- Individuals that do not turn 24 during college: No difference in student debt and grants around the December cut-off.
- Difference in total funding is unchanged. More

IV for student debt

Key criteria is being 24+ years of age at the end of the calendar year:

- Age-threshold: born 3-months prior December cut-off (independents) vs. born 3-months after the cut-off (dependents).

	Relative to Cut-Off		
	Prior	After	Differential
Average household net worth	$177,287	$173,448	$3,839
Average household income	$71,288	$71,285	$4
Share male	54%	51%	3%
Share white	71%	63%	8%
Ability (asvab pctile)	643.40	642.44	0.96

Student debt, initial wage and returns to experience

Dependent Variable: Log(earnings)	(I)
Effect of student debt ($000s) on:	
(i) Initial earnings	2.34%
(pvalue)	0.01
(ii) Returns to experience	-0.47%
(pvalue)	0.07

$1,000 increase in debt causes 2.3% increase in initial earnings. Equivalent to $736 higher initial earnings on average.

Existing literature: $400-800 Chapman (2015), $200 Rothstein, Rouse (2011), $211 Luo, Mongey (2019).

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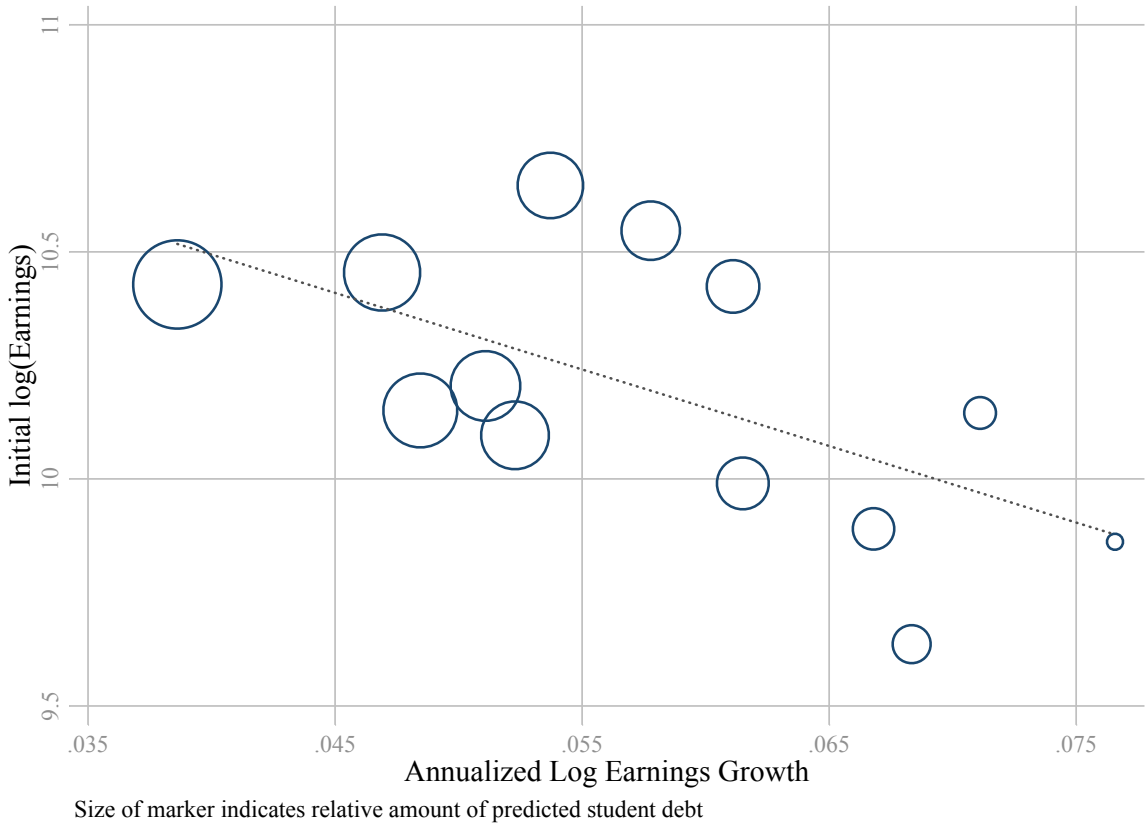
- $1K higher debt reduces returns to experience by 0.47% each year.
- Sizable c.f to 7.75% growth p.a. for 25-30 yr olds (Guvenen et al, 2018)
- Earnings profiles cross after 6 years.

Initial Occupation and Industry Choice

Dependent Variable: Log(earnings)	(I)	(II)	(III)
Effect of student debt ($000s) on:			
(i) Initial earnings	2.34%	1.45%	1.85%
(pvalue)	0.01	0.02	0.04
(ii) Returns to experience	-0.47%	-0.19%	-0.26%
(pvalue)	0.07	0.33	0.34
Fixed Effects:			
(a) Occupation FE & Occupation x Exp		Yes	
(b) Industry FE & Industry x Exp			Yes
Change in initial earnings coefficient (i)		38%	21%
Change in RTE coefficient (ii)		60%	45%

