Recruiting Talent

Simon Board Moritz Meyer-ter-Vehn Tomasz Sadzik

UCLA

July 13, 2016

Motivation

Talent is source of competitive advantage

- Universities: Faculty are key asset.
- Netflix: "We endeavor to have only outstanding employees."
- Empirics: Managers (Bertrand-Schoar), workers (Lazear).

Talent perpetuates via hiring

- Uni: Faculty responsible for recruiting juniors and successors.
- N: "Building a great team is manager's most important task."
- Empirics: Stars help recruit future talent (Waldinger)

Key questions

- Can talent dispersion persist/avoid regression to mediocrity?
- Why don't bad firms just compete advantage away?

Overview

Three ingredients for persistence

- High wages attract talented applicants
- Skilled management screens wheat from chaff.
- Today's recruits become tomorrow's managers.

Static Model

- When talent is scarce, matching is positive assortative.
- Efficient matching is negative assortative.

Dynamic model

- Persistent dispersion of talent, productivity and wages.
- Regression to mediocrity offset by PAM.
- Gradual adjustment to steady state.

Literature

Matching in labor markets

- Becker (1973), Lucas (1978), Garicano (2000), Levin & Tadelis (2005), Anderson & Smith (2010).

Adverse selection

- Greenwald (1986), Lockwood (1991), Chakraborty et al (2010), Lauermann & Wolitzky (2015), Kurlat (2016).

Wage & productivity dispersion

- Albrecht & Vroman (1992), Burdett & Mortensen (1998).

Firm dynamics

- Prescott & Lucas (1971), Jovanovic (1982), Hopenhayn (1992), Hopenhayn & Rogerson (1993), Board & MtV (2014).

Static Model

Baseline Model

Gameform

- Unit mass of firms $r \sim F[\underline{r}, \bar{r}]$ post wages $w(r)$.
- Unit mass of workers apply from top to bottom wage.
  Proportion $\bar{q}$ talented, $1 - \bar{q}$ untalented.
- Firms sequentially screen applicants, hire one each.
  Proportion r skilled recruiters $\theta = H$; $1 - r$ unskilled $\theta = L$.

Screening

- Talented workers pass test.
- Untalented screened out with iid prob. p_θ; $0 < p_L < p_H < 1$.
- Quality when recruiter θ hires from applicant pool q

$$\lambda(q; \theta) = q/(1 - (1 - q)p_\theta)$$

- Quality at firm r: $\lambda(q; r) = r\lambda(q; H) + (1 - r)\lambda(q; L)$
- Profits $\pi := \mu\lambda(q(w); r) - w - k$.

Preliminary Analysis

Applicant Pool Quality

- Top wage: Proportion $q(1) = \bar{q}$ talented workers.
- Wage rank x: Applicant pool quality $q(x)$ obeys

$$q'(x) = \frac{\lambda(q(x); r(x)) - q(x)}{x}$$

- Quality $q(x)$: $\begin{cases} \text{strictly increases in } x \\ \text{positive for } x > 0\text{, but } q(0) = 0. \end{cases}$

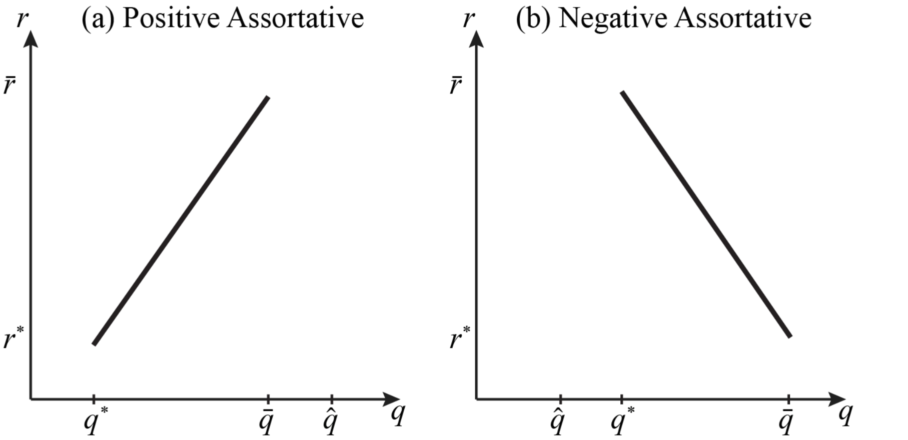
Wage posting equilibrium

- Equilibrium wage distribution $\{w(r)\}_r$ has no atoms or gaps.

