Transformative and Subsistence Entrepreneurs: Origins and Impacts on Economic Growth*

Ufuk Akcigit

University of Chicago

Harry Johnson Lecture

Money Macro and Finance Society - September 9, 2025

**based on a joint work with Harun Alp (FED Board), Jeremy Pearce (NY FED), Marta Prato (Bocconi)*

The Journey from Ideas to Enterprises

- A **symbiotic** relationship between **entrepreneurs** and **inventors** is crucial for a vibrant, dynamic, and progressive society.

- **Entrepreneurs**: Commercialize inventions, bring innovative ideas to the market. This boosts inventors economic reward and potential.

- **Inventors**: They generate new technologies and products. Without their innovations, entrepreneurs lack the foundational advancements needed to create economic value.

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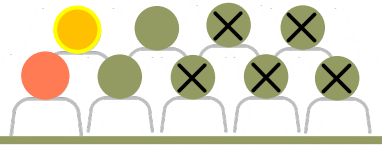
Schumpeter (1911) - The Theory of Economic Development

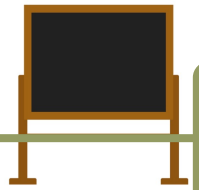
As long as they are not *carried into practice*, inventions are economically irrelevant. And to carry any improvement into effect is a task entirely different from the inventing of it, and a task, moreover, requiring entirely different kinds of aptitudes. Although entrepreneurs may be inventors [...], but not by nature of their function but by coincidence and vice versa.

Talent Allocation and Firm Dynamics

Innovative Firms



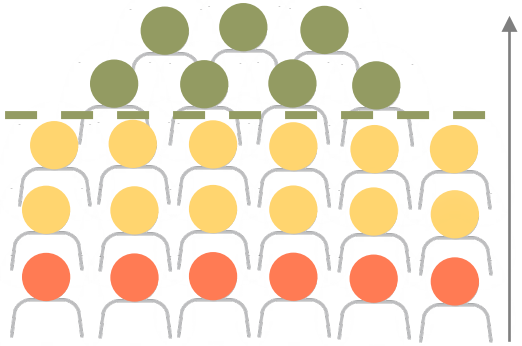
Creative Workforce

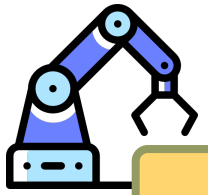


Technical Education

Productivity, technology

Talent Pool





Market Share

Value Added

Society

Research Questions

- Who becomes an entrepreneur? Who becomes an inventor?

- How do policies shape economic growth by influencing the distribution of talent between these two roles?

Outline

- **Data and Empirical Facts**
  - Data from Statistics Denmark (Universe of Danish economy)
  - Very detailed micro-data
    - Education, parental background, IQ, occupation, firm performance.
    - Firm-level data (matched employer-employee, revenue, innovation)
    - 305,092 unique firms and 3.9 million unique individuals (450,000+ w/ IQ data)
  - Facts on occupational sorting, innovative entrepreneurs and firm growth.

- **Model Framework**
  - Novel model of innovation and firm dynamics with occupational choice and heterogenous entrepreneurial ability.
  - Endogenous sorting, wages, and firm growth.

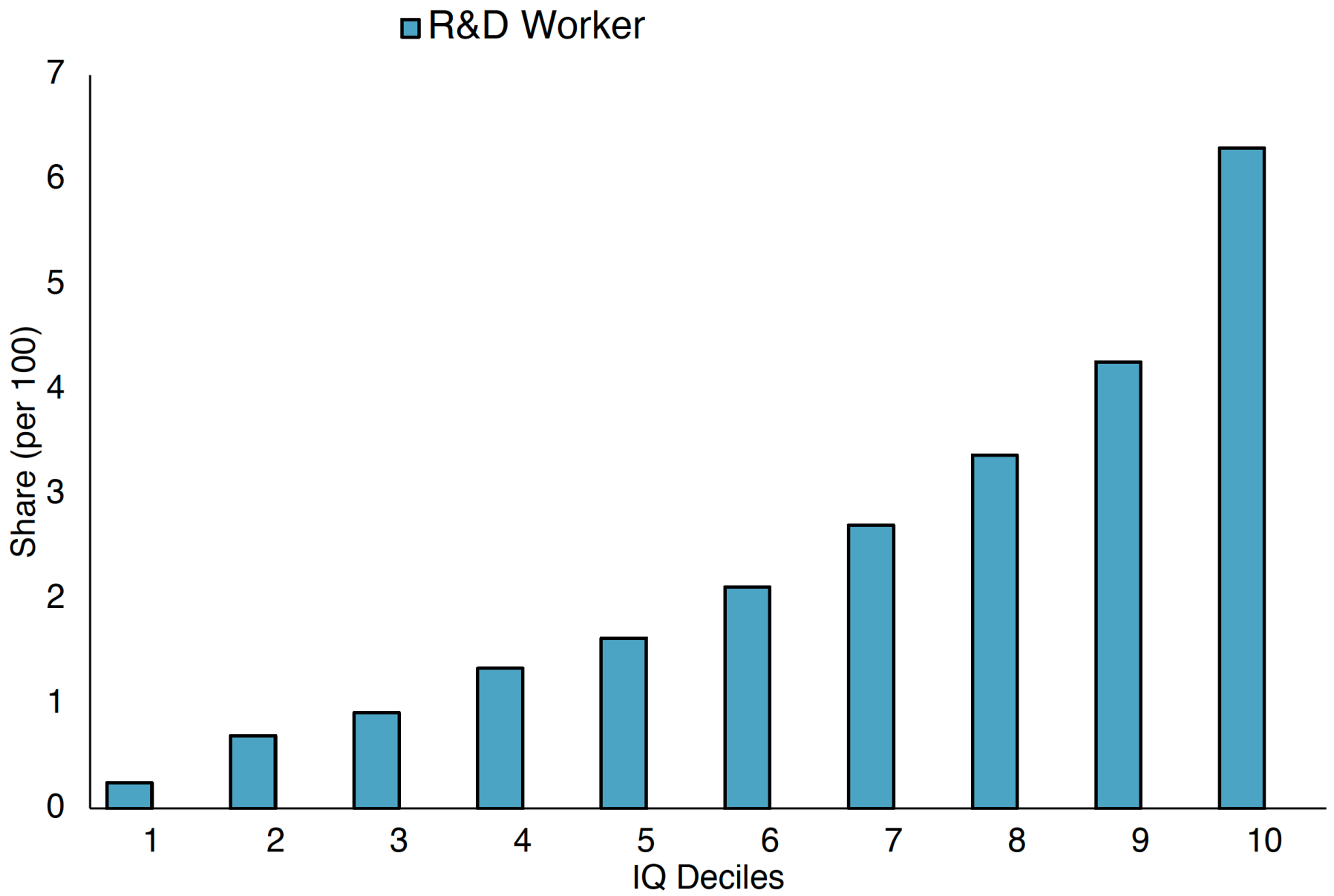
- **Quantitative Results & Counterfactuals**
  - Counterfactuals on the importance of entrepreneurial/R&D worker talent allocation.
  - Effect of R&D and education policy on talent allocation

Empirical Facts

Variable Definitions

- Probability of becoming:
  - Entrepreneur: founder of a new firm
  - R&D worker: working in an occupation with high patenting intensity
    - Physics and Earth Science Professionals, Electrotechnology Professionals, Engineers, Life Science Professionals, Physics and Engineering Technicians, Pharmacy and Health, General Scientist, etc.

Probability of Becoming Entrepreneur/Inventor



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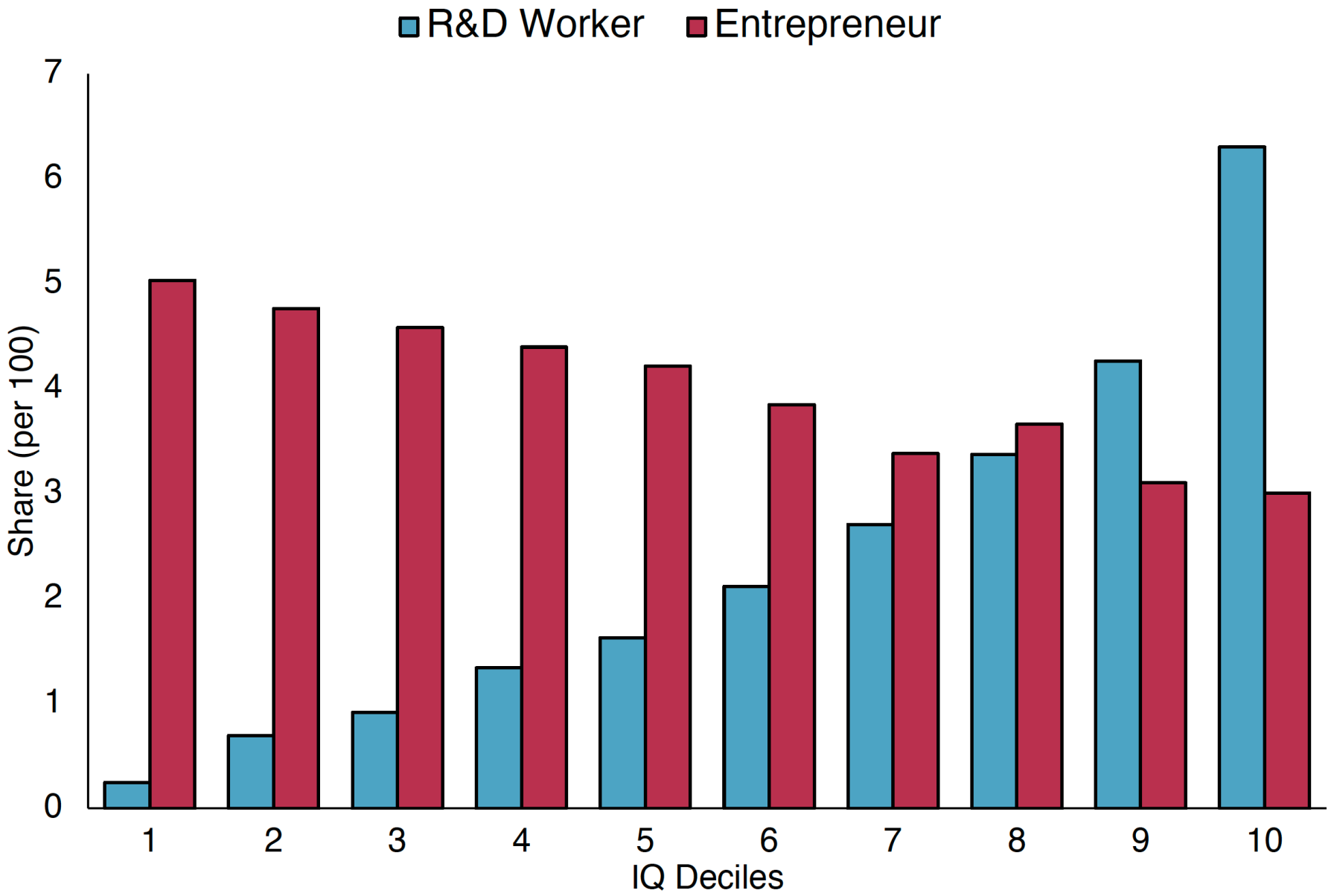
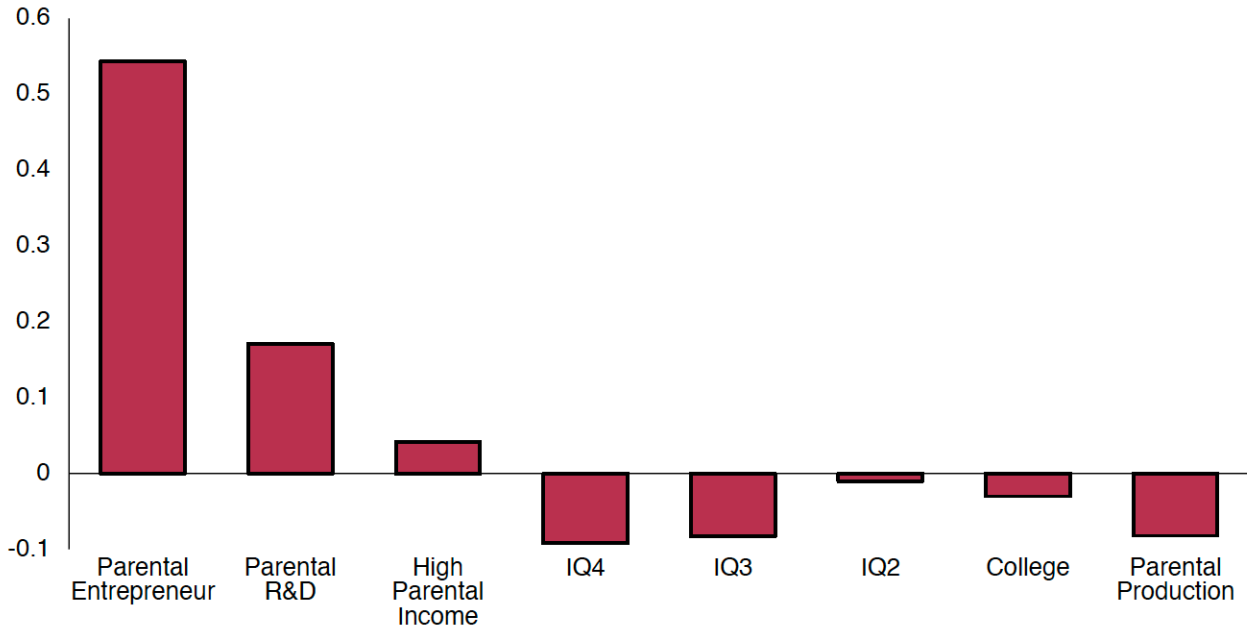