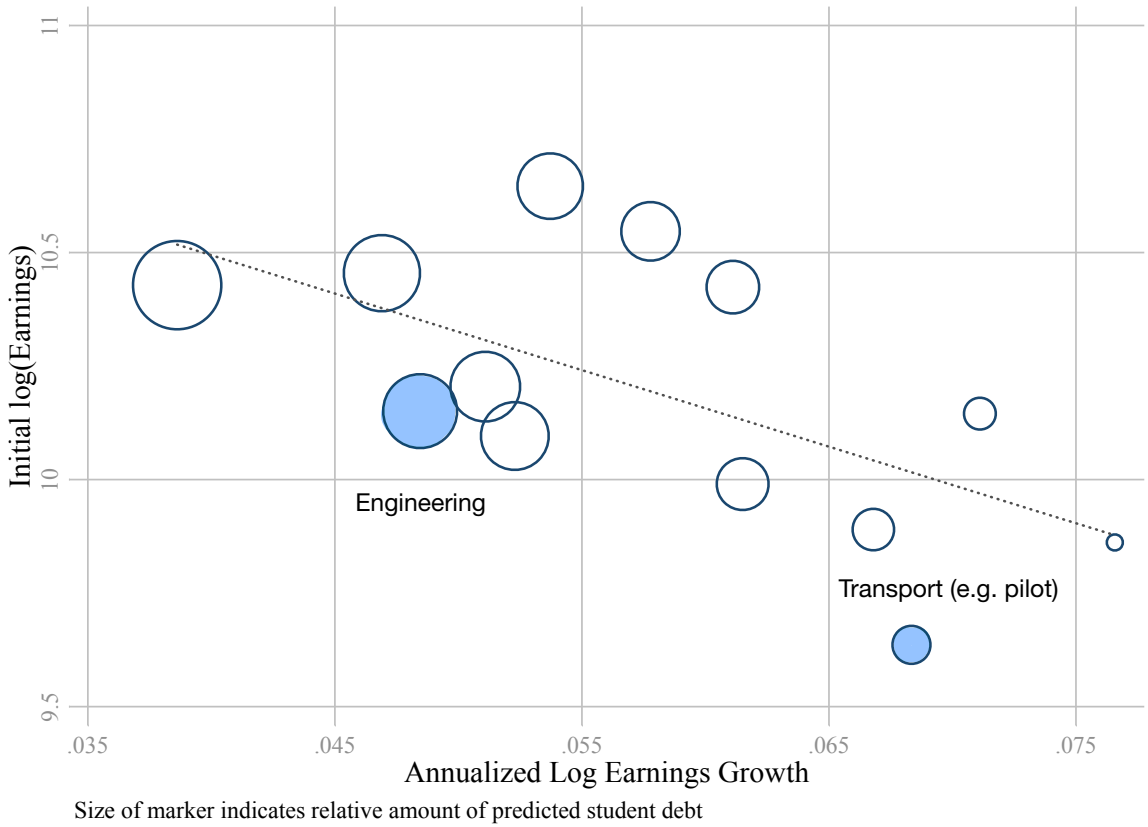
- Initial occupation and industry heterogeneity are relevant for understanding the effects of student debt on earnings. More

Average occupational earnings profiles



Major 3-digit occupation groupings exhibit negative correlation (-0.46) between initial earnings and average RTE in raw data. More

Average occupational earnings profiles



E.g. Aeronautical engineer vs. pilot: 50% higher initial earnings, but 2% lower RTE. Takes 25 years for profiles to cross. More Training Back

Key Empirical Findings

1. Higher initial earnings for those with more student debt.

2. Lower returns to experience over next 10-15 years for those with more student debt.

3. Initial occupation choice relevant for understanding differential earnings profiles of those with higher student debt.

What are the implications for aggregate human capital and policy?

Model

- Heterogeneous life-cycle model with credit constraints, plus
  - occupation choice (Roy framework)
  - within-occupation human capital decisions (Ben-Porath).
- Study how constraints affect human capital and talent allocation.
- Model abstracts from: non-wage utility, frictions outside credit markets, labor force participation, occupation switching.

Model Set-Up: Occupations

Production uses labor from K occupations, which differ in:

- w_k wage per effective hour worked.
- φ_k reflects scope for human capital accumulation:
  - Micro sources of φ_k: e.g. technological, search frictions, contracting frictions.

Model Set-up: Household

- **Born heterogeneous:** Initial assets a_{i0} and occupation talent $\{\theta_{ik}\}$.
- **Two financial assets:**
  - one-period asset, with limit
$$a_{it} \geq \bar{a}.$$
  - student loans, with limit
$$d_{ikt} \leq \max\{\bar{d}, P\}$$
where P is the sticker price of college.
- **Pre-period:**
  - Choose education level $e \in \{\text{high school}, \text{college}\}$. Outside funding for college g. Choose occupation k.

Model Set-up: Human Capital

- **Initial human capital:** $h_0(e_i)$, where $e_i \in \{\text{high school}, \text{college}\}$.
- **Human capital accumulation:** choose on-the-job investment s

$$h_{ik,t+1} = H^k(s_{ikt}, h_{ikt}).$$

Variation of Ben-Porath (1967):

$$H^k(s_{ikt}, h_{ikt}) = \varphi_k^{1-\alpha}(s_{ikt}h_{ikt})^{\alpha} + (1-\delta)h_{ikt}$$

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- **Labor income at** t**:** $y(\theta_{ik}, s_{ikt}, h_{ikt}) = w_k \cdot \theta_{ik}(1-s_{ikt})h_{ikt}$.

Household's problem

Individual i chooses education & occupation to maximize life-time utility:

$$V_0(\theta, a_0) = max\ \{V^{hs}, V^{col}\}$$

where

$$V^{col} = \max_{k \in \mathcal{K}} \{ \max_{d,\ a_1,\ c_0} V_{k,0} \}$$

s.t.

$$c_0 + a_1 + (P - g - d_1) \leq a_0$$

$$a_{t+1} \geq \bar{a}, \quad d_1 \ \leq \min\{\bar{d}, P\},$$

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s.t.

$$c_0 + a_1 + (P - g - d_1) \leq a_0$$

$$c_t + a_{t+1} + x_t \leq (1 + r) \cdot a_t + (1 - \tau) \cdot y(\theta, s_t, h_t)$$

$$a_{t+1} \geq \bar{a}, \quad d_1 \leq \min\{\bar{d}, P\}, \quad x_t \geq \bar{x}$$

$$d_{t+1} = (1 + r^d) \cdot d_t + x_t,$$

$$h_{t+1} = H^k(s_t, h_t), \quad s_t \in [0, 1].$$

V^{hs} is modeled as the outside option.