Firm-Applicant Matching

Wage profile $\{w(r)\}_r$ induces firm-applicant matching

$$Q(r) = q(x(w(r)))$$



Equilibrium Matching - Necessary Condition

Incentive Compatibility in Equilibrium $\{w(r)\}_r$

- Firms $r, \tilde{r}$ do not mimic each other:

$$\mu\lambda(Q(r);r) - w(r) \geq \mu\lambda(Q(\tilde{r});r) - w(\tilde{r})$$
$$\mu\lambda(Q(\tilde{r});\tilde{r}) - w(\tilde{r}) \geq \mu\lambda(Q(r);\tilde{r}) - w(r)$$

- Hence, $\lambda(Q(\tilde{r});r)$ supermodular in $(\tilde{r}, r)$.

Return to Recruiter Quality

$$\Delta(q) := \lambda(q;H) - \lambda(q;L) = \frac{\partial}{\partial r}\lambda(q;r)$$

- IC: $\Delta(Q(r))$ rises in r.
- $\Delta(\cdot)$ is single-peaked, with maximum $\hat{q} \in (0,1)$.
- $\lambda(q;r)$ is super-modular for $q < \hat{q}$; sub-modular for $q > \hat{q}$.

Scarce Talent — Positive Assortative Matching

Theorem 1.
If $\bar{q} \leq \hat{q}$, there is a unique equilibrium. It exhibits PAM.

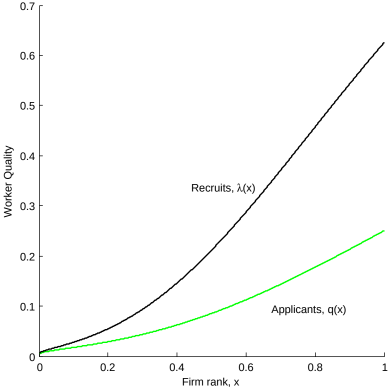
Proof

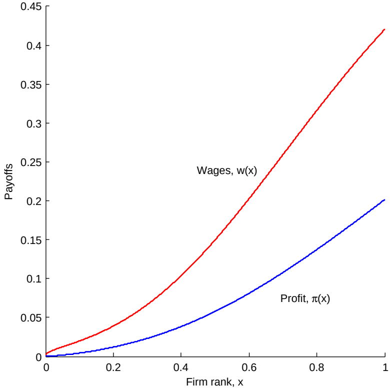
- $\Delta(q)$ increases for $q \leq \bar{q}$, and $\Delta(Q(r))$ must increase.
- Hence, $Q(r)$ must increase.

Equilibrium described by

- Profits
$$\pi(r) = \mu \int_{\underline{r}}^{r} \Delta(Q(\tilde{r}))d\tilde{r}.$$
- Wages
$$w(r) = \mu \int_{\underline{r}}^{r} \lambda'(Q(\tilde{r}); \tilde{r})Q'(\tilde{r})d\tilde{r}.$$

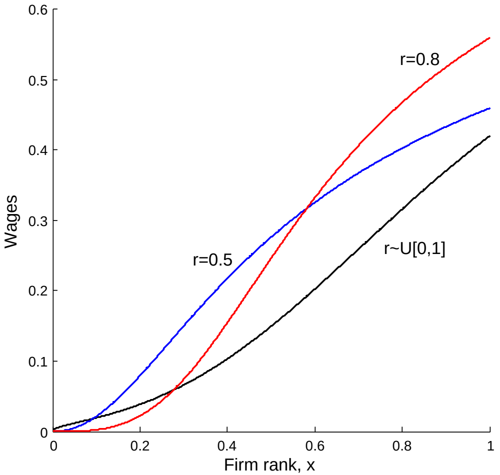
PAM: Example





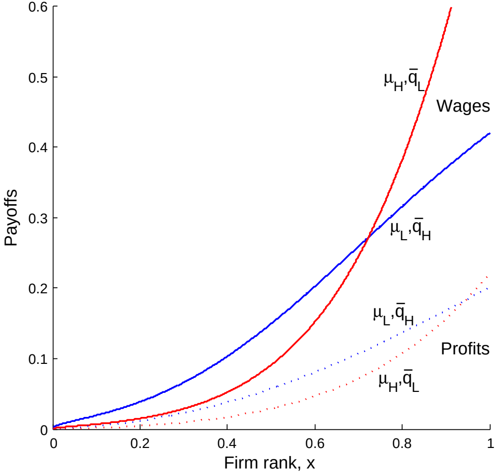
Assumptions: $p_H = 0.8$, $p_L = 0.2$, $r \sim U[0,1]$, $\bar{q} = 0.25$, $\mu = 1$.