Variable Definitions

- Multinomial Logistic Regression (baseline: production worker)
- Independent variables :
  - IQ: quartile 1-4
  - Education: college vs. no college
  - Parents' Income: Top half/ bottom half percentiles
  - Parents' Occupation: Entrepreneur, R&D, production, other
  - Cohort controls

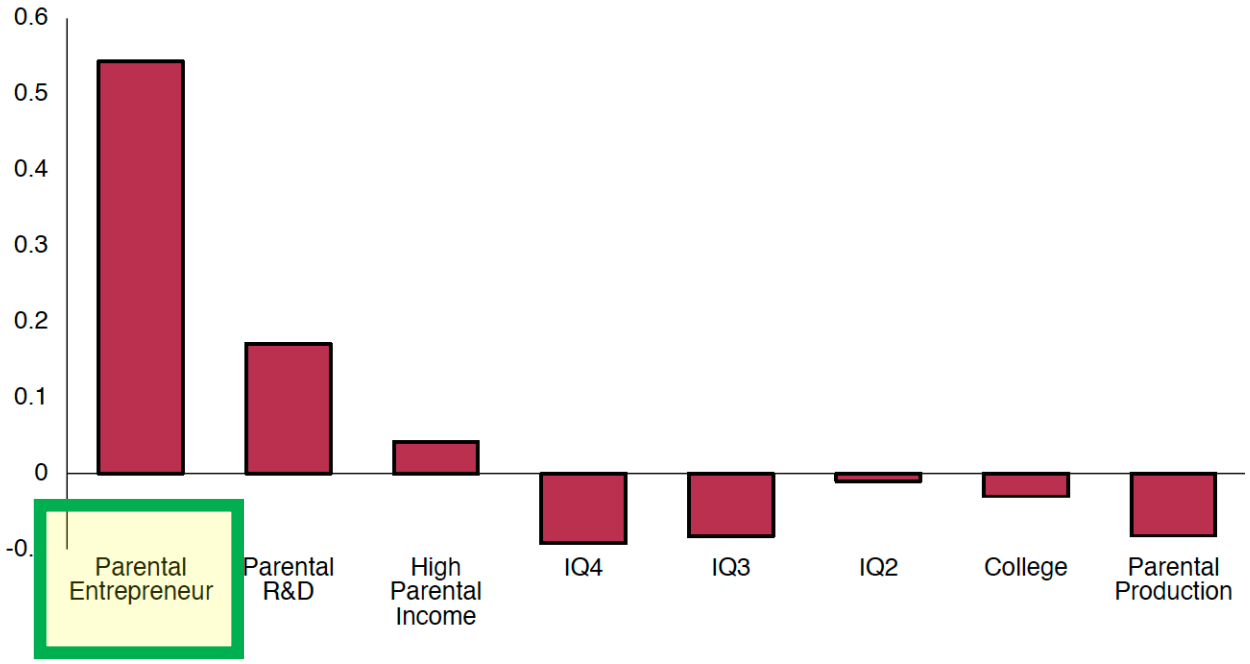
Probability of Becoming Entrepreneur/Inventor



(a) Entrepreneur

Coefficient: An individual with a parent entrepreneur is 65% ($= e^{0.5} - 1$) more likely to become an entrepreneur than a production worker. ▸ Partial R2 ▸ Occupations by IQ ▸ Back

Probability of Becoming Entrepreneur/Inventor



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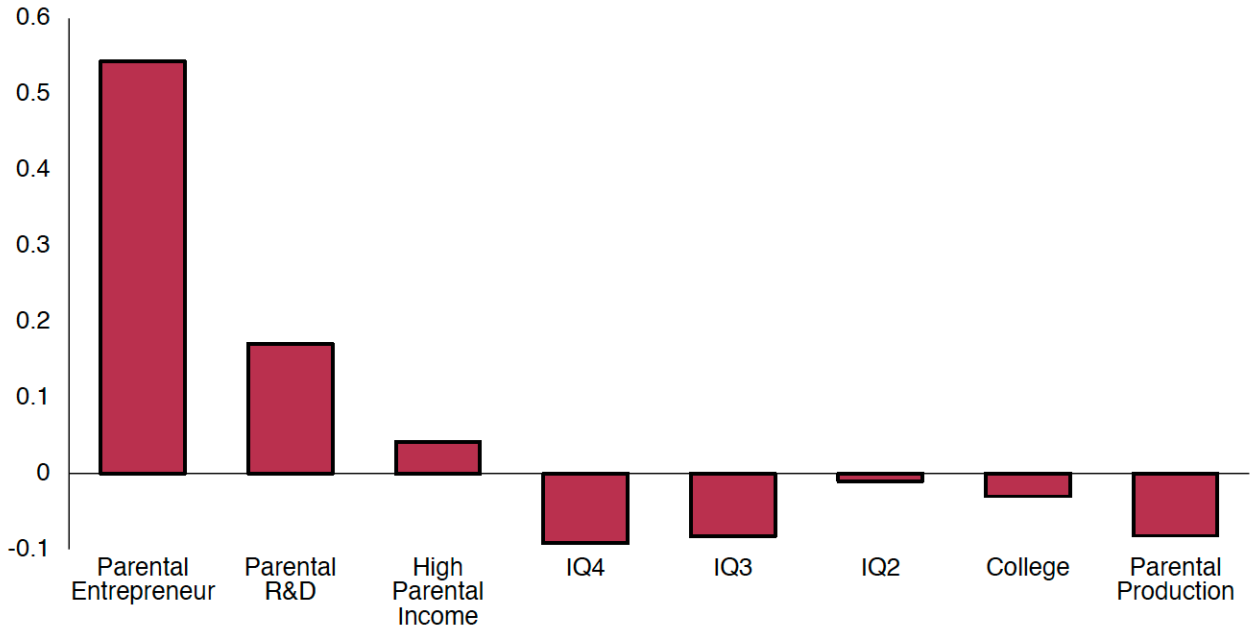

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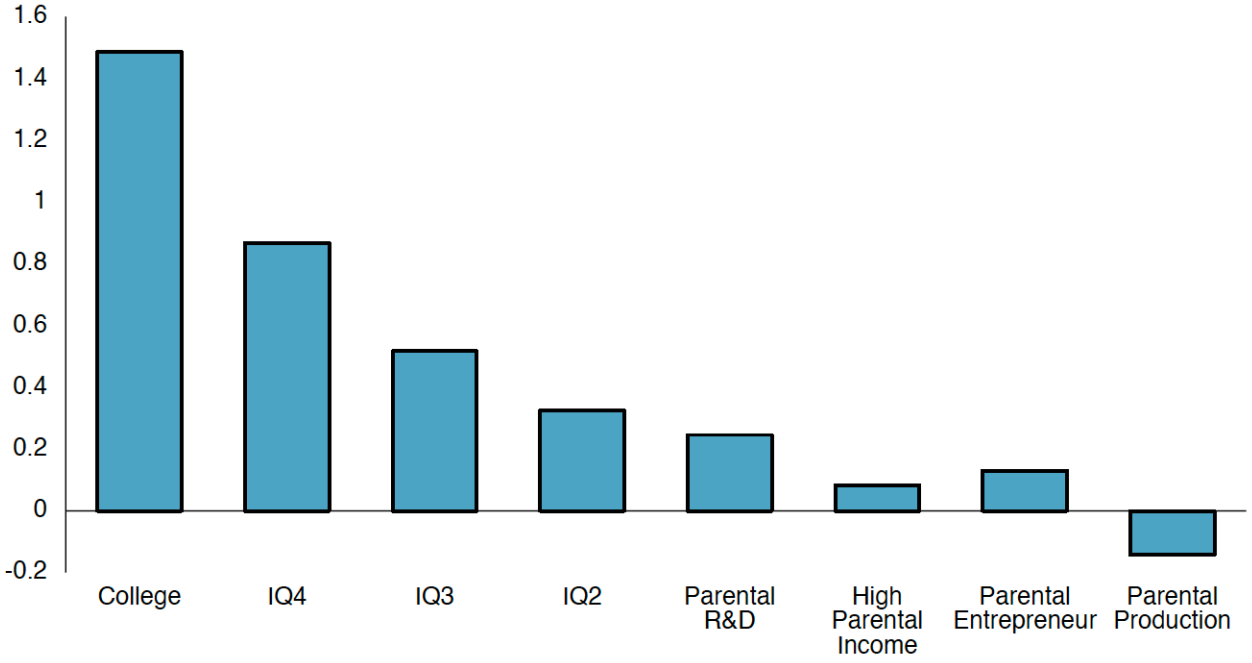

(b) R&D Worker

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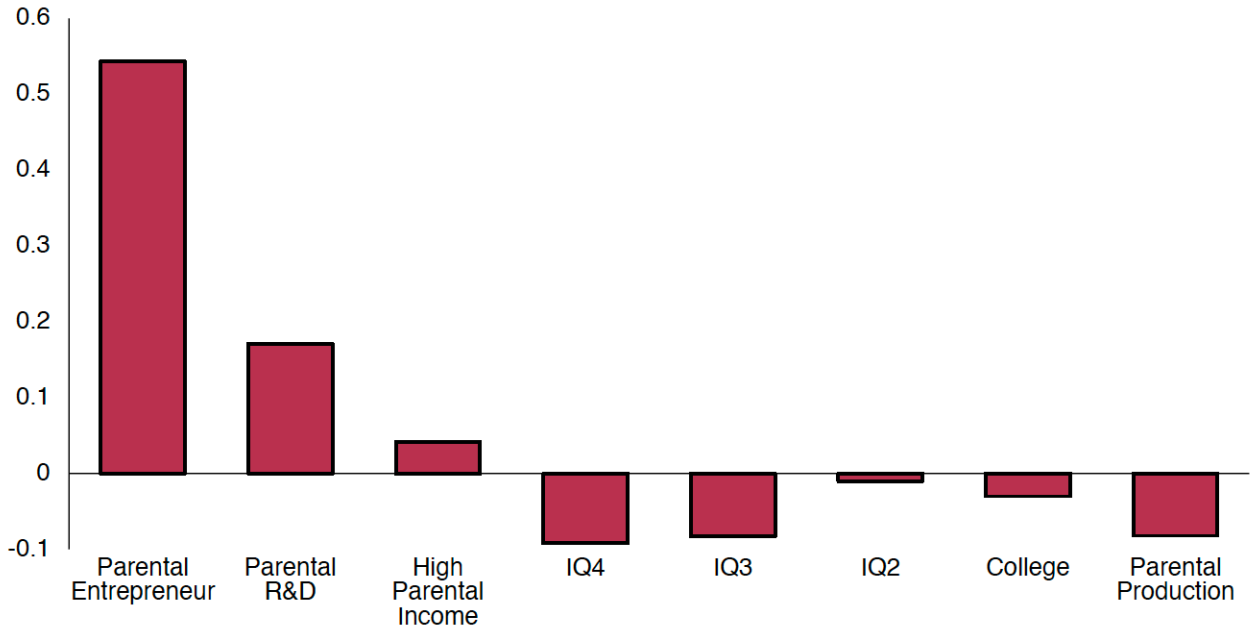
Probability of Becoming Entrepreneur/Inventor



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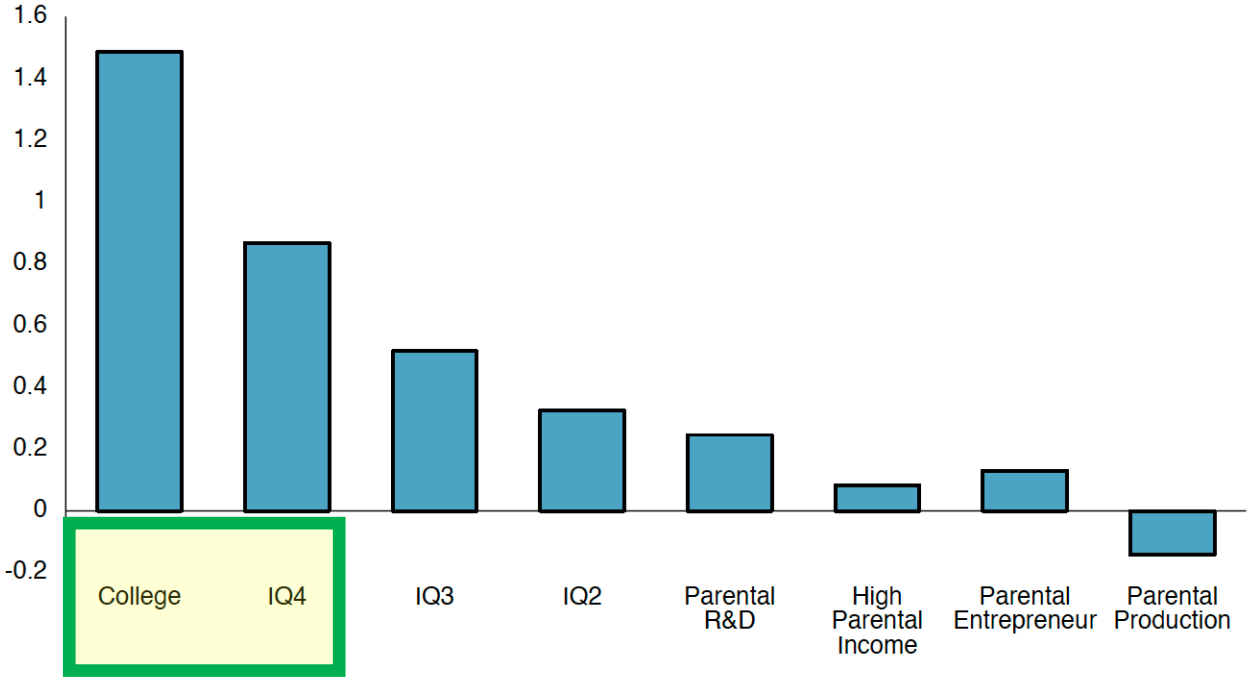

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▸ Partial R2 ▸ Occupations by IQ ▸ Back

Entrepreneurial Heterogeneity

- There are two types of entrepreneurs:
  - Schoar (2010), Hurst and Pugsley (2012), Decker, Haltiwanger, Jarmin and Miranda (2014), Akcigit, Alp, Peters (2021)

- Subsistence (non-innovative) entrepreneurs:
  - No intention and/or ability to grow
  - Want to keep the business within the family.