Individual's human capital within a given occupation

- Optimal effective hours investment in human capital accumulation:

$$s_t^* h_t^* = \left[\frac{\alpha \varphi_k^{1-\alpha} \beta}{w \theta \lambda_t} \frac{\partial V_{t+1}}{\partial h_{t+1}} \right]^{\frac{1}{1-\alpha}}$$

where

$$\frac{1}{\lambda_t} \frac{\partial V_{t+1}}{\partial h_{t+1}} = w\theta \sum_{j=0}^{T-t-1} (1-\delta)^j \frac{\beta^j \lambda_{t+j}}{\lambda_t}$$

- Human capital:

$$h_t^* = \varphi_k \sum_{j=1}^{t-1} (1-\delta)^{t-j-1} \left(s_j^* h_j^* \right)^{\alpha} + (1-\delta)^t h_0(col).$$

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- Binding constraints: $s_t^* h_t^*$ and path of h_{t+j}^* are lower.

  Early in life constraints have larger effects.

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- Binding constraints: higher initial earnings & lower RTE: More

$$\text{IE} = w\theta \left(h_1 - s_1 h_1\right), \quad \text{RTE}_t \equiv \frac{1}{t} \frac{y(\theta, s_t, h_t)}{y(\theta, s_1, h_1)} = \frac{1}{t} \frac{(1-s_t)h_t}{(1-s_1)h_1}.$$

Occupation choice $k_i^* \in argmax\{ V_{ik0}^* \}_{k \in \mathcal{K}}$

- Unconstrained individuals:

$$V_{ik0}^* = w_k \varphi_k \theta_{ik} f(\Omega) + a_{i0} + P - g, \quad \text{where } \Omega = \{r, \beta, \alpha, \tau\}.$$

If θ_{ik} i.i.d. Frechet, probability choose k among unconstrained:

$$P\left(V_{ik0}^* \geq V_{ij0}^*, \forall j \neq k\right) = \frac{\left(w_k \varphi_k\right)^\epsilon}{\sum_l \left(w_l \varphi_l\right)^\epsilon}$$

where w_k is price per effective hours worked. φ_k summarizes scope to develop one's talent and increase future earnings in k since

$$h_{ik,t+1} = \varphi_k^{1-\alpha}(s_{ikt} h_{ikt})^\alpha + (1-\delta) h_{ikt}.$$

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- Constrained individuals:

$$V_{ik0}^* = f\left(\Omega, w_k, \varphi_k, \theta_{ik}, a_{i0}, P - g, \bar{d}, \bar{a}\right).$$

Example: Variation in g which can affect student debt

Consider 2 occupations:

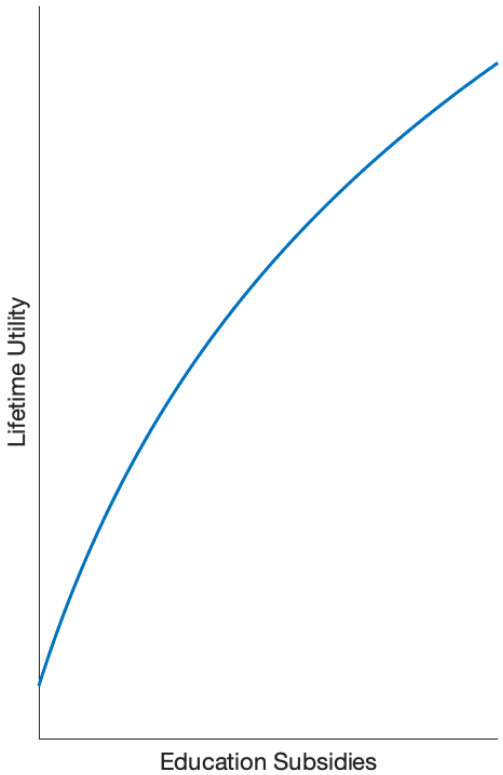
- $w_A > w_B$, and $\varphi_A < \varphi_B$ (e.g. engineer vs pilot).

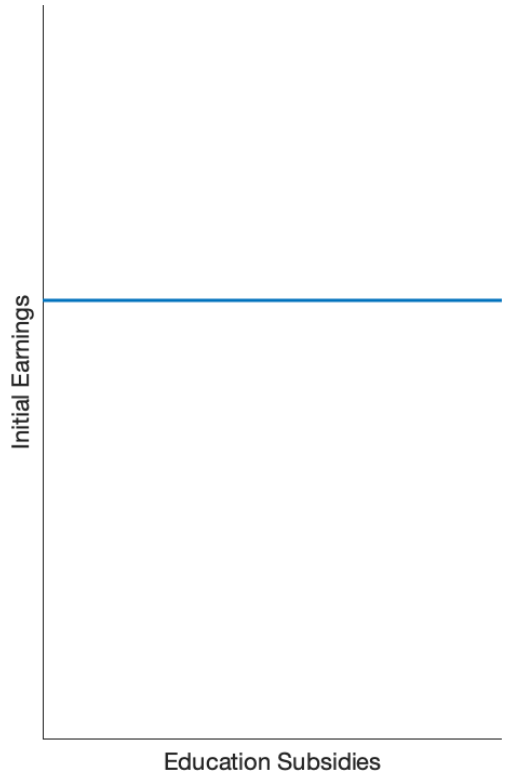
Effect of g on utility, initial earnings and RTE of:

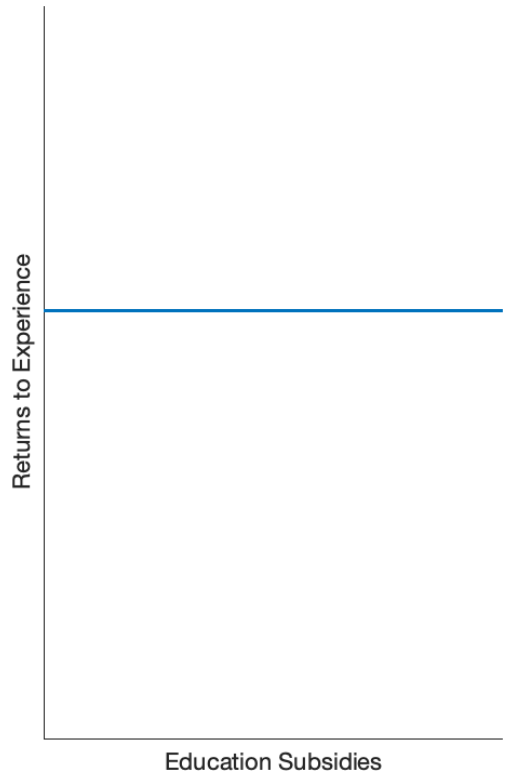
- an unconstrained individual.
- a constrained individual, who is :
  - more talented in A (low φ).
  - more talented in B (high φ).

Unconstrained

No effect on human capital decisions.





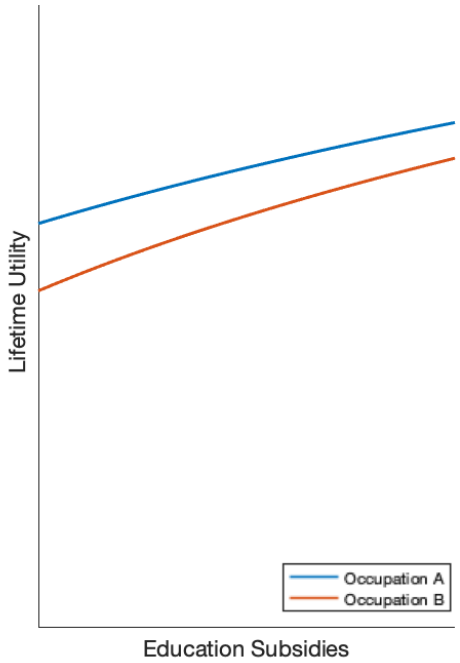


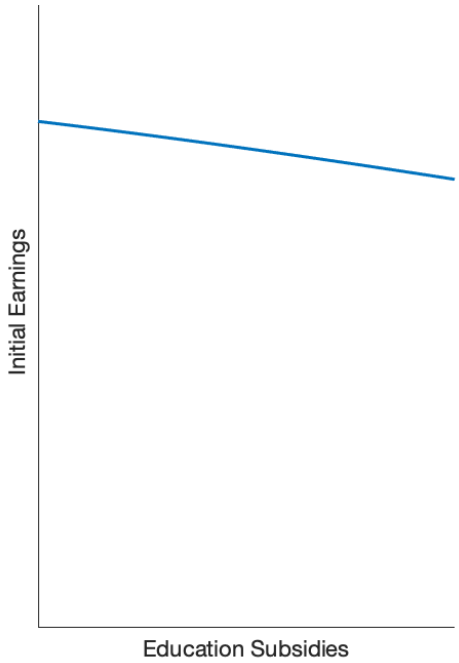
Constrained & more talented in occupation with lower φ_k

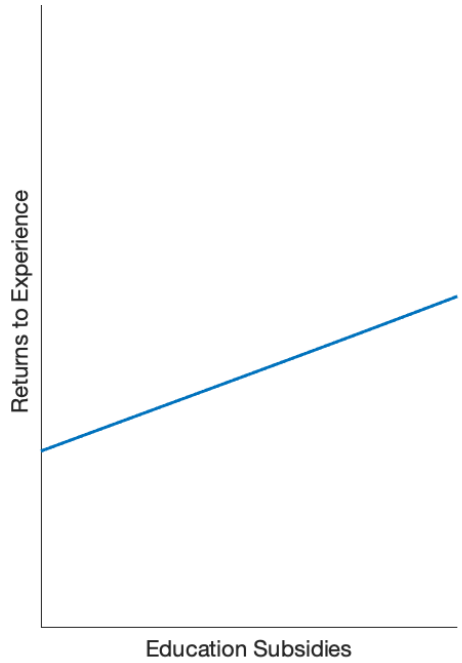
- More talented in A (φ_A low e.g. engineer) and $w_A > w_B$.
- Choose to be in A which has higher initial earnings.

Constrained & more talented in occupation with lower φ_k

- More talented in A (φ_A low e.g. engineer) and $w_A > w_B$.
- Choose to be in A which has higher initial earnings.
- Constraints lead to distortions in s *within* the occupation A.