Comparative Statics — Screening Skills



Assumptions: $p_H = 0.8$, $p_L = 0.2$, $\bar{q} = 0.25$, $\mu = 1$.

Comparative Statics — Technological Change



$$\bar{q}_H = .25,\ \mu_L = 1 \quad \rightarrow \quad \bar{q}_L = .05,\ \mu_H = 5.$$

Abundant Talent

Theorem 2.

Assume $\bar{q} > \hat{q}$. There is a unique equilibrium. It has PAM on $[q^*, \hat{q}]$ and NAM on $[\hat{q}, \bar{q}]$.

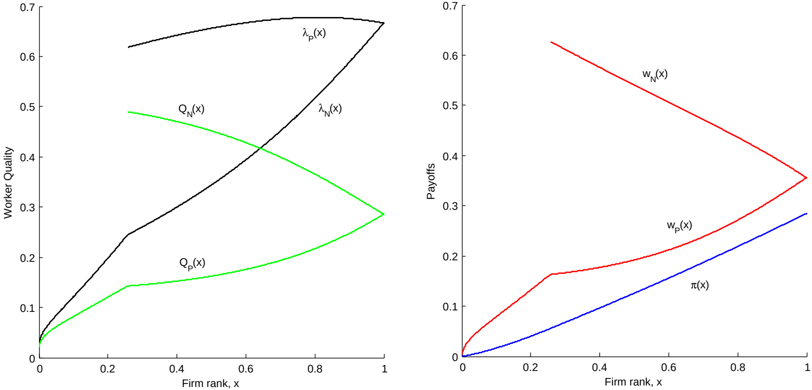
Proof

- Key fact: $\Delta(Q(r))$ increases in r.
- Top firm $\bar{r}$ matches with $\hat{q}$.
- Below, r matches with $Q_P(r) < \hat{q} < Q_N(r)$ s.t.

$$\Delta(Q_P(r)) = \Delta(Q_N(r))$$

and Q_P, Q_N obey the usual differential equations.

PAM-NAM: Example



Assumptions: $p_H = 0.8$, $p_L = 0.2$, $r \sim U[0,1]$, $\bar{q} = 0.5$.

Dynamic Model

Model

Basics

- Continuous time t, discount rate ρ.
- Workers enter and retire at flow rate α.
- Talented workers become skilled recruiters.
- Assume talent is scarce, $\bar{q} < \hat{q}$.

Firm's problem

- Firm's product μr_t; initially, r_0 exogenous.
- Attract applicants q_t with wage $w_t(q_t)$ to manage talent r_t

$$\dot{r}_t = \alpha(\lambda(q_t; r_t) - r_t).$$

- Firm value $V_t(r)$.

Firm's Problem

- The firm solves

$$V_0(r_0) = \max_{\{q_t\}} \int_0^\infty e^{-\rho t}(\mu r_t - \alpha w_t(q_t))dt,$$
$$\text{s.t.} \quad \dot{r}_t = \alpha(\lambda(q_t; r_t) - r_t).$$

- Bellman equation

$$\rho V_t(r) = \max_q \{\mu r - \alpha w_t(q) + \alpha V_t'(r)[\lambda(q; r) - r] + \dot{V}_t(r)\}.$$

- First order condition

$$\lambda'(q; r)V_t'(r) = w_t'(q).$$

Positive Assortative Matching

Theorem 3.
Equilibrium exists and is unique. Firms with more talent post higher wages. The distribution of talent has no atoms at $t > 0$.

Idea

- The value function $V_t(r)$ is convex.
- FOC implies matching is PAM.
- FOC also implies atoms immediately dissolve.

Thus

- Time-invariant firm-rank x, s.t. $r_t(x), q_t(x)$ increase in x.

