College as Human Capital Investments or Tournament: A macroeconomic analysis

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Motivation

Two prevailing but **opposite** views about college education

- Productive: people accumulate human capital and become more productive — Becker 1962
- Competitive: college does not affect people but only works as credentials — Lazear & Rosen 1981

Which channel is more important?

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Which channel is more important?

Why it matters? Different policy implications for college subsidy

- Productive channel: college subsidy could increase aggregate output
- Competitive channel: college subsidy could be a waste of resources

Theoretical framework

A general equilibrium life-cycle model with college decisions and skill allocation

- Workers are allocated to different occupations based on **relative ranking** of HC

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College education serves two roles:

- HC (*productive*): directly increases efficiency units
- Tournament (*competitive*): increases the prob. of working in high-paying occ.

$$\text{labor earnings} = \underbrace{\text{efficiency units}}_{\text{HC}} \cdot \underbrace{\text{wage rate}}_{\text{tournament}}$$

Main takeaways

The competitive channel

- accounts for 53% of college attendance
- distorts aggregate output by 1.3%
- leads to over-investment in human capital and **negative externalities**

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Optimal policy: eliminate college subsidy and reduce tax progressivity

- average lifetime earnings increases by 5.9%
- 16% of people now skip college and are better off
- Why? Alleviate rat race competition in college education

Model

Overview of the model

Three main building blocks:

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  - Workers are allocated to different occupations based on **relative ranking** of human capital

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Three main building blocks:

- College decision and endogenous skill allocation
    - Workers are allocated to different occupations based on **relative ranking** of human capital
- A standard life-cycle model with human capital accumulation
- Standard GE setups
    - The government collects taxes to subsidize college education
    - Wage rates are determined in the equilibrium

Endogenous skill allocation and wages

Workers meet with occupations (firms) in a frictionless job market

- A measure one of firms with heterogenous productivity $z \sim U[0,1]$
- Firms observe noisy human capital $h^o = h + \epsilon$ with $\epsilon \sim N(0, \sigma_\epsilon^2)$
- Output of a match: $y = zh$ (evenly split between two sides)

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Equilibrium allocation satisfies positive assortative matching:

- highest z firm matches with highest h^o worker (and so on)

Hopkins 2012

Endogenous skill allocation: equilibrium

A matching function in the equilibrium is an assignment function $\Gamma(h^o) = z$ such that

$$\int_{h^o}^{\bar{x}} f_h(x)dx = \int_{\Gamma(h^o)}^{\bar{y}} f_z(y)dy$$

$f_h(h^o)$: pdf of observed human capital of workers

$f_z(z)$: pdf of firms' productivity

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Wage rate function:

$$w(h^o) = \frac{1}{2}\Gamma(h^o)$$

Life-cycle: college stage

Workers are heterogenous in initial human capital h_0 and learning speed k.

Value of non-college path

$$V_{nc}(h_0, k) = \int_{\epsilon} V(h_0, k, w(h_0 + \epsilon), 0) dF(\epsilon)$$

- Non-college workers enter labor market at age 0
- learning speed k governs how fast to accumulate human capital.

Life-cycle: college stage

Workers go to college choose how much to invest in HC:

$$V_c(h_0, k) = \max_s \quad -s + \mathbb{1}\{s > 0\}\phi + \frac{1}{R}\int_\epsilon V(h', k, w(h' + \epsilon), 1)dF(\epsilon)$$
$$\text{s.t.} \quad h' = h + k \cdot (s \cdot h)^\gamma$$

ϕ: college subsidy

s: human capital investments

ϵ: noise of human capital

h': human capital after college graduation

- productive: college directly increases h'
- competitive: college also increases the chance of working in high-paying occupations