- Transformative (innovative) entrepreneurs:
  - Create businesses with the intention to innovate and grow
  - Create employment for other workers and value added for the economy.

- Who becomes an innovative entrepreneur?

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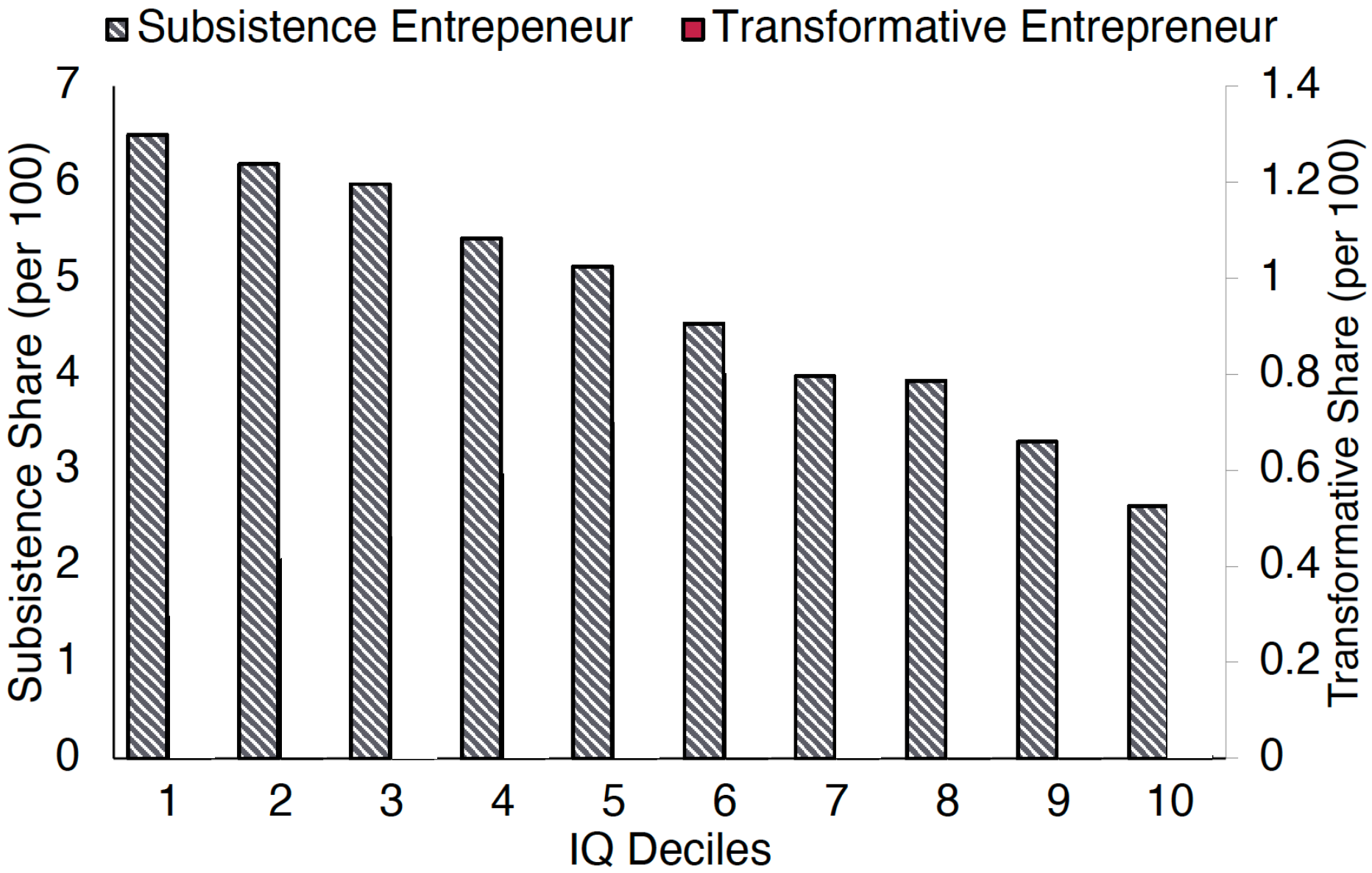
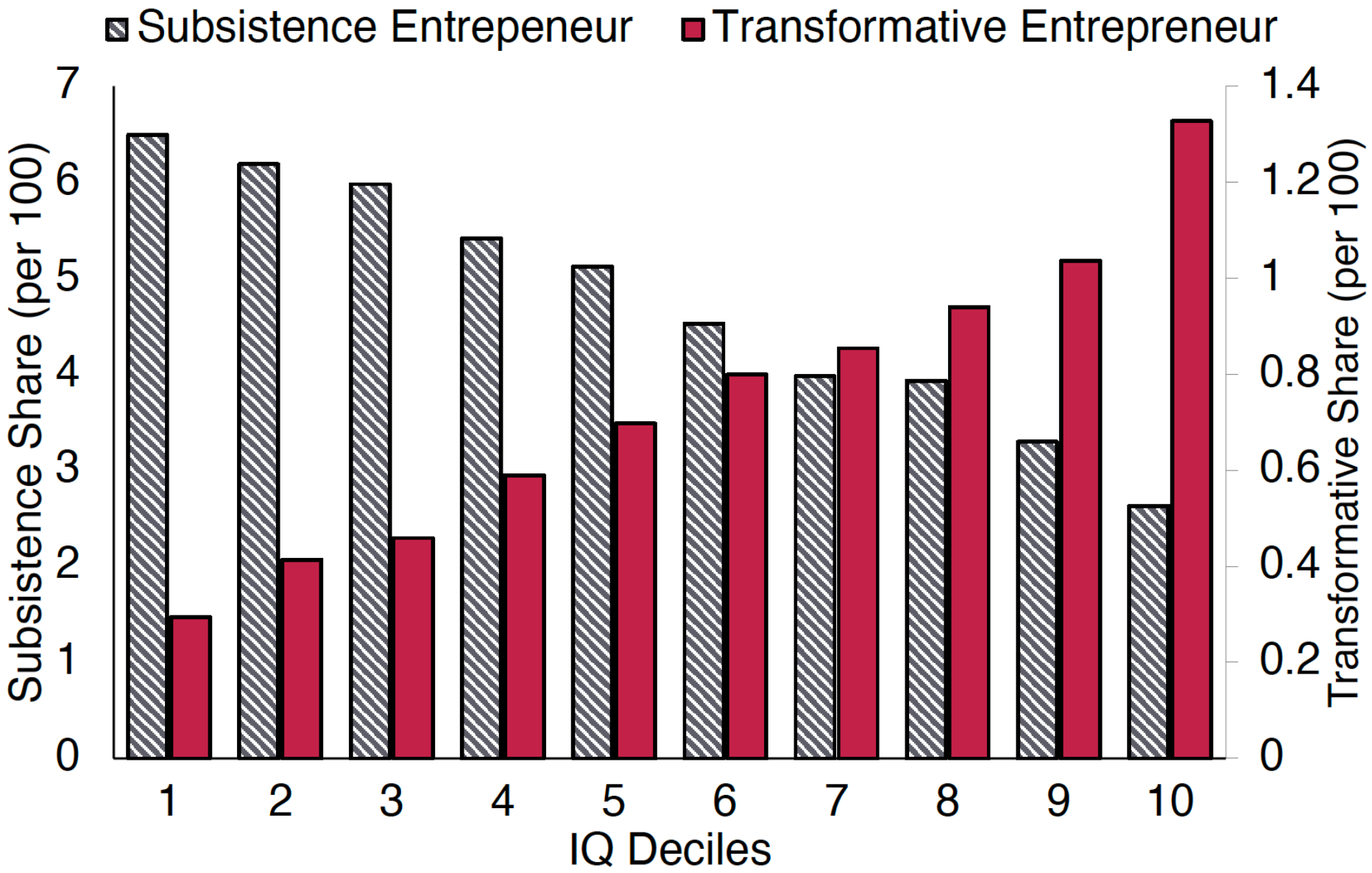
- (Empirical definition) **Innovative entrepreneur: Hires at least 1 R&D worker**.

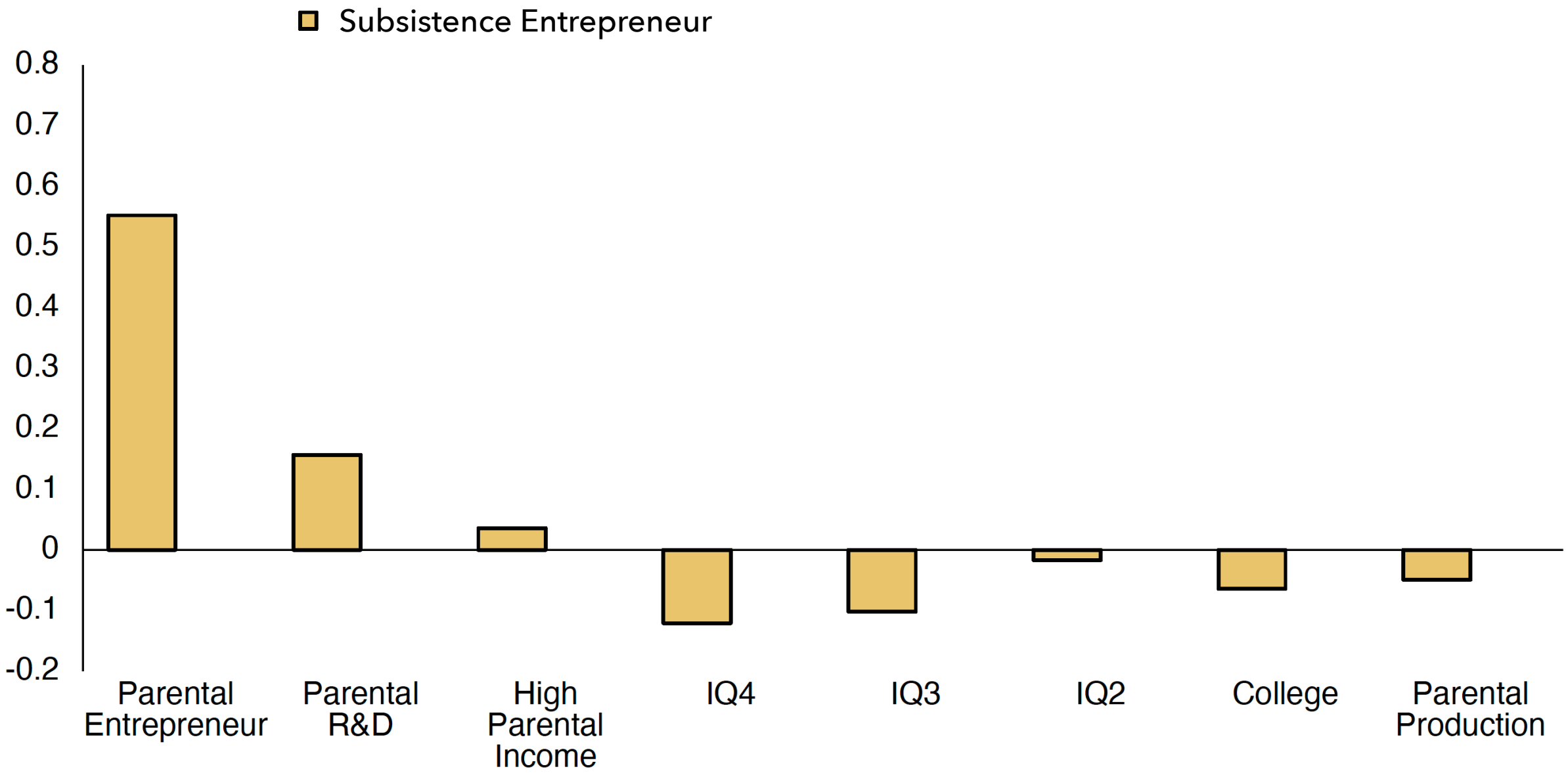
Transformative vs Subsistence Entrepreneurs by IQ