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- Depending on relative $\{w_k, \varphi_k, \theta_{ik}\}$ jointly, may choose A as constraints bind because it endogenous has higher initial earnings.
- As constraints more binding: (i) reduce s; (ii) move occupations

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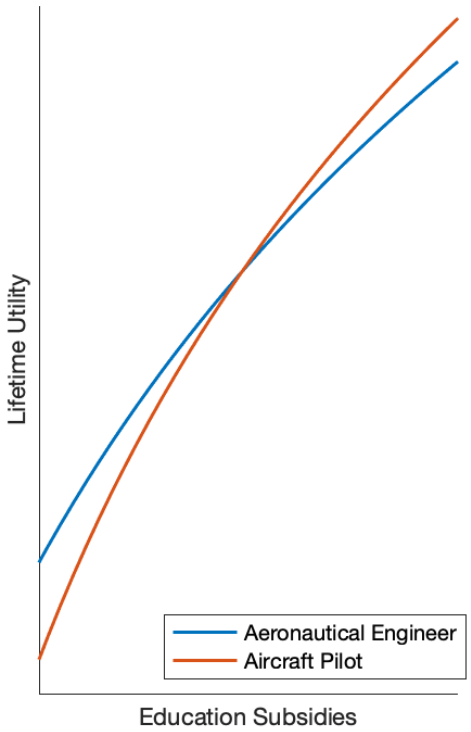
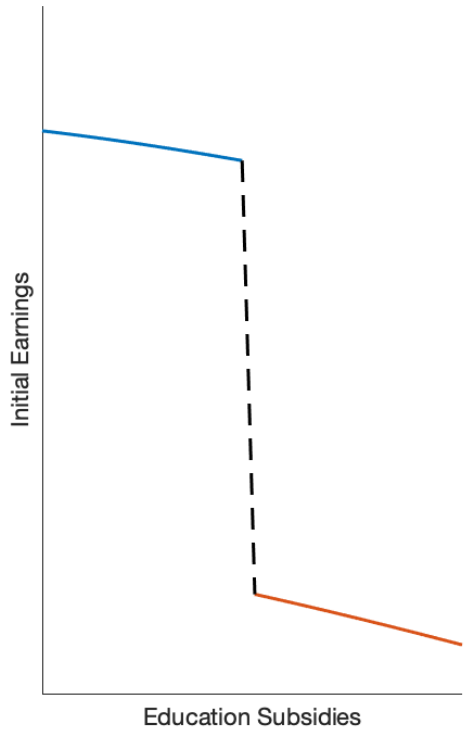
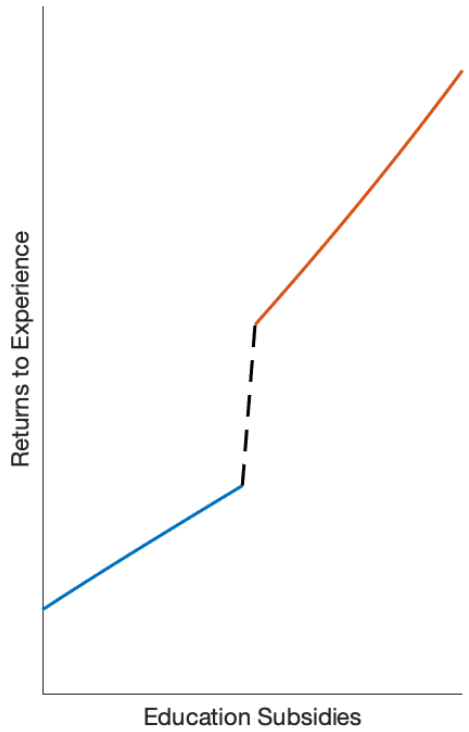






Data Consistent with Model Predictions

1. Student debt leads to:
   - higher initial earnings,
   - lower returns to experience (RTE) over the next 10-15 years.

2. Initial occupation relevant for understanding earnings differences.

Natural question: What are the implications for welfare and policy?

Quantitative Analysis

- Identification of parameters More
  - $\Omega_1 = \{h_0, \delta, \alpha, \epsilon, \tau, \varphi_{\mathbf{k}}, \mathbf{w}_{\mathbf{k}}\}, \qquad \Omega_2 = \{g, P, \bar{a}, \bar{d}, a_{i0}\}.$
- Alternative grant systems: More
  - Uniform grants
    $$g_{ik} = g.$$
  - Occupation-specific grants.
    $$g_{ik} = \tilde{g} \times (\varphi_k / \bar{\varphi}).$$

Occupation-specific grant scheme

Relative to uniform grants	Occupation specific
Average PV of life-time earnings	0.46%
Average labor productivity	0.72%
Average life-time utility	5.14%

Conclusion

Empirical Evidence:

- Higher debt: higher initial earnings, but lower RTE.
- Initial occupation relevant for understanding earnings effects.

Model Explanation:

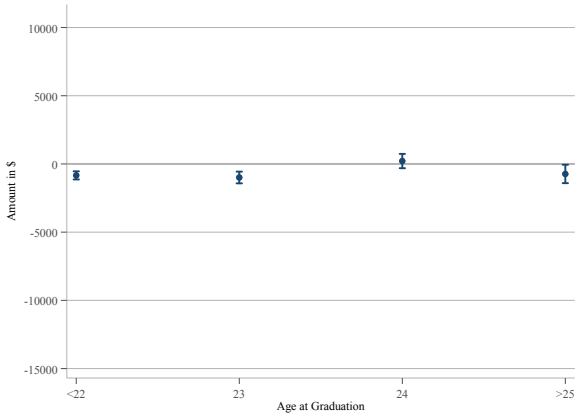
- Individuals smooth credit constraints by altering human capital.

Implications for aggregate human capital: depends on joint distribution of constraints, talent and occupational profiles.