Life-cycle: working stage

Workers maximize lifetime earnings by making human capital investments

$$V(h,k,w,j) = \max_{s} \quad w \cdot h - T(w \cdot h) - s + \frac{1}{R} V(h',k,w,j+1)$$
$$\text{s.t.} \quad h' = (1-\delta) \cdot h + k \cdot h^{\eta_1} \cdot s^{\eta_2}$$

- s: human capital investments
- h: human capital
- k: learning speed
- w: wage rate (determined by skill allocation)
- j: age
- R: real interest rate
- $T()$: progressive labor income tax
- δ: human capital depreciation

Close the model

College subsidy is financed by a fixed fraction of total taxes:

$$\theta \cdot \text{Total taxes} = \text{college subsidy}$$

- Total taxes: progressive labor income tax τ and corporate income tax τ_c
- The rest is used for non-productive government spending G

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Endogenize wage rates across occupations

- occupations sorted into high-skill and low-skill as intermediates
- relative supply $\rightarrow$ relative price

Stylized facts and parameterization

Matching model to the data

Key implication: high-skill workers are **NOT** guaranteed to work in high-skill occupations

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What are high-skill occupations
→ O*NET data set provides required level of education at occupational level

Divide occupations into two types based on education requirement

- Non-college (high-school) occupations: cashiers/bartenders
- College occupations: physicians/teachers/accountants

Mismatch in the data

		Worker Education level	
		Non-college	College
Occupation	Non-college	57%	**13%**
	College	**8%**	22%

Source: CPS 2003-2020 and O*NET. Full-time full-year male workers only.

- More than 1/3 (13%/13%+22%) of college workers work in low-skill occupations
- Robust patterns across different age groups

Detail

Earnings structure across education and occupation

		Worker Education level	
		Non-college	College
Occupation	Non-college	0	0.48
	College	0.43	0.81

Note: Log earnings of non-college workers in non-college occupations are normalized to 0.

College premiums $\rightarrow$ HC production at college

Paramterization

External parameters: real interest rate, labor income tax, corporate tax, HC depreciation

Targeted moments

- Fractions of skill allocation (over/undereducation): size of noise
- Earnings structure: initial distributions and HC production at college
- Growth in mean earnings and inequality: HC production at working stage
- Government spending: fraction of taxes to finance college subsidy subsidy

Model fit

Moment	Model	Data
Skill allocation		
% non-college workers in high-skill occ	11%	8%
% non-college workers in low-skill occ	57%	58%
% college workers in high-skill occ	19%	22%
% college wokers in low-skill occ	12%	13%
Earnings structure (relative to non-college workers in low-skill occ)		
non-college workers in high-skill occ	0.36	0.43
college workers in low-skill occ	0.47	0.48
college workers in high-skill occ	0.84	0.81
Life-cycle patterns		
growth in mean log earnings (25-55)	0.633	0.627
growth in earnings inequality (25-55)	0.116	0.103
Government spending		
college subsidy/total college expenditure	36%	38%
non-productive government spending/GDP	16%	17%

Life-cycle Parameterization

Quantitative analysis

How important is the competitive channel?

What if skill allocation is based on initial HC h_0 $\rightarrow$ college is only about HC investment

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What if skill allocation is based on initial HC h_0 $\rightarrow$ college is only about HC investment

	Benchmark	No competitive
College attendance	31.6%	16.8%
Aggregate output	100	101.3
Output per worker	100	99.5
Life-cycle patterns		
growth in mean log earnings	0.633	0.645
growth in earnings inequality	0.116	0.095

Full results

What is the optimal policy

Optimal policy: maximize average net lifetime earnings

- college subsidies
- labor tax progressivity
- labor tax rate

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Tradeoff between labor tax and college subsidies

- labor tax distorts the incentive of human capital accumulation $\rightarrow$ suppress output
- college subsidies encourage more people to accumulate human capital $\rightarrow$ boost output

Optimal tax system

Policy parameters	Benchmark	Optimal
College subsidy ϕ	1.31	0
Progressivity τ	0.1	0.025
Tax rate λ	0.90	0.93
Aggregate outcomes		
College attendance	31.6%	16.0%
Average (net) lifetime earnings	100	105.9
Output per worker	100	107.6
Aggregate output	100	113.6
Level of income inequality	0.237	0.280

Decomposition

Conclusion

I propose a theoretical framework where college education has both productive and competitive values.