Constructing the Equilibrium

Equilibrium Matching $r_t(x)$, $q_t(x)$

- Talent evolution

$$\dot{r}_t(x) = \alpha(\lambda(q_t(x); r_t(x)) - r_t(x))$$

- Sequential Screening

$$q_t'(x) = (\lambda(q_t(x); r_t(x)) - q_t(x))/x$$

Equilibrium Wages

$$w_t'(q) = V_t'(r)\lambda'(q; r)$$

where $q = q_t(x)$, $r = r_t(x)$ and

$$V_t'(r_t) = \frac{\partial}{\partial r_t} \int_t^\infty e^{-\rho(s-t)}[\mu r_s^* - \alpha w_s(q_s^*)]ds$$

Constructing the Equilibrium

Equilibrium Matching $r_t(x)$, $q_t(x)$

- Talent evolution

$$\dot{r}_t(x) = \alpha(\lambda(q_t(x); r_t(x)) - r_t(x))$$

- Sequential Screening

$$q_t'(x) = (\lambda(q_t(x); r_t(x)) - q_t(x))/x$$

Equilibrium Wages

$$w_t'(q) = V_t'(r)\lambda'(q; r)$$

where $q = q_t(x)$, $r = r_t(x)$ and

$$V_t'(r_t) = \mu \int_t^\infty e^{-\rho(s-t)} \frac{\partial r_s^*}{\partial r_t} ds$$

Constructing the Equilibrium

Equilibrium Matching $r_t(x)$, $q_t(x)$

- Talent evolution

$$\dot{r}_t(x) = \alpha(\lambda(q_t(x); r_t(x)) - r_t(x))$$

- Sequential Screening

$$q_t'(x) = (\lambda(q_t(x); r_t(x)) - q_t(x))/x$$

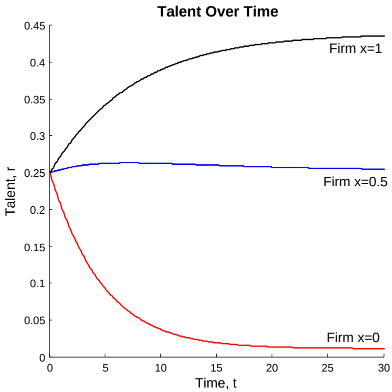
Equilibrium Wages

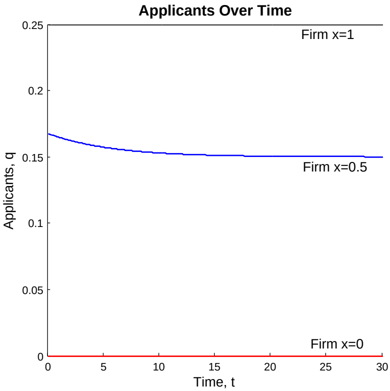
$$w_t'(q) = V_t'(r)\lambda'(q; r)$$

where $q = q_t(x)$, $r = r_t(x)$ and

$$V_t'(r_t(x)) = \mu \int_t^\infty e^{-\int_t^s (\rho + \alpha(1 - \Delta(q_u(x))))du} ds$$

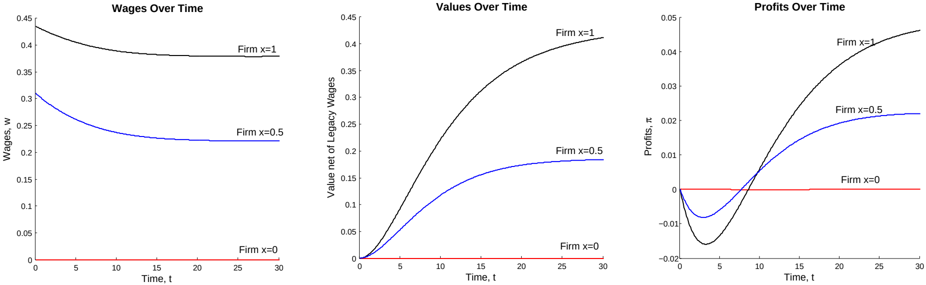
Equilibrium Firm Dynamics — Talent





Assumptions: $p_H = 0.8$, $p_L = 0.2$, $\mu = 1$, $\rho = 0.1$, $\alpha = 0.2$, and $\bar{q} = 0.25$.

Equilibrium Firm Dynamics — Payoffs



Assumptions: $p_H = 0.8$, $p_L = 0.2$, $\mu = 1$, $\rho = 0.1$, $\alpha = 0.2$, and $\bar{q} = 0.25$.

The Equilibrium Steady State

Steady-state matching $r^*(x)$, $q^*(x)$

- Constant quality, $\lambda(q; r) = r$, links q and r.
- Seq. screen., $q'(x) = (\lambda(q; r) - q)/x$, determines $r(x), q(x)$.

