Heterogeneous agents and occupational choice in a directed search market

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14 July, 2021

Overview

- The model features:
  - Occupational choice (entrepreneur/worker)
  - Sector choice
  - Two-sided heterogeneity
  - Large firms
  - Directed search
- I calibrate the model focusing on the mechanisms it proposes with respect to stylized facts about:
  - Technological development and high-tech entrepreneurhip rate
  - Technological development and inequality

Some related literature

Technological development and inequality

- *Worker*: Acemoglu (2002b), Shimer (2005)
- *Entrepreneur*: Aghion et al. (2019)

Technological development and entrepreneurship

- Poschke (2013; 2018)

The model setup

Agents

- Continuum of agents with total measure equal to 1
- Utility equal to c
- Characterized by an α (e.g. ability) endowment distribution
  - pdf: $\varphi(\alpha)$
  - Compact support $[\alpha_l, \alpha_h]$

Good

- Homogeneous
- Numéraire

The model setup

Occupational choice

- Entrepreneur
  - If an entrepreneur, he draws his/her entrepreneurial factor (EF) ϕ
    - Distribution is conditional on α
    - For $\alpha' > \alpha''$, $P[\phi \geqslant x|\alpha = \alpha'] > P[\phi \geqslant x|\alpha = \alpha'']$
  - No sunk cost, EF distribution has compact support $[0, U_1]$
  - Sunk cost $c(\alpha)$, EF distribution has compact support $[0, U_2]$
    $U_2 > U_1$

  Charecterize them as non-innovative and innovative entrepreneur respectively

- Worker

The model setup

Labor market frictions

Directed and competitive search

- Entrepreneurs
  - Post vacancies
  - Announce the wages attached to the vacancies
- Workers
  - Given the posted terms, workers direct their search
- Matching technology
  - $m(v, u)$ where v are the vacancies and u the unemployed queueing for the vacancies
  - m is
    - continuous
    - nonnegative
    - increasing in both arguments and in market tightness $(\frac{v}{u})$
    - constant returns to scale

The model setup

- Production is a function of labor quantity, entrepreneur's and worker's ability, $F(\phi, x, \ell)$
- x is the α type of a worker while y (appears later) is the α type of an entrepreneur
- F is increasing and concave in all its arguments. In particular, $F(\phi, x, \ell) = \Delta(\phi, x)\ell^{\gamma_i}$ for $i \in \{n, I\}$
- $\Delta(\phi, x)$
  - nonnegative
  - twice continuously differentiable
  - $\frac{\partial^2 \Delta(\phi, x)}{\partial x \partial \phi} > 0$
  - $\Delta(\phi, \alpha_I) = 0$

The model setup

$$\max_{\ell, x, \overline{w}_n^y} \underbrace{\left(\int_0^{U_1} \Delta(\phi, x) \frac{1}{U_1} f_y \left(\frac{\phi}{U_1} \right) d\phi \right)}_{Q^n(x,y)} \ell^{\gamma_n}$$

$$-\ell \underbrace{\left(\int_0^{U_1} w_n^y(\phi, x) \frac{1}{U_1} f_y \left(\frac{\phi}{U_1} \right) d\phi \right)}_{\overline{w}_n^y(x)} - \kappa v$$

$$s.t. \quad \ell = m(v, u) \quad and \quad w_n(x) = \frac{m(v, u)}{u} \overline{w}_n^y(x) \tag{1}$$

The model setup

- κ: cost of posting a vacancy
- f_y: pdf of continuous stochastic variable that ranges from zero to one
- $\overline{w}_n^y(x)$: wage posted by the entrepreneur
- $w_n(x)$: Exprected equilibrium wage