The competitive margin accounts for 53% of college attendance but distorts output by 1.3%.

The optimal policy is to eliminate college subsidies and lower tax progressivity to reduce the rat race competition.

Appendix

Parameterization

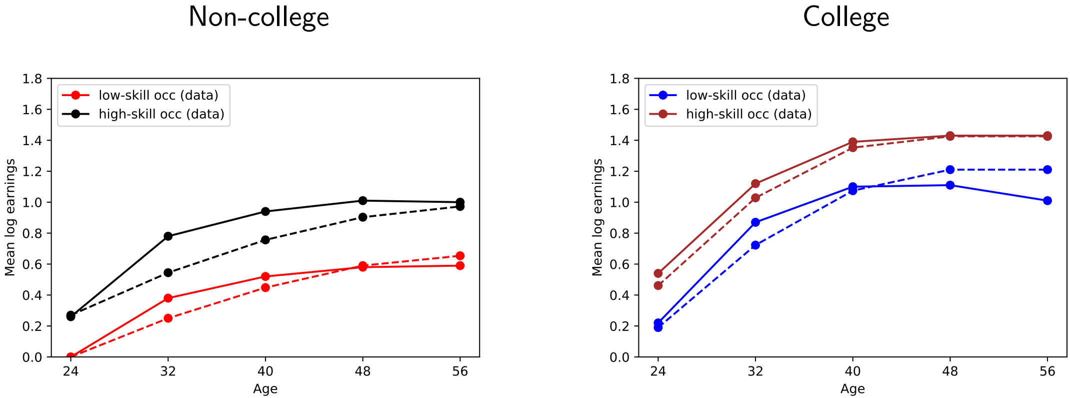
Back

Parameter	Meaning	Value
	Internal	
μ_h, σ_h	distribution of initial human capital	1.78, 0.13
μ_k, σ_k	distribution of learning ability	-0.51, 0.29
γ	HC production (college)	0.34
η_1, η_2	HC production (work)	0.56, 0.30
σ_ϵ	signal noise	2.07
α	high-skill labor share in production	0.405
θ	fraction of taxes used for college subsidy	0.012
z	threshold value of high-skill occupation	1.19

Mismatch by age group back

		Worker Education level	
		NC	C
Age group: 23-34			
Occupation	NC	61%	**12%**
	C	**7%**	20%
Age group: 35-46			
Occupation	NC	57%	**13%**
	C	**8%**	22%
Age group: 47-58			
Occupation	NC	57%	**13%**
	C	**8%**	22%

Life-cycle earnings by education and occupation



Note: Mean log earnings at age 24 are normalized to 0 for non-college workers in low-skill occupations. Dashed (solid) lines represent moments in the model (data).

Back

Decomposition

	Benchmark	Only competitive	Only productive
Aggregate outcomes			
College attendance	31.6%	12.4%	16.8%
Aggregate output	100	99.6	101.3
Output per worker	100	97.5	99.5
Skill allocation mismatch			
non-college workers in high-skill occ	13%	29%	30%
college workers in low-skill occ	12%	2%	14%
Life-cycle patterns			
growth in mean log earnings	0.633	0.639	0.645
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Back

Welfare decomposition

Table: Welfare changes by education groups: optimal policy

	Always college	Always non-college	C to NC
Fractions	16.0%	68.4%	15.6%
Changes relative to benchmark			
Average social welfare	+11.1%	+3.3%	+9.6%
Lifetime income	+26.8%	+9.4%	+15.1%
Human capital growth (log points)	+15.5	+8.2	+9.2

Back