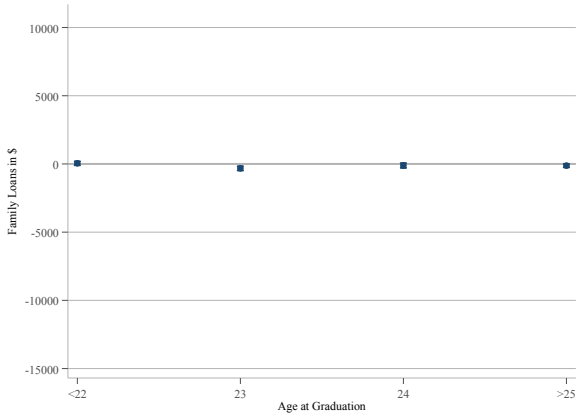
- Larger effects if constrained individuals are highly talented in occupations with more scope for human capital accumulation.
- Occupation-based grants improve human capital accumulation and utility.

Other funding prior and after age cut-off

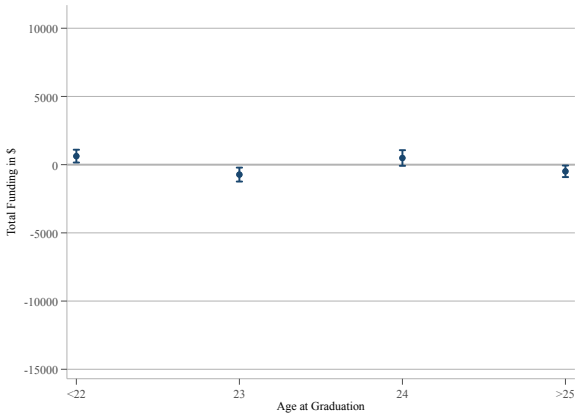
Back



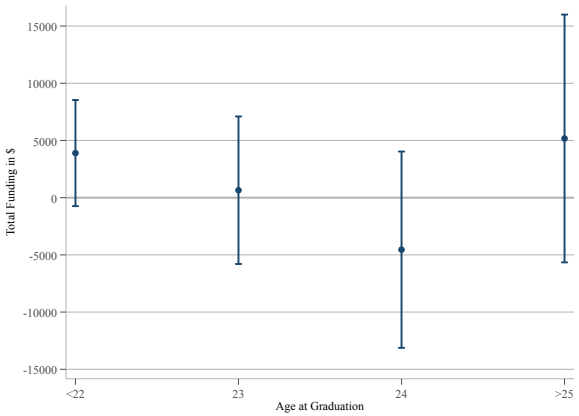
(a) Self Funding



(b) Family Loans

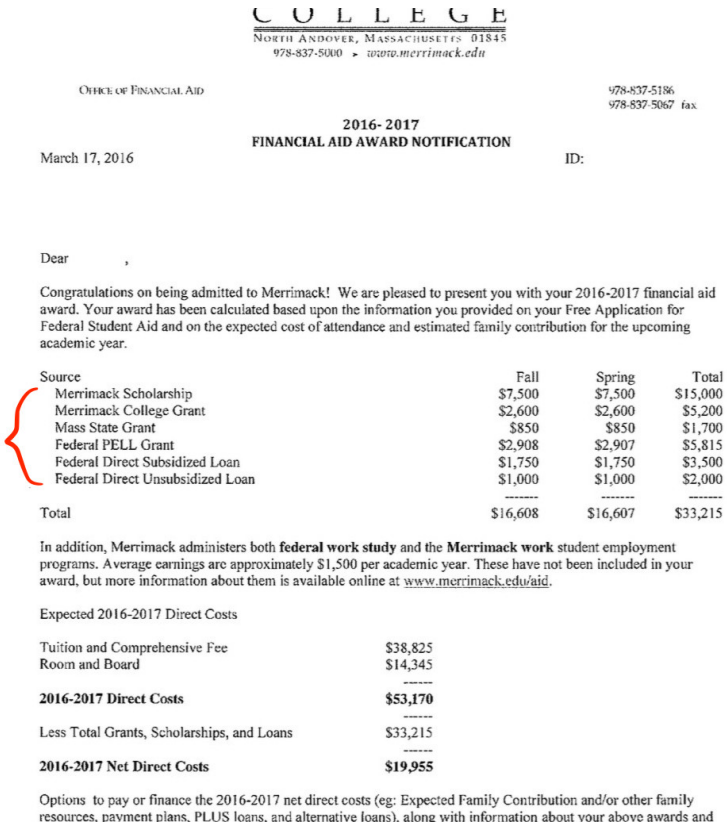


(c) Work Study Funding



(d) Total Funding

Example of Grant/Loan Financial Aid Letter



C O L L E G E
North Andover, Massachusetts 01845
978-837-5000 ▸ www.merrimack.edu

Office of Financial Aid

978-837-5186
978-837-5067 fax

2016- 2017
FINANCIAL AID AWARD NOTIFICATION

March 17, 2016 ID:

Dear ,

Congratulations on being admitted to Merrimack! We are pleased to present you with your 2016-2017 financial aid award. Your award has been calculated based upon the information you provided on your Free Application for Federal Student Aid and on the expected cost of attendance and estimated family contribution for the upcoming academic year.

Source	Fall	Spring	Total
Merrimack Scholarship	$7,500	$7,500	$15,000
Merrimack College Grant	$2,600	$2,600	$5,200
Mass State Grant	$850	$850	$1,700
Federal PELL Grant	$2,908	$2,907	$5,815
Federal Direct Subsidized Loan	$1,750	$1,750	$3,500
Federal Direct Unsubsidized Loan	$1,000	$1,000	$2,000
Total	$16,608	$16,607	$33,215

In addition, Merrimack administers both **federal work study** and the **Merrimack work** student employment programs. Average earnings are approximately $1,500 per academic year. These have not been included in your award, but more information about them is available online at www.merrimack.edu/aid.