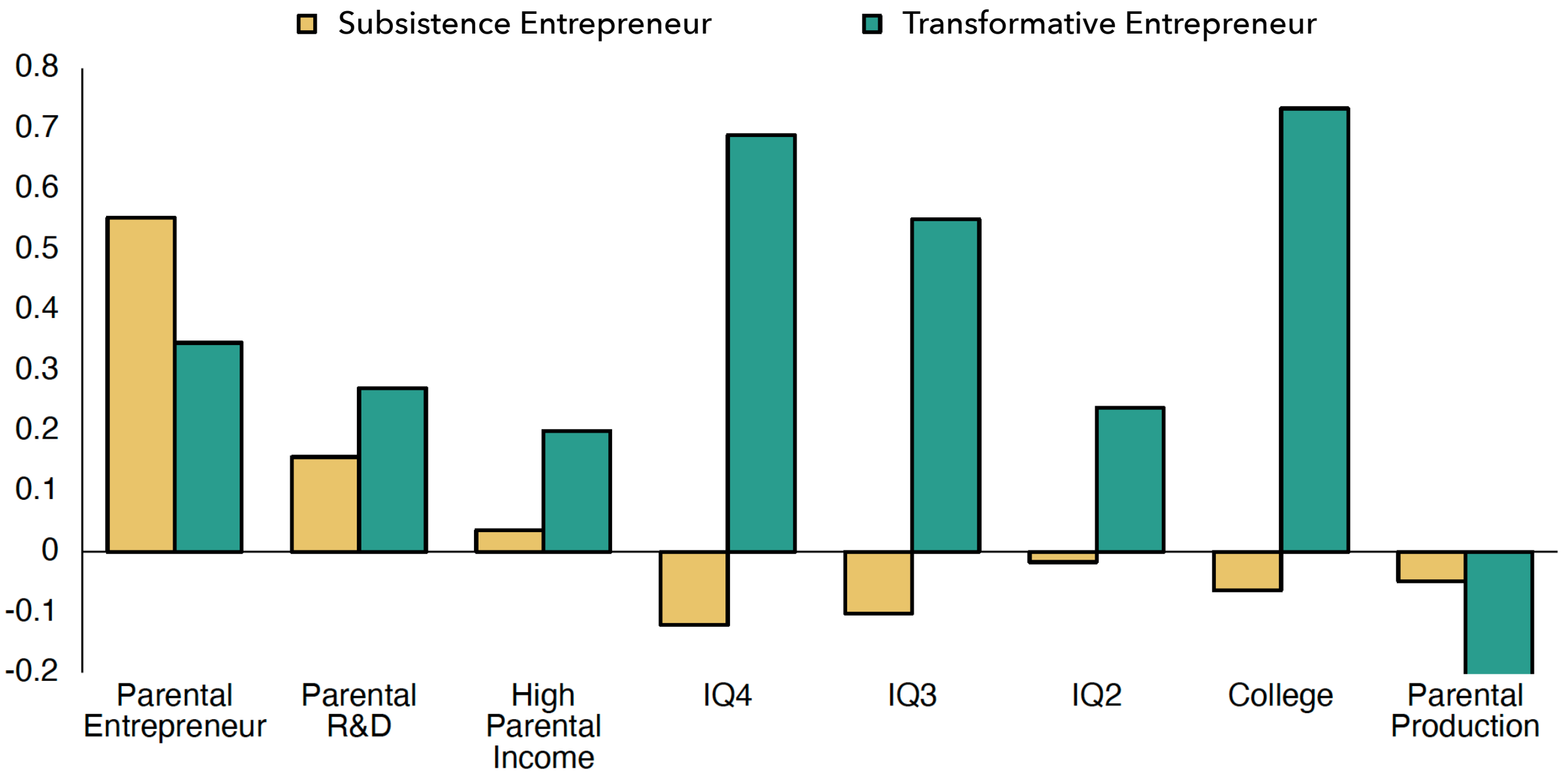
Transformative vs Subsistence Entrepreneurs by IQ



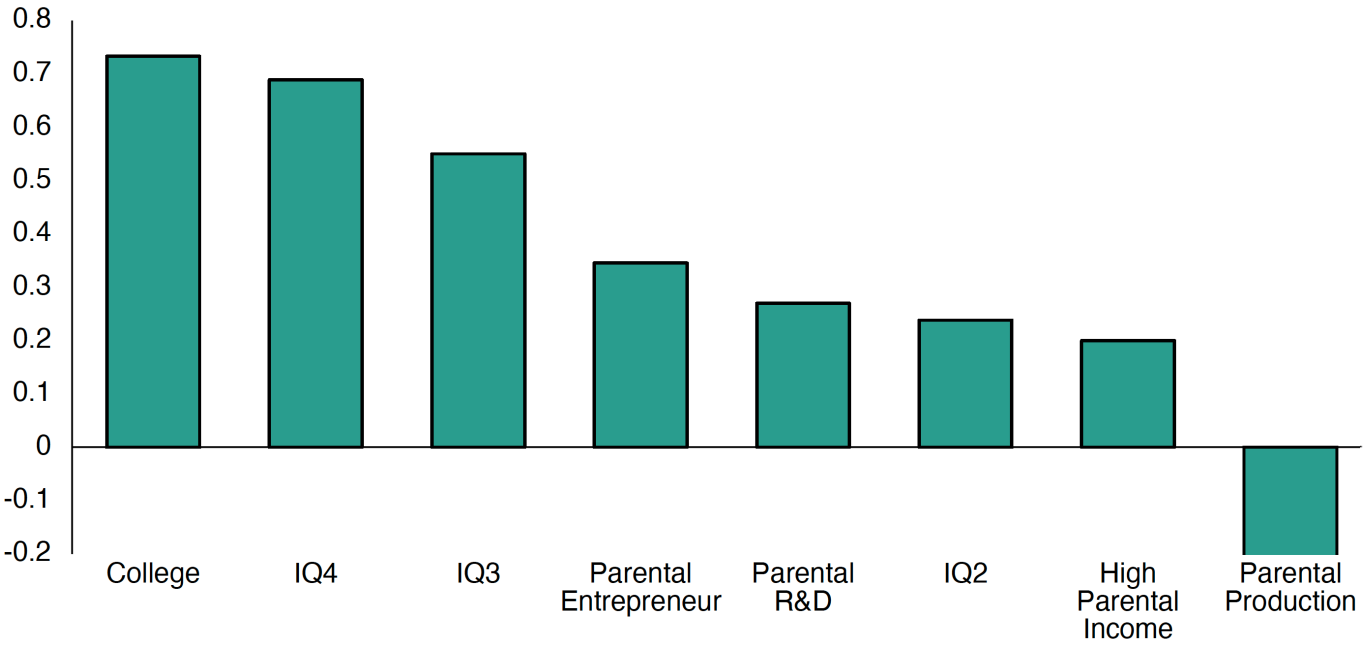
Who Becomes a Transformative Entrepreneur?



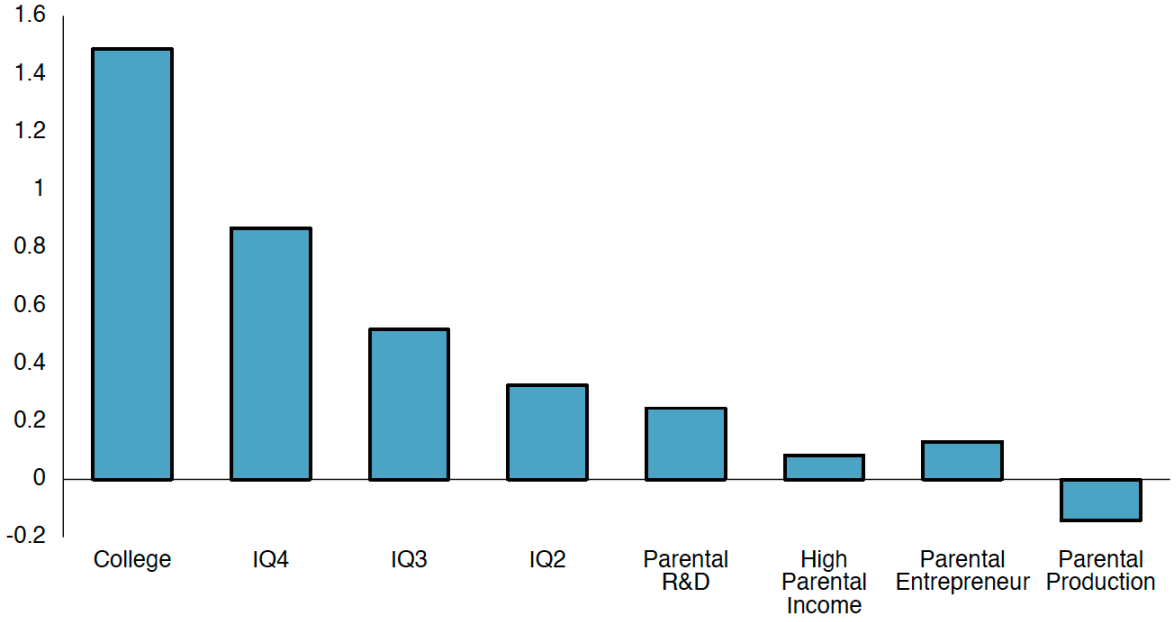
Who Becomes a Transformative Entrepreneur?