The model setup

$$\max_{\ell, x, \overline{w}_I^y} \underbrace{\left(\int_0^{U_2} \Delta(\phi, x) \frac{1}{U_2} f_y \left(\frac{\phi}{U_2} \right) d\phi \right)}_{Q^I(x,y)} \ell^{\gamma_I}$$

$$-\ell \underbrace{\left(\int_0^{U_2} w_I^y(\phi, x) \frac{1}{U_2} f_y \left(\frac{\phi}{U_2} \right) d\phi \right)}_{\overline{w}_I^y(x)} - \kappa v - c(y)$$

$$s.t. \quad \ell = m(v, u) \quad and \quad w_I(x) = \frac{m(v, u)}{u} \overline{w}_I^y(x) \qquad (2)$$

Profit maximization

$$\max_{v} Q^i(x,y)m(v,u)^{\gamma_i} - \kappa v \tag{3}$$

results in $\tilde{v}(u,x,y)$

$$\max_{u} Q^i(x,y)m(\tilde{v},u)^{\gamma_i} - uw(x) - \kappa\tilde{v} - \mathbf{1}_{\{\mathbf{i}=\mathbf{I}\}}c(y) \tag{4}$$

results in $\tilde{u}(x,y)$

$$\max_{x} Q^i(x,y)m(\tilde{v},\tilde{u})^{\gamma_i} - \tilde{u}w_i(x) - \kappa\tilde{v} - \mathbf{1}_{\{\mathbf{i}=\mathbf{I}\}}c(y) \tag{5}$$

The model setup

Assuming that $m(v,u) = Bv^{\eta}u^{1-\eta}$, we get

$$\frac{\varepsilon_{Q^i}(x,y)}{\gamma_i(1-\eta)} = \varepsilon_{w_i}(x) \tag{6}$$

where:

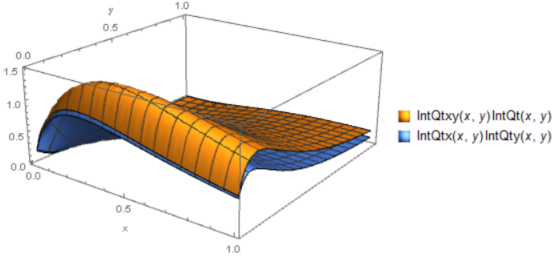
$$\varepsilon_{Q^i}(x,y) = x\left(\frac{\frac{\partial Q^i(x,y)}{\partial x}}{Q^i(x,y)}\right) \quad \textit{and} \quad \varepsilon_{w_i}(x) = x\left(\frac{\frac{\partial w_i(x)}{\partial x}}{w_i(x)}\right)$$

Hence,

$$w_i(x) = c_i Q^i(x,y)^{\frac{1}{\gamma_i(1-\eta)}} \quad \textit{and} \quad x = \mu_i(y) \tag{7}$$

In order to obtain positive assortative matching, it should hold that:

$$\frac{\partial^2 Q^i(x,y)}{\partial x \partial y} \geq \frac{\frac{\partial Q^i(x,y)}{\partial x}\frac{\partial Q^i(x,y)}{\partial y}}{Q^i(x,y)} \quad (8)$$



Occupation sorting

- Sufficient conditions for an economy where all types are active:

$$Q^l(\alpha_h, \alpha_l) m(\tilde{v}(\alpha_h, \alpha_l), \tilde{u}(\alpha_h, \alpha_l))^{\gamma_l} - \tilde{u}(\alpha_h, \alpha_l) w(\alpha_h) - \kappa \tilde{v}(\alpha_h, \alpha_l)$$

$$-c(a_l) = 0 \tag{8}$$

$$c(a_h) = 0 \tag{9}$$

The model setup

Occupation sorting

- Sufficient condition for higher ability workers to be employed by innovative entrepreneurs:

$$\gamma_n \geqslant \gamma_I \tag{10}$$

Possible equilibria

- $\{E_n, W_n, W_I, E_I\}$ (A)
- $\{E_n, W_n, E_I, W_I\}$ (B)
- $\{E_n, E_I, W_n, W_I\}$ (C)