Steady state wages $w^*(q)$

- Marginal value of talent

$$V'(r) = \frac{\mu}{\rho + \alpha(1 - \Delta(q))}.$$

- Marginal wages

$$w'(q) = \frac{\mu}{\rho + \alpha(1 - \Delta(q))}\lambda'(q; r).$$

Convergence to Steady State

Theorem 4.
a) Steady State $\{r^*(x), q^*(x), w^*(q)\}$ *is unique; no gaps or atoms.*
b) For any initial talent distribution, equilibrium converges to SS.

Persistence of competitive advantage

- Random hiring: regression to mean at rate α.
- Screening applicants q: regression to mean at $\alpha(1 - \Delta(q))$.
- But under PAM, high-quality firms pay more.
- Hence, talent is source of sustainable competitive advantage.

Comparative Statics

Talent dispersion rises in talent-skill correlation β

- Suppose recruiting skill is $(1-\beta)\bar{q}+\beta r$.
- PAM if $\beta > 0$, but NAM if $\beta < 0$.
- Talent dispersion $r^*(1) - r^*(0)$ rises in β.

Wages rise in turnover α

- Does not affect steady-state talent.
- Raises steady-state flow wages $(\rho+\alpha)w_t$.

$$(\rho+\alpha)w'(q(x)) = \mu\lambda'(q(x);r(x))\frac{\rho+\alpha}{\rho+\alpha(1-\Delta(q(x)))}$$

- Intuition: Effect of talent outlasts employment.

Dynamic Model with Heterogenous Technology

Heterogeneous Technology

Two types of heterogeneity

- Exogenous technology $\mu \in \{\mu_L, \mu_H\}$; mass ν low.
- Evolving talent r_t.
- Firms *stratified*, if r_t and μ correlate perfectly.

Wages increase in μ and r

- Recall FOC

$$w_t'(q) = V_t'(r;\mu)\lambda'(q;r)$$

- Higher r raises $V_t'(r;\mu)$ and $\lambda'(q;r)$.
- Higher μ raises $V_t'(r;\mu)$.

Convergence to Steady State

Theorem 5.

a) There is a unique steady-state equilibrium.
b) The steady state is stratified.
c) Any equilibrium converges to this steady-state.
d) Distribution $r^*(x), q^*(x)$ *independent of* $\{\mu_L, \mu_H\}$.

Idea

- Talent distribution becomes continuous.
- High-tech firms outbid low-tech firms when talent is close.

Adjustment Dynamics of Single Firm

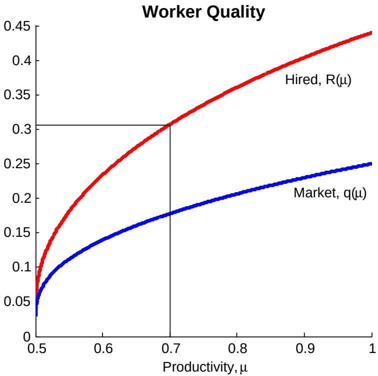
- Steady state with firms $r \geq r^*$ high tech; wages $w^*(r)$.
- Low-tech firm with $r < r^*$ becomes high-tech.

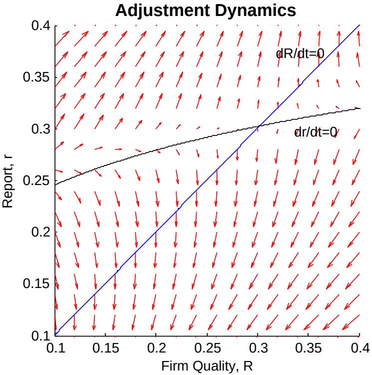
Theorem 6.
a) Wages satisfy $w_t \in (w^*(r_t), w^*(r^*)]$
b) Talent r_t *converges to* r^* *as* $t \to \infty$.

Idea

- $w_t > w^*(r_t)$ since firm has higher tech.
- $w_t \leq w^*(r^*)$ since firm has less talent.
- Since $w_t > w^*(r_t)$, talent r_t rises over time.

Saddle-point Stable Adjustment Path





- r_0 chosen to hit r^*. Near steady state,

$$\begin{bmatrix} r_t - r^* \\ r_t - r^* \end{bmatrix} = (r_0 - r^*) \begin{bmatrix} 0.2032 \\ 1 \end{bmatrix} e^{-0.2281t}.$$

Welfare

Welfare

Introducing Welfare

- Entry cost $k > 0$.
- Marginal firm: $\mu\lambda(Q(\check{r});\check{r}) = k$.
- Welfare $\int_{\check{x}}^{1}(\mu\lambda(q(x);r(x)) - k)dx$.