Probability of Becoming Entrepreneur/Inventor

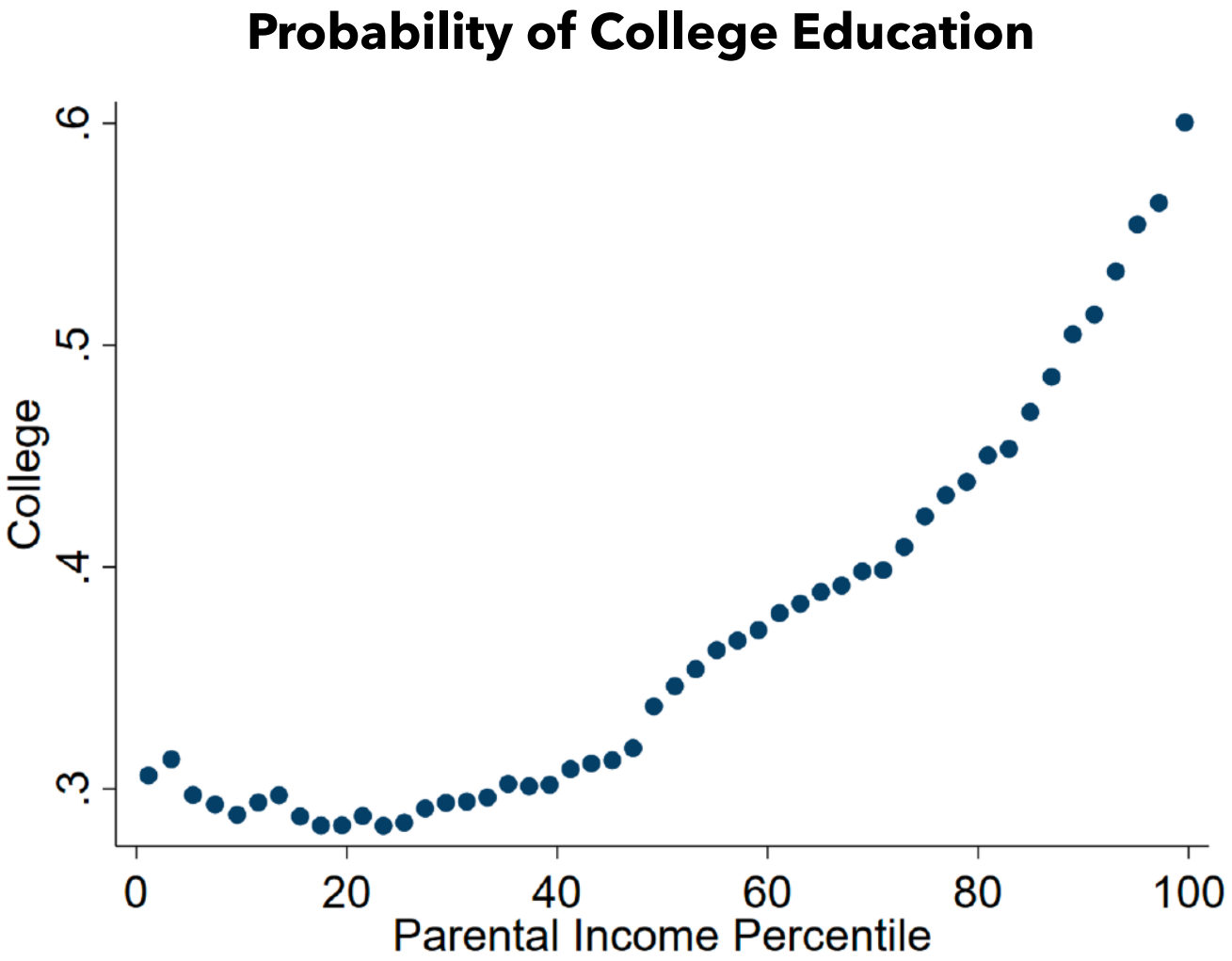


Transformative Entrepreneurs



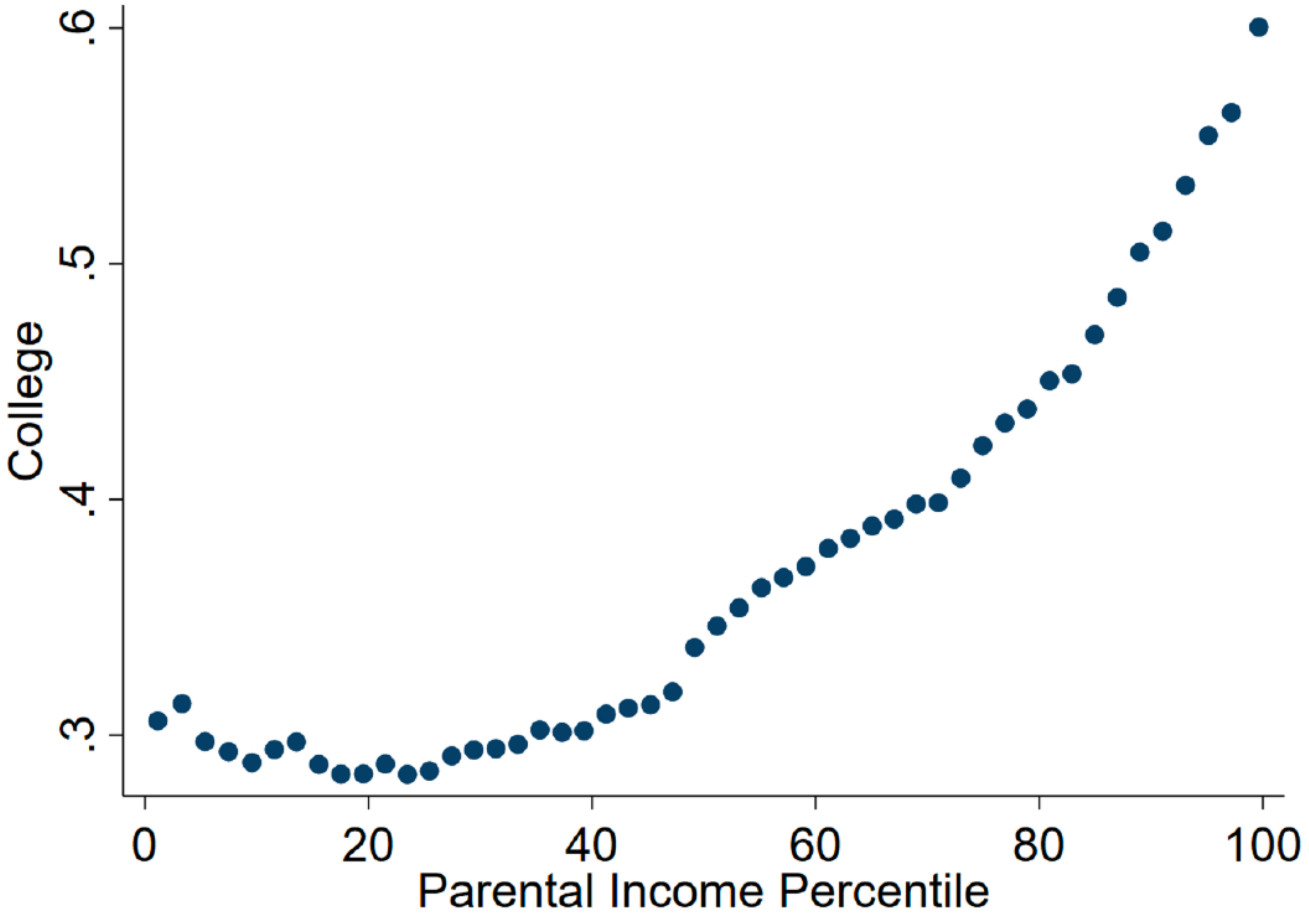
R&D Workers (inventors)

Family Income and Access to Education



Family Income and Access to Education

Probability of College Education



$$college_{ib} = \alpha_0 + \alpha_1 IQ_i + \alpha_2 \text{parental income}_i + \Lambda_b + \epsilon_{ib}$$

Table: Determinants of College Attendance

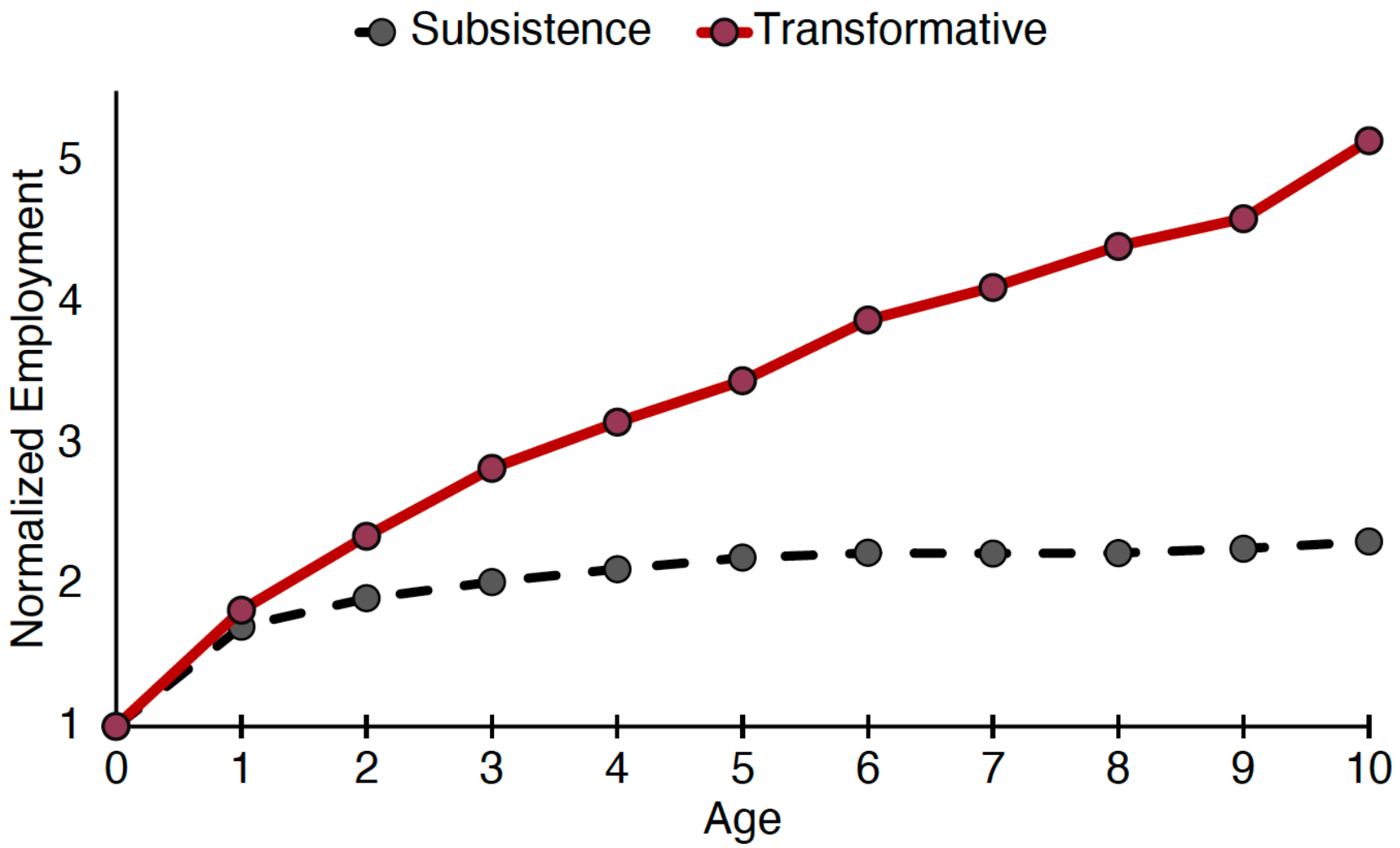
	(1) College
IQ (pctile)	0.479***
	(0.002)
Parental Income (pctile)	0.172***
	(0.002)
Observations	354002
R^2	0.224

Standard errors in parentheses

*** p<0.001, ** p<0.01, * p<0.05

Firm Life Cycle by Entrepreneurial Type

FIGURE 4: EMPLOYMENT BY ENTREPRENEUR TYPE / AGE



Innovative entrepreneurs are **57% larger** (normalized) and **308% larger** (unnormalized) by age 5.

Empirical Facts: Summary

Career Choice

R&D Workers vs Entrepreneurs

- R&D workers → Education and high IQ .
- Entrepreneurs → Entrepreneur parents .

Transformative vs. Subsistence Entrepreneurs

- Most are subsistence entrepreneurs; they do not hire R&D workers or produce patents.
- Education + high IQ → transformative entrepreneurs.

Education and Family Background

Schooling: Parental income and child IQ are strong predictors for college attendance.

Firm Dynamics

Performance: Transformative entrepreneurs create innovative firms and grow faster (steeper lifecycle).

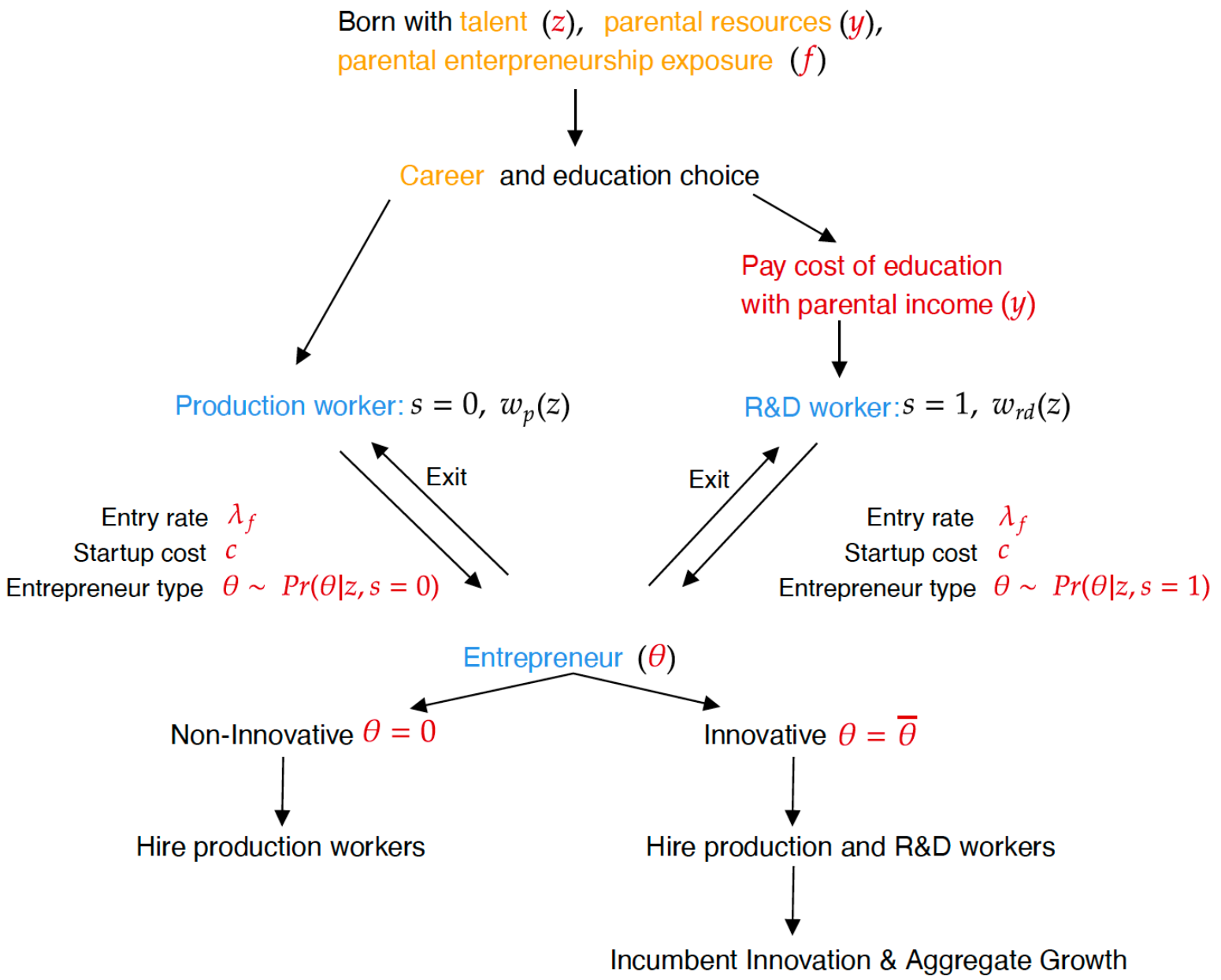
Theory

Model Overview

Production worker: $w_p(z)$ R&D worker: $w_{rd}(z)$

Incumbent Innovation & Aggregate Growth

Model Overview



$$z \in [1, \overline{z}]$$

$$y \in [\underline{y}, \overline{y}]$$

$$f \in \{0, 1\}$$

Access to education is a bottleneck to R&D and innovative entrepreneurs

$$w_p(z) = w_p z^{\alpha_p}$$

$$w_{rd}(z) = w_{rd} z^{\alpha_{rd}}$$

Idea arrival increases with family exposure

$$\lambda_f \in \{\underline{\lambda}, \overline{\lambda}\}$$

$$Pr(\theta = \overline{\theta}|z, s = 1) > Pr(\theta = \overline{\theta}|z, s = 0)$$

Probability of becoming innovative entrepreneur increases in talent and schooling

Innovative entrepreneurs grow faster

Model

- Mass M of agents heterogeneous along 3 dimensions: $(z, y, f) \sim \Omega(z, y, f)$
  talent (z), parents' resources (y), and entrepreneurial family exposure (f)

- Agents go to school ($s = 1$) to become an R&D worker, otherwise production worker, ($s = 0$)

- Schooling cost κ paid upfront with parental income, afford if $\kappa < y$

- Individuals who can afford school choose:

$$\max \{ V_1(z, y, f) - \kappa + \epsilon, V_0(z, y, f) \},$$

  where ϵ is a preference shock for schooling.