Expected 2016-2017 Direct Costs

Tuition and Comprehensive Fee	$38,825
Room and Board	$14,345
2016-2017 Direct Costs	**$53,170**
Less Total Grants, Scholarships, and Loans	$33,215
2016-2017 Net Direct Costs	**$19,955**

Options to pay or finance the 2016-2017 net direct costs (eg: Expected Family Contribution and/or other family resources, payment plans, PLUS loans, and alternative loans), along with information about your above awards and

- Schools offer "aid" packages that treat grants and loans equally.
- Target the "Total" amount of aid, not the grant amount specifically. Allows for crowd out when loan limits increase. Back

Debt and other labor outcomes

	(I)	(II)	(III)	(IV)
Dependent Variable:	Standard deviation of occupation, from CPS	Probability of job switch within a year	Probability of occupation switch within a year	Number of weeks in unemployment in the year
IV Coefficient	-0.012**	0.017	0.022	0.648
Std. Error	(0.080)	(0.023)	(0.023)	(0.762)
Unconditional mean	*0.926*	*0.247*	*0.159*	*4.906*

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Instrument for student debt

	Financial Dependency Status			
	Dependent		Independent	
	Subsidized	Cumulative	Subsidized	Cumulative
Level	2008-Present			
First Year	3,500.00	5,500.00	3,500.00	9,500.00
Second Year	4,500.00	6,500.00	4,500.00	10,500.00
Third Year and Above	5,500.00	7,500.00	5,500.00	12,500.00
Lifetime	23,000.00	31,000.00	23,000.00	57,500.00
	2007-2008			
First Year	3,500.00	3,500.00	3,500.00	7,500.00
Second Year	4,500.00	4,500.00	4,500.00	8,500.00
Third Year and Above	5,500.00	5,500.00	5,500.00	10,500.00
Lifetime	23,000.00	23,000.00	23,000.00	46,000.00
	1994-2007			
First Year	2,625.00	2,625.00	2,625.00	6,625.00
Second Year	3,500.00	3,500.00	3,500.00	7,500.00
Third Year and Above	5,500.00	5,500.00	5,500.00	10,500.00
Lifetime	23,000.00	23,000.00	23,000.00	46,000.00

Simplify – only include cumulative columns.

- Financial dependency status determined end of calender year.
- Compare grants and debt of individuals with birthday in the quarter before year-end vs. after year-end.

Student debt and occupational earnings profiles

Size of marker indicates relative amount of predicted student debt

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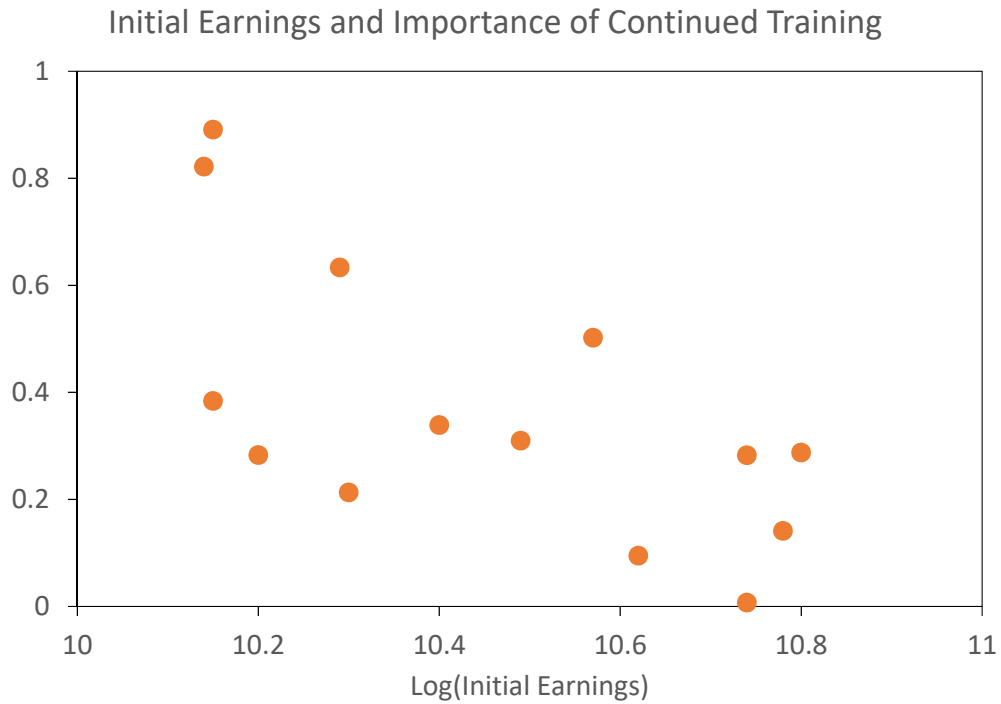
Importance of Continued Training in Occupation



- Correlation of -0.67 with fraction of individuals that replied that continued training is important in their occupation.
- Scope for training may be a component of job amenities not reflected in initial earnings. Back

Model Set-up: Production

- Production: Labor from K occupations.
- The aggregate production technology is given by,

$$Y_t = \left[\sum_{k=1}^{K} (A_k H_{kt})^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}$$

- H_{kt} is total labor services supplied by individuals in occupation k.
- Occupations differ in: wage per unit of human capital w_k, and degree of human capital accumulation from young to old φ_k ("back-loading").