Maximize Aggregate Sorting

- Planner chooses entry and rank x for every firm r.
- Equilibrium entry threshold $\check{x}$ is efficient (given PAM).
- But, does PAM for $x \in [\check{x}, 1]$ maximize employed talent?

Efficient Matching

Theorem 7.
For any entry threshold $\check{x}$, NAM maximizes employed talent.

Two economics forces

- Becker: PAM maximizes comparative advantage (if $q < \hat{q}$).
- Akerlof: PAM also maximizes adverse selection.
- And. . .

Efficient Matching

Theorem 7.
For any entry threshold $\check{x}$, NAM maximizes employed talent.

Two economics forces

- Becker: PAM maximizes comparative advantage (if $q < \hat{q}$).
- Akerlof: PAM also maximizes adverse selection.
- And... Akerlof wins!

Proof Sketch

Marginal Employed Talent

- Employed talent $\omega(\check{x})$, where $\omega(x) = \bar{q} - xq(x)$
- Effect of better screening skills at rank x

$$\zeta(x) := \frac{\partial \omega(\hat{x})}{\text{“}\partial r(x)\text{”}} = \frac{\partial \omega(\hat{x})}{\partial \omega(x)} \frac{\partial \omega(x)}{\partial r(x)}$$

$$= \exp\left(- \int_{\hat{x}}^{x} \frac{\lambda'(q(x); r(x))}{x} dx \right) \Delta(q(x))$$

Shifting Screening Skills Up

$$\zeta'(x) \simeq \underbrace{\Delta'(q(x))q'(x)}_{\text{Becker}} - \underbrace{\lambda'(q(x); r(x))\Delta(x)/x}_{\text{Akerlof}} < 0.$$

Dynamic Efficiency

- Upfront entry cost $k/\rho > 0$.
- Present surplus $\int_0^\infty e^{-\rho t}(\mu R_t - k)dt$, with $R_t = \int_{\check{x}}^1 r_t(x)dx$.
- Choose entry and wage ranks to maximize surplus.

Theorem 8.
For any $\check{x}$, NAM surplus exceeds PAM surplus at all times.

Idea

- For fixed recruiting skills R_t, NAM maximizes talent input.
- Additional talent under NAM helps recruit even more talent.

Extensions

Model of Hierarchies

Hierarchy

- $N+1$ layers: Level $n=0$ directors; level $n=N$ workers.
- Mass 1 of firms; each has α^n positions at level n.
- Mass α^n of job seekers at each level; proportion $\bar{q}$ skilled.

Firms

- Director quality r_0 exogenous.
- Level n agents hire level $n+1$ agents, $r_{n+1} = \lambda(q_{n+1}, r_n)$.
- Only workers produce, $v_N = \mu\alpha^N r_N$.

Hierarchies: Equilibrium Wages

Equilibrium with $\bar{q} < \hat{q}$

- Assume $r_0 \sim F_0$ steady state; then $r_{n+1} = r_n$.
- Level-$(n-1)$ value $v_{n-1}(r) := v_n(\lambda(q_n; r)) - \alpha^n w_n$; then

$$v_n'(r) = \mu \alpha^N \Delta(q)^{N-n}$$

- Marginal level-n wages

$$w_n'(q) = \lambda'(q; r)\mu(\alpha\Delta(q))^{N-n}.$$

- Assume $\alpha\Delta(q) > 1$; then wages increase in rank.

Wage dispersion across firms $q > \tilde{q}$ and levels $n < \tilde{n}$

- Inter-firm dispersion greater at high levels: $\frac{w_n(q)}{w_n(\tilde{q})} \geq \frac{w_{\tilde{n}}(q)}{w_{\tilde{n}}(\tilde{q})}$.
- Intra-firm dispersion greater at high firms: $\frac{w_n(q)}{w_{\tilde{n}}(q)} \geq \frac{w_n(\tilde{q})}{w_{\tilde{n}}(\tilde{q})}$.

Conclusion

We've proposed a model in which

- Firms compete to identify and recruit talent.
- Today's recruits become tomorrow's recruiters.

Main results

- Positive assortative matching.
- Persistent productivity dispersion.
- Equilibrium inefficiency due to adverse selection.

Next steps

- Characterize dynamic matching with $\bar{q} > \hat{q}$.
- Characterize dynamic and steady state dispersion.
- Study dynamics when μ_t are stochastic.