- At rate ψ agents die and are replaced by an identical individual.

Production

Firms

- Final good Y is produced competitively using a continuum of product lines as intermediate inputs

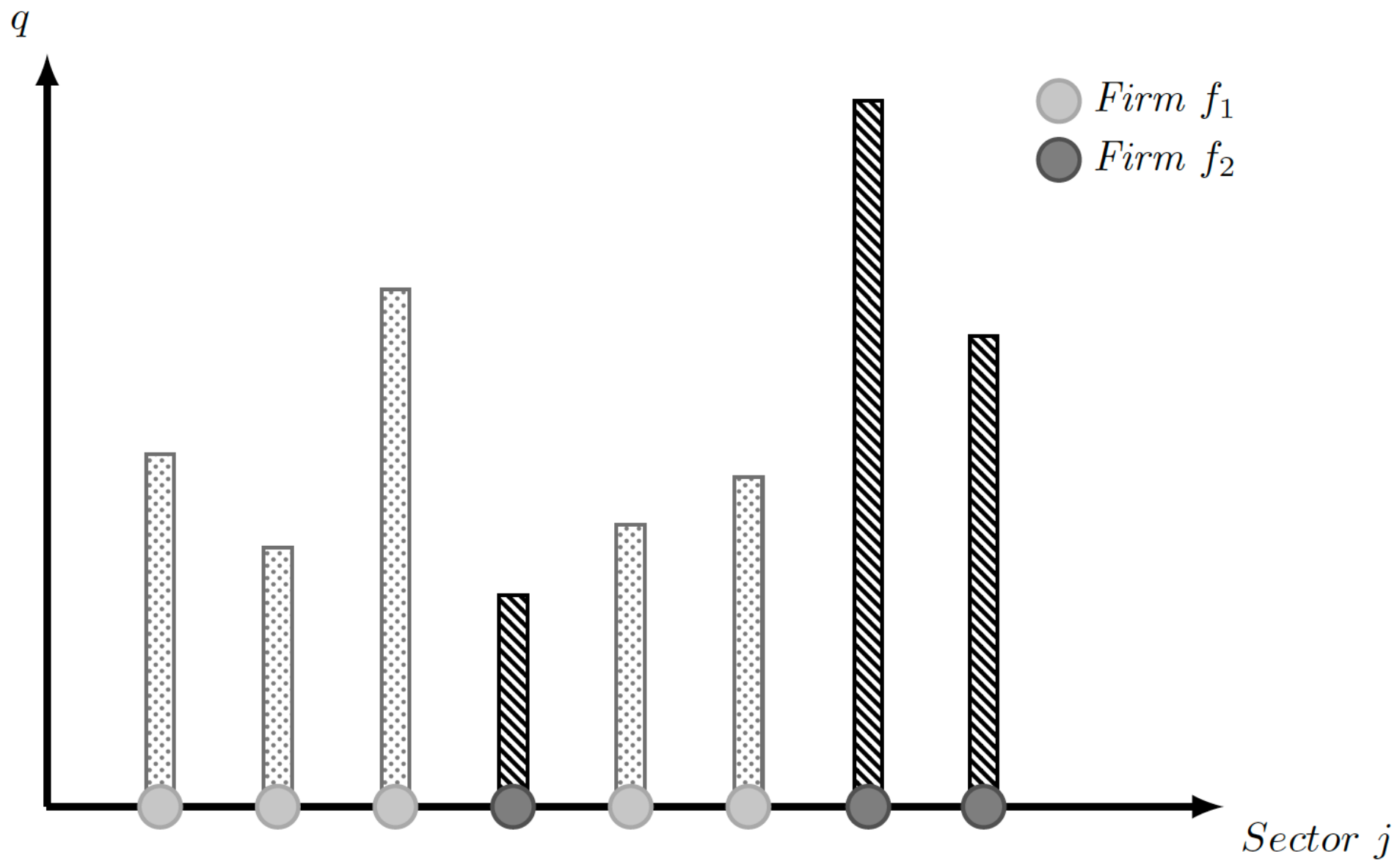
$$\ln Y_t = \int_{j \in \mathcal{N}} \ln(y_{j,t})\, dj.$$

- Each product line is produced by one firm, which is founded and managed by an entrepreneur.

$$y_{j,t} = q_{j,t} l_{j,p,t},$$

- Profits on each product line: $\pi = \frac{\gamma - 1}{\gamma} Y$

Firm

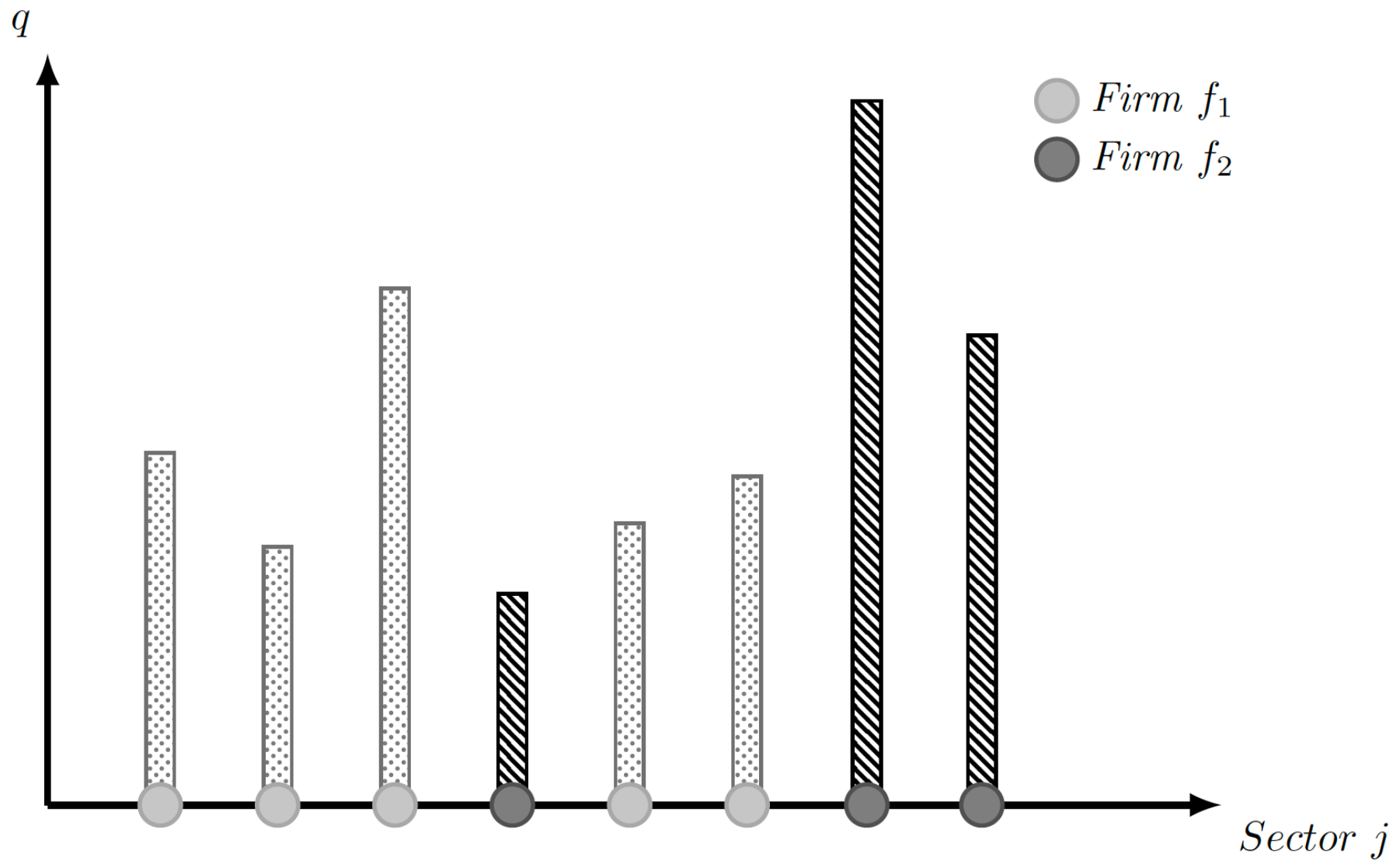


Entrepreneurship

Entrepreneurs

- Entry: Production workers and R&D workers receive an entrepreneurial opportunity at rate λ_f, which depends on whether they have entrepreneurial parents ($f \in \{0, 1\}$, $\lambda_1 > \lambda_0$)
- Draw entrepreneur type θ from a distribution $P(\theta|z, s)$, where $\theta \in \Theta = \{0, \bar{\theta}\}$,
  - $Pr\{\theta = \bar{\theta}|z, s = 1\} > Pr\{\theta = \bar{\theta}|z, s = 0\}$
- After observing θ, decide whether to pay startup cost c and become an entrepreneur.
- Hire production workers to produce and R&D workers to capture new product lines through innovation

New Entrepreneurs



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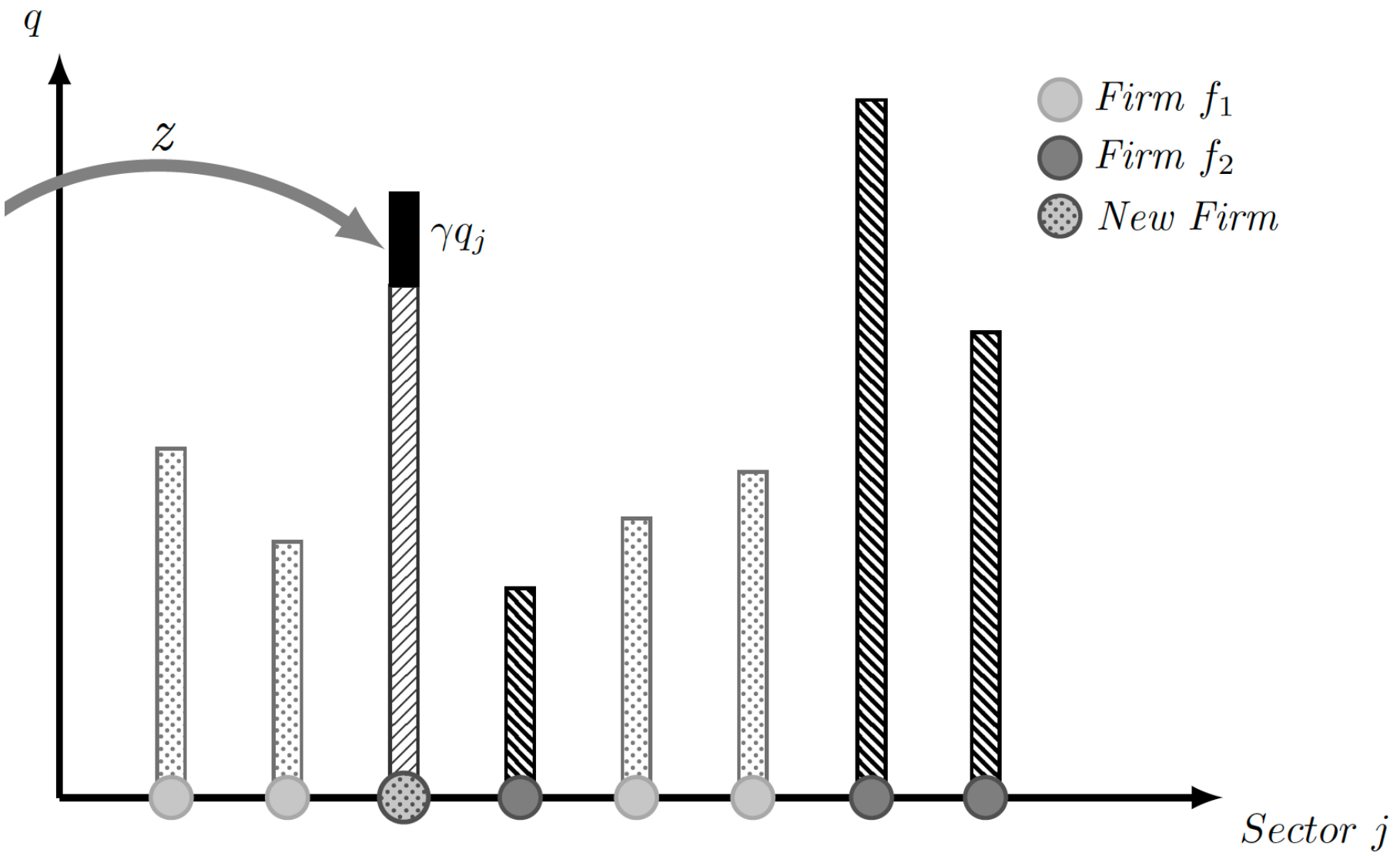