Here, I examine equilibrium (A) which is more in line with empirical findings
e.g. Blanchflower (2000), Andersson and Wandensjö (2013), Poschke (2013; 2018)

From now on (A) is Equilibrium Type I

Equilibrium Type I

Equilibrium conditions

$$Q^n(x_1, x_0)m(\tilde{v}(x_1, x_0), \tilde{u}(x_1, x_0))^{\gamma_n} - \tilde{u}(x_1, x_0)w(x_1) - \kappa\tilde{v}(x_1, x_0)$$

$$= w_n(x_0) \tag{11}$$

$$Q^I(x_1, x_2)m(\tilde{v}(x_1, x_2), \tilde{u}(x_1, x_2))^{\gamma_I} - \tilde{u}(x_1, x_2)w(x_1) - \kappa\tilde{v}(x_1, x_2) - c(x_2)$$

$$= w_I(x_2) \tag{12}$$

$$w_n(x_1) = w_I(x_1) \tag{13}$$

Equilibrium Type I

$$\int_{\alpha_l}^{x_0} \frac{u(\mu_n(y), y)}{v(\mu_n(y), y)} \varphi(y) dy = \int_{x_0}^{x_1} \frac{u(\mu_n(y), y)}{v(\mu_n(y), y)} \varphi(\mu_n(y)) \mu_n'(y) dy \tag{14}$$

$$\int_{x_2}^{\alpha_h} \frac{u(\mu_l(y), y)}{v(\mu_l(y), y)} \varphi(y) dy = \int_{x_1}^{x_2} \frac{u(\mu_l(y), y)}{v(\mu_l(y), y)} \varphi(\mu_l(y)) \mu_l'(y) dy \tag{15}$$

Application

Main Data

- *Income Inequality Database*: Income shares of the top 1%, annual, 1998-2006
- *BEA*: GDP by NAICS industry, state-level, annual, 1998-2006
- *IPUMS-CPS*: Agents employment class (entrepreneur-employee) and primary occupation's NAICS industry, annual, 1998-2006

High-tech entrepreneurship definition

- *Hecker's (2005)*: 4-digit NAICS industry groups with the highest concentration of STEM workers (five times the average proportion in all industries)
- *NSF Infobriefs (2016)*: The whole ICT

High-tech entrepreneurship and technological level

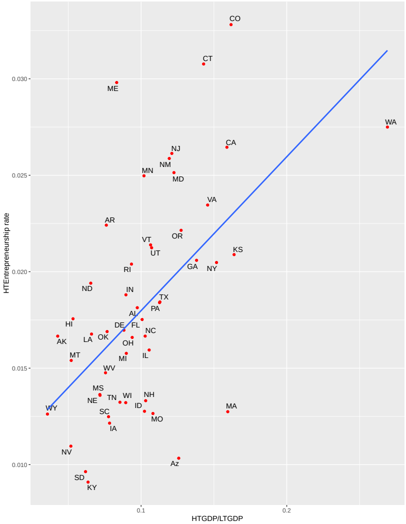
y-axis

- Using IPUMS-CPS I calculate the average percentage of high-tech entrepreneurs for the different US states
- Entrepreneurs:self-employed, both incorporated and not incorporated, those who reported receiving wage/salary in the private sector but were employed as chief executives or managers and administrators n.e.c.

x-axis

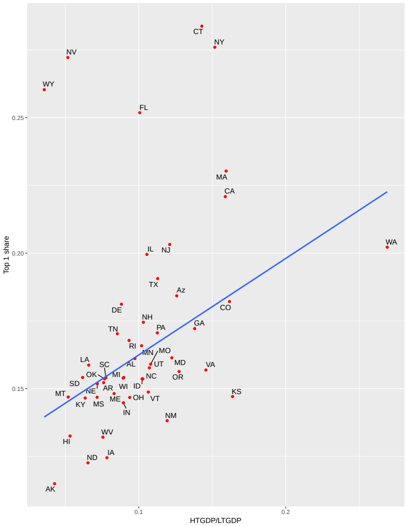
- GDP produced by the high-tech industries over GDP produced by non-high-tech industries
- Exclusion of GDP from public sector and monetary authorities