Life-cycle profiles, Within a given occupation

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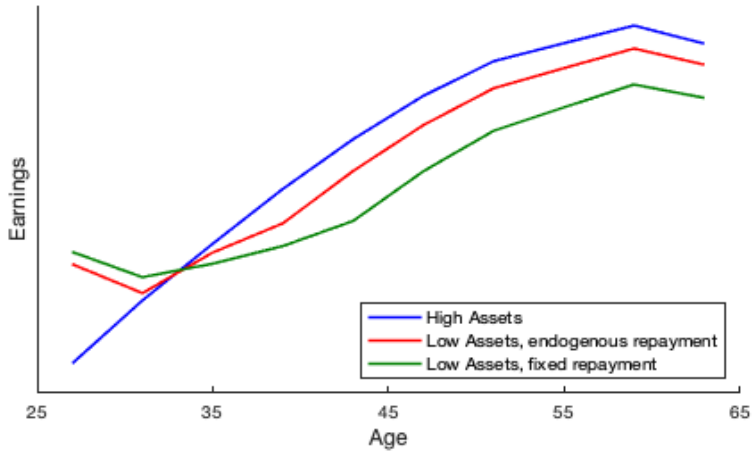

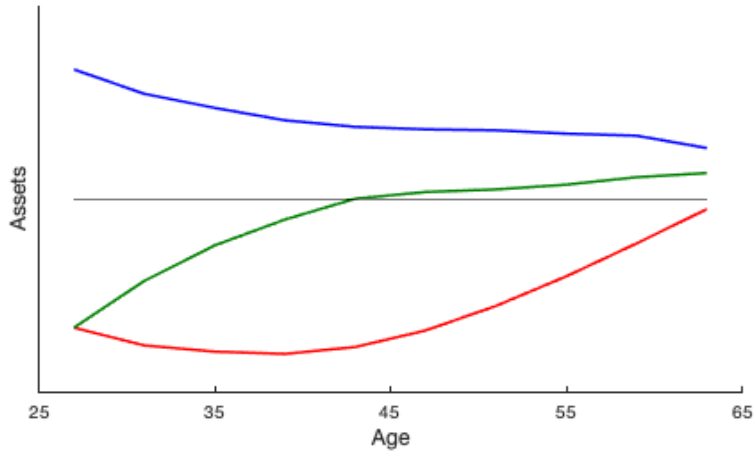

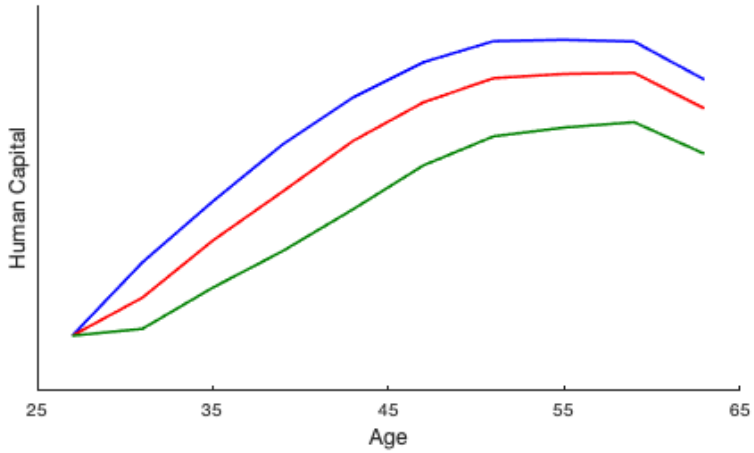

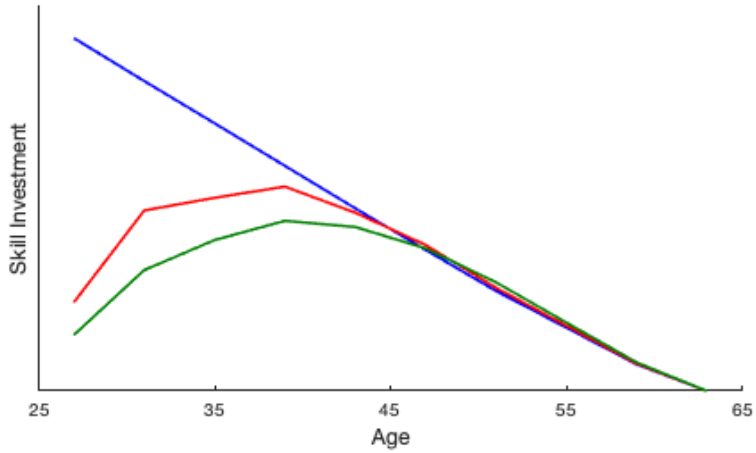

Model parameters

- $\Omega_1 = \{g, P, \bar{a}, \bar{d}, a_{i0}, \tau\}, \qquad \Omega_2 = \{\varphi_{\mathbf{k}}, \mathbf{w}_{\mathbf{k}}, \epsilon, h_0, \delta, \alpha, h_0\}$

- Ω_1 set exogenously from data:
  - P set to match average level of student debt.
  - g set to match average share of financing from grants.
  - $\bar{a} = 0$, $\bar{d} = P$.
  - a_{i0} from SCF distribution.
  - τ marginal tax rate.

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Model parameters

$\Omega_2 = \{\varphi_{\mathbf{k}}, \mathbf{w}_{\mathbf{k}}, \epsilon, h_0, \delta, \alpha, h_0\}$ set to match moments:

- Occupation choice probabilities & average initial earnings.
- Marginal change in occupation choice probabilities and in initial earnings given change in g.
- Variance in initial earnings.
- Average RTE & marginal change in RTE to change in g.
- Average initial earnings of college graduate vs. high school graduate.

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Model parameters

Paramters	Value	Description
T	10	Lifetime after age 25
R	1.03	Annualized compound interest
beta	0.995	Annualized discount factor
delta	0.01	Annualized depreciation
alpha	0.486	HC curvature
sigma	2	IES
epsilon	2.69	Frechet talent parameter
tau	set for budget neutral	Labor income tax
varphi_k	0.8 - 7.2	Scope for human cpaital accumulation
P	35000	Sticker price for college

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