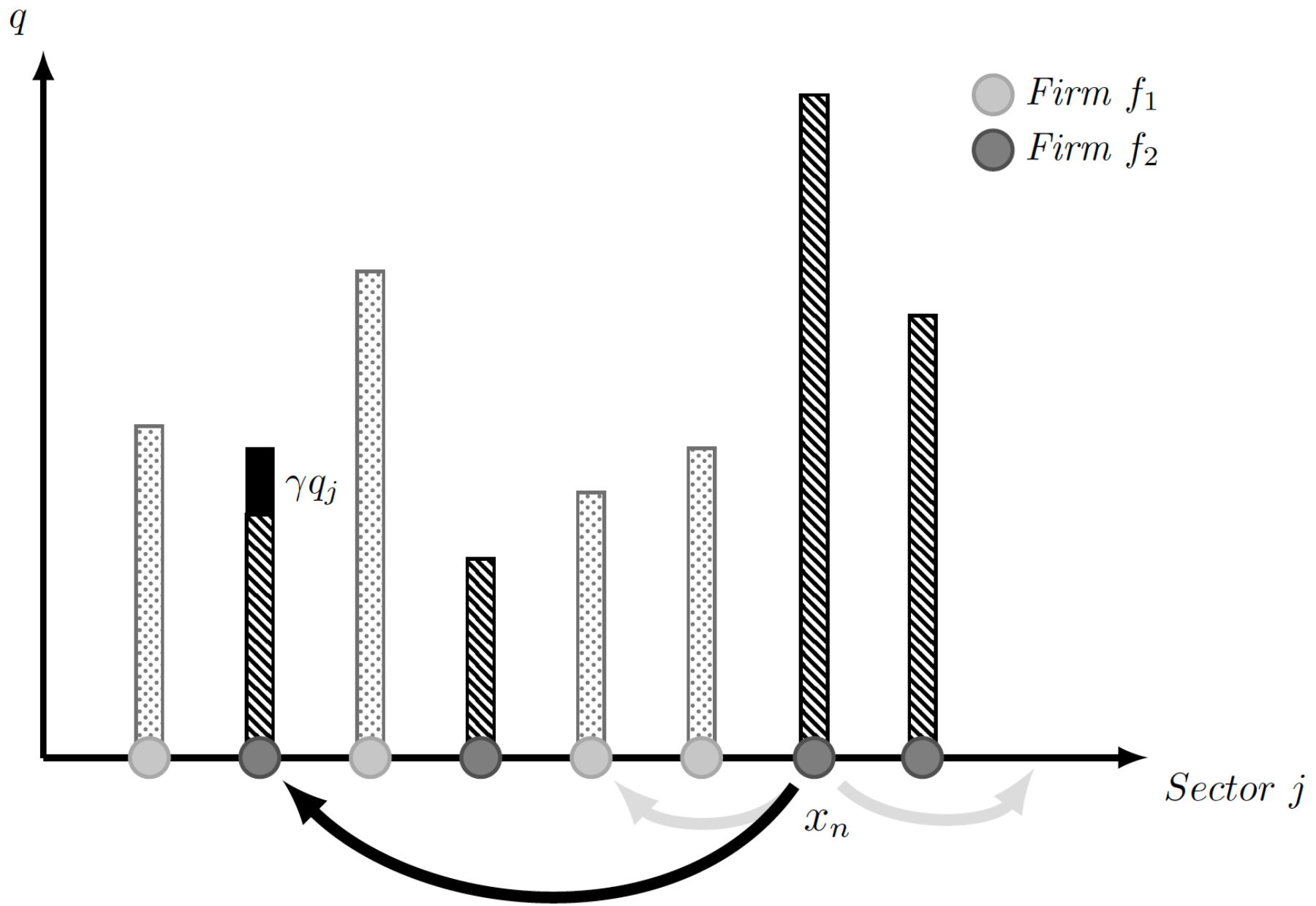
Innovation

- Entrepreneur with type θ and n product lines hires L^{rd} R&D workers efficiency units to generate innovation arrival rate X :

$$X(n,\theta) = \theta l_{rd}^{\sigma} n^{\eta},$$

- Successful innovation $\Rightarrow$ capture new product line, displace incumbent w/ step size γ

Incumbent Firms



Innovation

Production and R&D Workers

$$\begin{aligned} rV_s(z,y,f) = w_s(z) \\ &+ \lambda_f \left[\mathbb{E}_{c,\theta}\left(\max\left\{V_e(1,\theta) - c,\, V_s(z,y,f)\right\}\right) - V_s(z,y,f)\right] \\ &+ \psi\left[0 - V_s(z,y,f)\right] \end{aligned}$$

where $w_s(z)$ is wage rate.

Entrepreneur

$$\begin{aligned} rV_e(n,\theta) &= \pi n + \tau n\left[V_e(n-1,\theta) - V_e(n,\theta)\right] \\ &+ \max_{X(n,\theta)} \left\{ X(n,\theta)\left[V_e(n+1,\theta) - V_e(n,\theta)\right] - \omega_{rd}\left(\frac{X(n,\theta)}{\theta n^{1-\sigma}}\right)^{\frac{1}{\sigma}} \right\} \\ &+ \psi\left[0 - V_e(n,\theta)\right] \end{aligned}$$

where τ is the creative destruction rate and ω_{rd} is the wage rate for R&D workers per efficiency unit.

Structural Estimation

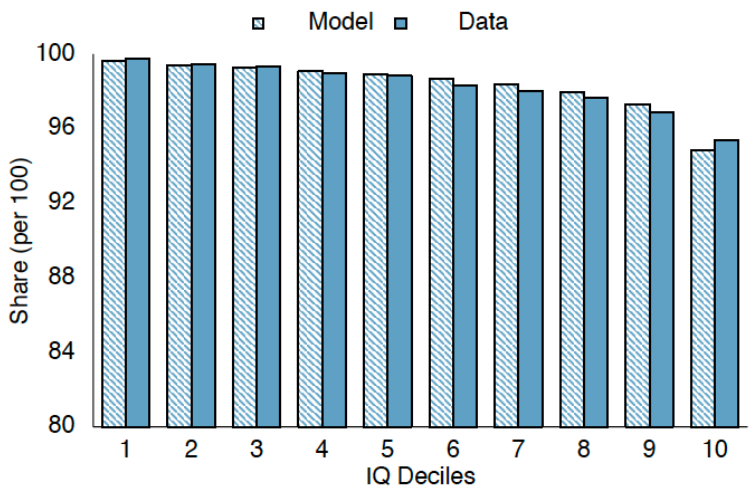
Calibration / Moment Matching - 25 Parameters

Parameter	Description	Value
	— Panel A. External Calibration —	
r	Discount rate	0.050
ψ	Death rate rate	0.025
σ	Labor share in innovation function	0.500
σ_z	SD of talent distribution	0.224
σ_y	SD of family income distribution	0.619
$\rho_{z,y}$	Correl of talent and family income	0.144
p_f	Probability of parental entrepreneurship exposure	0.080
c_s	Education cost	0.275
γ	Innovation step size	1.250
	— Panel B. Internal Calibration —	
λ_1	Entrepreneurship arrival rate w/ entrepreneur parent	0.0005
λ_0	Entrepreneurship arrival rate w/o entrepreneur parent	0.0002
λ_e	Contribution of education to entrepreneurship arrival rate	0.001
$\bar{\theta}$	Scale for innovation function	0.235
κ	Entrepreneurial type draw function	1.413
ι	Entrepreneurial type draw function	3.358
ζ	Entrepreneurial type draw function	3.519
ϵ	Entrepreneurial type draw function	0.354
α_{rd}	Wage function - R&D workers	0.545
α_p	Wage function - Production workers	0.495
m	Entrant cohort mass	0.181
μ	Mean of family income distribution	0.461
η	Product line share in innovation function	0.338
χ	Disutility from education	3.153
ς	Education preference shock scale	0.389
ν	Exogenous arrival rate of products	0.125

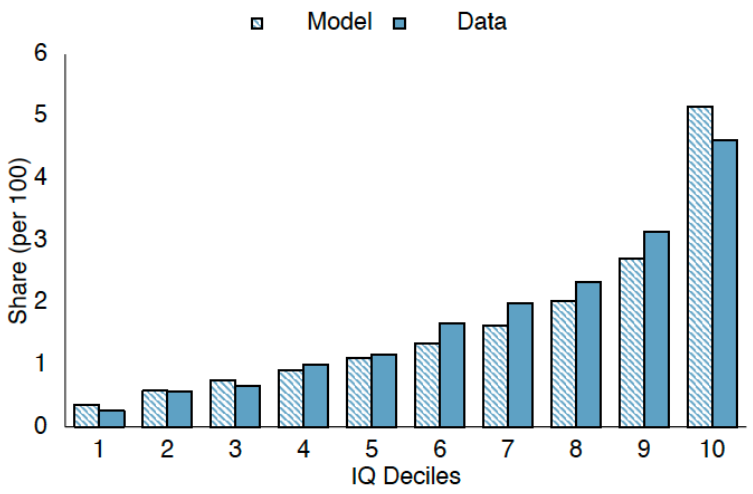
Structural Estimation – Moment Matching

Description	Model	Data
R&D workers share by IQ	In Figures	
Entrepreneurs share by IQ	In Figures	
Transformative entrepreneur share by IQ	In Figures	
R&D workers share in highest family income decile	0.027	0.028
Entrepreneur share by entrepreneur parent	0.100	0.100
Entrepreneur share by non-entrepreneur parent	0.060	0.060
Entrepreneur family share	0.080	0.080
Average firm size at age 10 - Subsistence entrepreneur	2.297	2.270
Average firm size at age 10 - Transformative entrepreneur	4.963	5.080
Share of transformative entrepreneurs within uneducated entrepreneurs	0.006	0.007
Share of transformative entrepreneurs within educated entrepreneurs	0.049	0.050
R&D workers log wage premium - highest to lowest IQ decile difference	0.089	0.090
Share of financially constrained agents	0.300	0.300
Regression coefficient in Equation (9)	0.378	0.380
Aggregate growth rate(%)	1.000	1.000