Application



Application

Inequality and technological level



Model Calibration

Parameters taken directly from literature

- κ: 0.213. Taken from Shimer (2005) and Hall (2017)
- η: 0.4. Intermediate between Hall (2005), Shimer (2005) and Mortensen and Nagypal (2007)

Parameters that I set

- α ability distribution
  - Truncated normal
  - μ_α: 0.5
  - σ_α
- Entrepreneurial factor destributions with pdf f_y
  - Truncated normal
  - μ_c: y
  - σ_c: 0.45

Model Calibration

- $\Delta(x, \phi)$
  - $[x^r + x^{r(1-q)}\phi^{rq}]^{\frac{1}{r}}$
  - r: -0.4
  - q: 0.84
- Functional form for $c(\alpha)$: $c(\alpha) = \delta_2(y-1)$
- Normalize U_1 and set it equal to 1

Parameters calibrated to match data targets

- $(\sigma_\alpha, \gamma_r, \gamma_t, B, U_2, \delta_2)$

Data moments
(Benchmark: Pennsylvania)

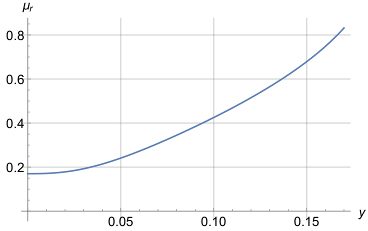
- Percentage of entrepreneurs in the high-tech sector: 0.0184 (IPUMS-CPS)
- Percentage of workers employed in the high-tech sector: 0.097 (IPUMS-CPS)
- Percentage of entrepreneurs in the non-high-tech sector: 0.113 (IPUMS-CPS)
- Unemployment rate: 4.91 (BLS)
- Top 1 income share: 0.171 (WID)
- Ratio of GDP produced by the high-tech sector over the GDP produced by the non-high-tech sector: 0.113 (BEA)

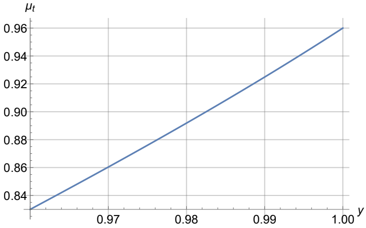
Model Calibration

Calibrated parameters	Values
γ_r	0.995
γ_t	0.792
B	1.147
U_2	1.8
δ_2	2.13
σ_α	0.35

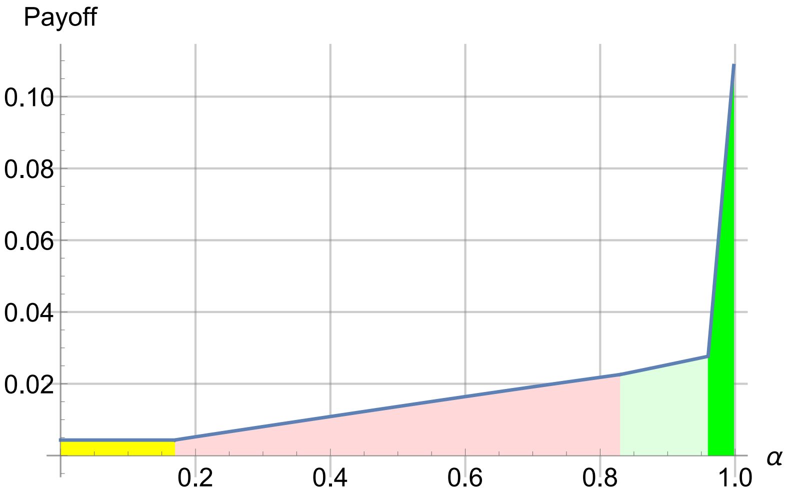
Ability cutoffs	Values
x_0	0.17
x_1	0.83
x_2	0.96