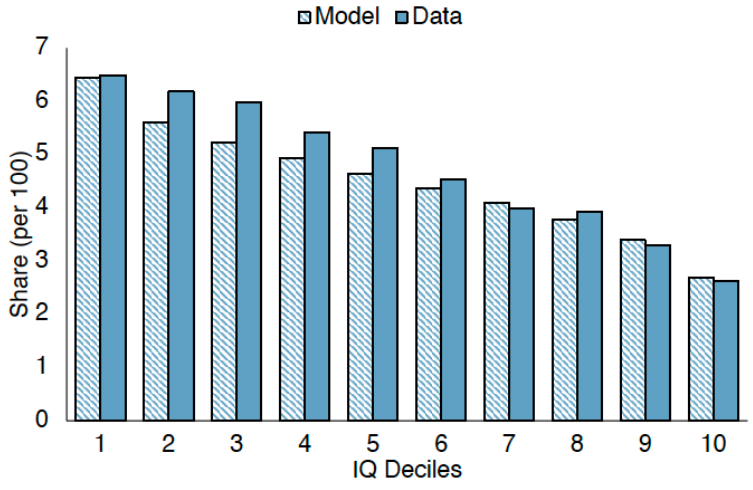
Goodness of Fit – Occupational Choice



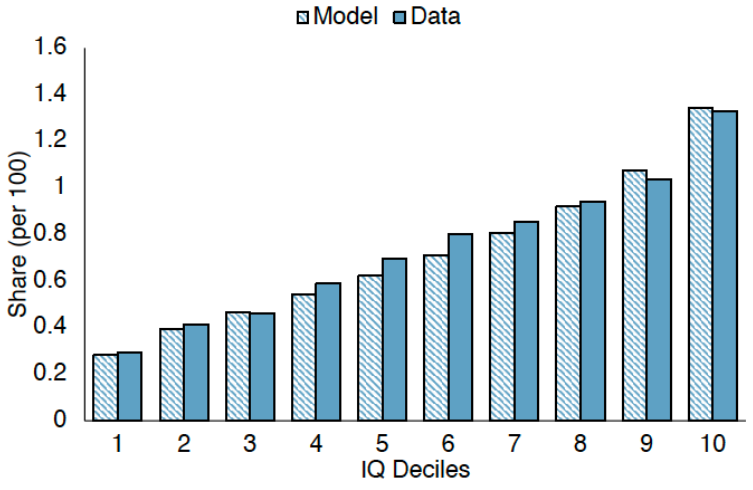
Production Workers



R&D Workers

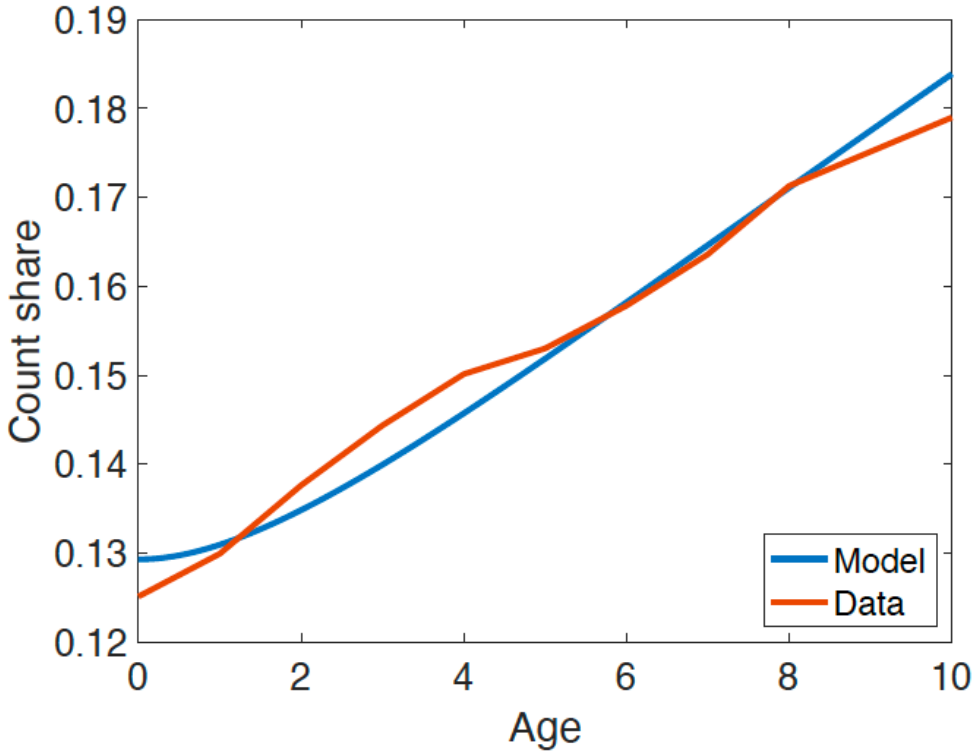


Subsistence Entrepreneurs

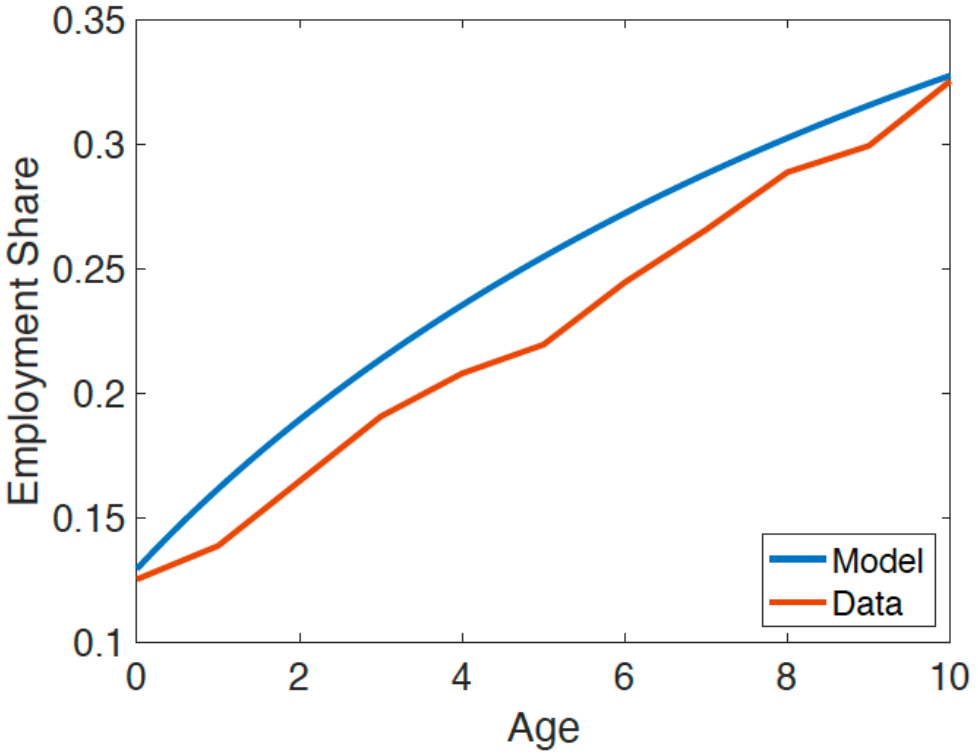


Transformative Entrepreneurs

Structural Estimation – Untargeted Moments



(A) Share of Transformative Entrepreneurs



(B) Employment Share of Transformative Entrepreneurs

Role of Education

TABLE 4: IMPORTANCE OF EDUCATION FOR ENTREPRENEURSHIP

	Baseline	No Educational Impact on Entrepreneurship	Change(%)
Growth (%)	1.00	0.92	-7.95
	Occupations Shares		
Production Workers	96.33	96.47	0.15
R&D Workers	1.58	1.44	-8.55
Subsistence Entrepreneurs	1.59	1.63	2.57
Transformative entrepreneurs	0.50	0.45	-9.20

Role of Education

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- **Fewer Transformative Entrepreneurs**: Education plays a crucial role in driving growth through entrepreneurship.

- **Reduced R&D Worker**: Individuals are less likely to pursue education when employment opportunities are scarce.

Removing Financial Frictions

TABLE 5: ALLEVIATING FINANCIAL FRICTIONS IN EDUCATION ACCESS

	Baseline	No Financial Frictions	Change (%)
Growth (%)	1.00	1.11	11.08
	Occupations Shares (% Change wrt Baseline)		
Production Workers	96.33	96.11	-0.23
R&D Workers	1.58	1.82	15.24
Subsistence Entrepreneurs	1.59	1.53	-3.60
Transformative entrepreneurs	0.50	0.54	7.49

Removing Financial Frictions

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- More Transformative Entrepreneurs
- Direct Impact on R&D Workers: They have the opportunity to pursue education if they choose.
- Indirect (Synergistic) Impact on R&D Workers: Greater market demand for R&D workers leads to higher salaries.

Synergy between Inventors and Entrepreneurs

TABLE 6: SYNERGY BETWEEN R&D WORKERS AND ENTREPRENEURS

	Baseline	No Change in Entrepreneurship	Full GE
Growth (%)	1.000	1.066	1.111

Synergy between Inventors and Entrepreneurs

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Synergy between Inventors and Entrepreneurs

TABLE 6: SYNERGY BETWEEN R&D WORKERS AND ENTREPRENEURS

	Baseline	No Change in Entrepreneurship	Full GE
Growth (%)	1.000	1.066	1.111

Merely increasing the number of inventors is insufficient;
there must be a corresponding rise in job opportunities created by transformative entrepreneurs to fully unlock their potential and drive maximum growth.

Talent Allocation: Policy Analysis

	Uniform Entry
Growth (% Change wrt Baseline)	0.11
	Occupations Shares (% Change wrt Baseline)
Production Workers	-0.01
R&D Workers	-0.02
Subsistence Entrepreneurs	0.76
Transformative entrepreneurs	0.50
	Wages (% Change wrt Baseline)
Production worker wage	0.04
R&D wage	0.01

Talent Allocation: Policy Analysis

	Uniform Entry	R&D Subsidy
Growth (% Change wrt Baseline)	0.11	2.31
Occupations Shares (% Change wrt Baseline)		
Production Workers	-0.01	-0.04
R&D Workers	-0.02	2.86
Subsistence Entrepreneurs	0.76	-0.74
Transformative entrepreneurs	0.50	1.49
Wages (% Change wrt Baseline)		
Production worker wage	0.04	0.07
R&D wage	0.01	0.36

Talent Allocation: Policy Analysis

	Uniform Entry	R&D Subsidy	Innovative Entry
Growth (% Change wrt Baseline)	0.11	2.31	4.38
Occupations Shares (% Change wrt Baseline)			
Production Workers	-0.01	-0.04	-0.08
R&D Workers	-0.02	2.86	4.04
Subsistence Entrepreneurs	0.76	-0.74	-1.45
Transformative entrepreneurs	0.50	1.49	6.69
Wages (% Change wrt Baseline)			
Production worker wage	0.04	0.07	0.13
R&D wage	0.01	0.36	0.43

Talent Allocation: Policy Analysis

	Uniform Entry	R&D Subsidy	Innovative Entry	Education Subsidy
Growth (% Change wrt Baseline)	0.11	2.31	4.38	16.14
Occupations Shares (% Change wrt Baseline)				
Production Workers	-0.01	-0.04	-0.08	-0.33
R&D Workers	-0.02	2.86	4.04	22.26
Subsistence Entrepreneurs	0.76	-0.74	-1.45	-5.27
Transformative entrepreneurs	0.50	1.49	6.69	10.84
Wages (% Change wrt Baseline)				
Production worker wage	0.04	0.07	0.13	0.52
R&D wage	0.01	0.36	0.43	-2.87

Talent Allocation: Policy Analysis

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	Wages (% Change wrt Baseline)			
Production worker wage	0.04	0.07	0.13	0.52
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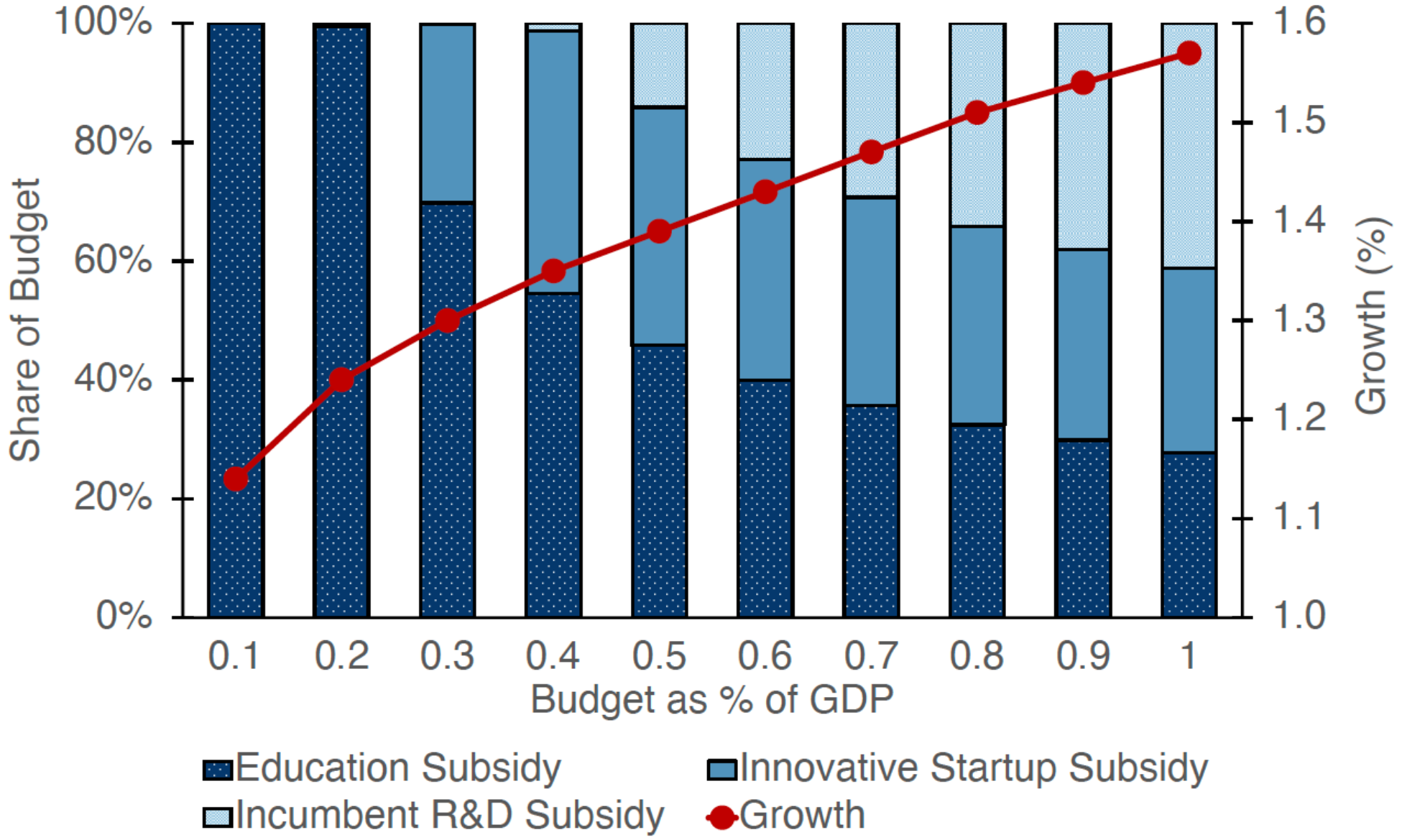
Optimal Policy Mix



Conclusion

Mutual Dependence

- Inventors and entrepreneurs rely on each other for success.
- Good inventors drive entrepreneurship by creating valuable innovations.
- More entrepreneurs increase the market value of innovative ideas.

Key Factors for Inventors

- IQ and education are crucial for fostering inventive capabilities.

Key Factors for Entrepreneurs

- Having an entrepreneurial parent often influences the decision to become an entrepreneur.
- Entrepreneurs can be categorized into two types:
  - **Transformative Entrepreneurs**: Those who bring new ideas and technologies to market.
  - **Subsistence Entrepreneurs**: Those who focus on traditional business models and markets.
- Education and IQ are particularly important for transformative entrepreneurs.

Challenges in Talent Allocation

- Financial barriers can lead to the misallocation of talent: fewer inventors and fewer transformative entrepreneurs.

Policy Implications

- Policies should prioritize both the supply (inventors) and the demand side (innovative entrepreneurs) of innovation.
- Education policy is critical in developing the skills necessary for both inventors and innovative entrepreneurs.

Thank You

uakcigit@uchicago.edu
www.ufukakcigit.com