Model Calibration





Model Calibration

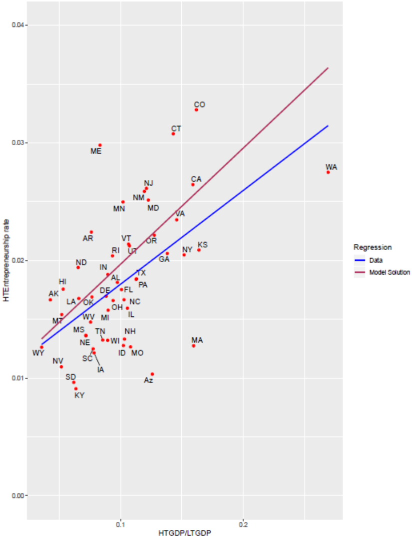


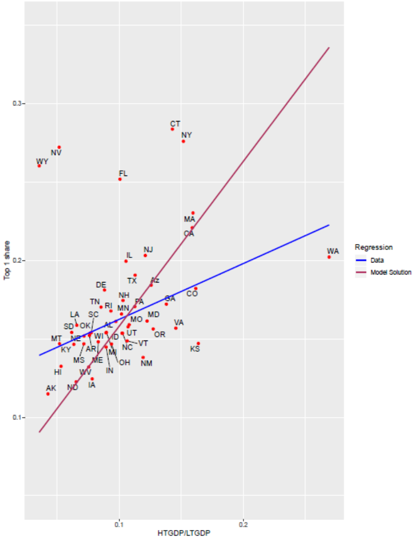
Model Calibration

Cross-states results

- Goal
  - Examine the impact of a change in U_2/U_1 (regional technological development) on the high-tech entrepreneurship rate and on top 1 income share
- How?
  - Keep Pennsylvania based calibrated parameters except U_2
  - Estimate the moments of interest for each state
  - Plot the resulting OLS fit against the data and their own regression line

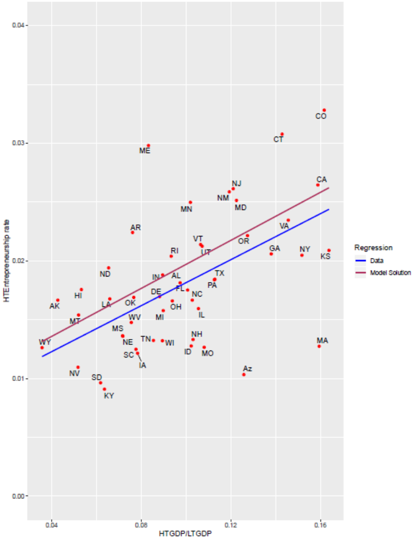
Model Calibration

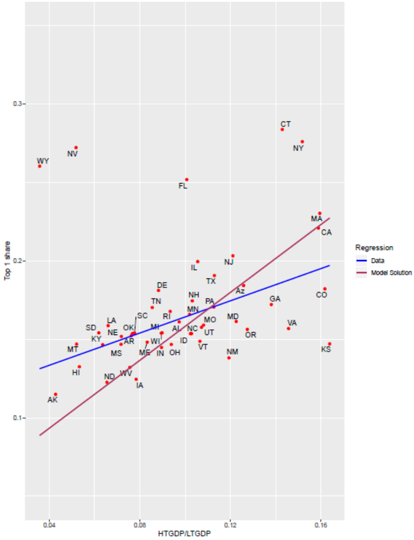




Model Calibration

*Excluding Washington





Summary

- This paper:
  - Introduces a model that uniquely combines: A general equilibrium search model with two-sided heterogeneity and large firms where agents choose whether to become entrepreneurs or workers
  - Discusses the pattern between regional technological development, entrepreneurship rate and inequality
  - Successfully replicates these patterns