Social Connections, Strategic Referrals, and On-the-Job Search

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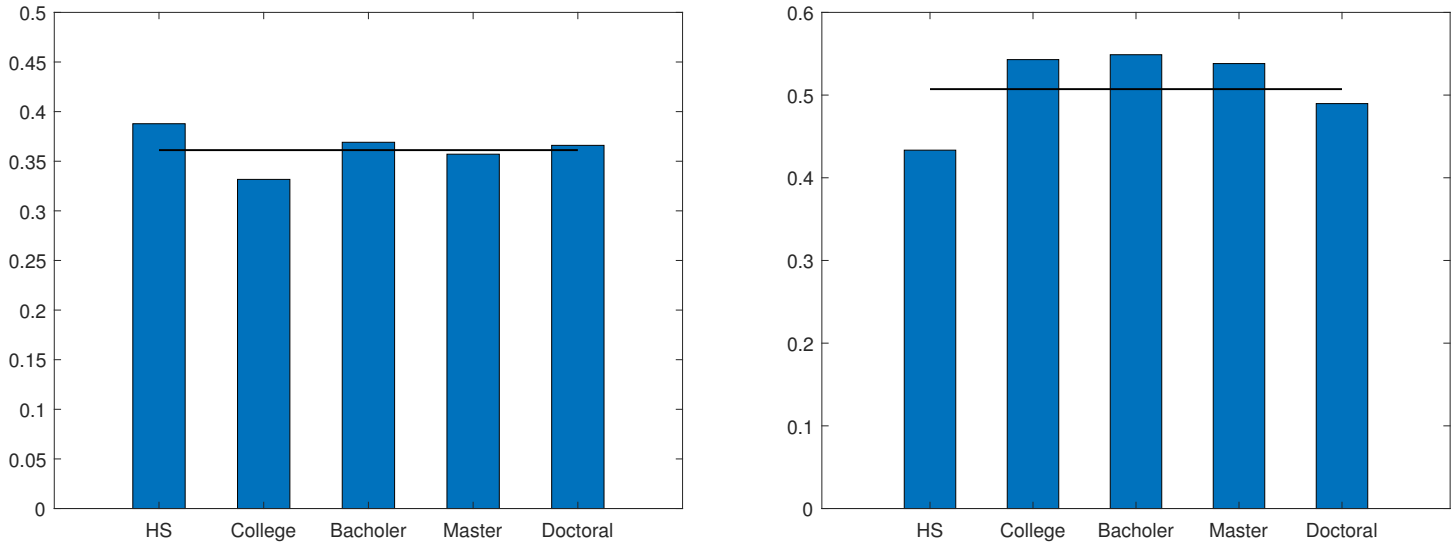
Outline

Introduction

Referral is prevalent in labor market



(a) Referred to the current job (b) Use network in the job search

Figure: Referral usage in the labor market[1]

- 36% of workers are referred to the current job
  - online + career center + help ads + professional registers = 34%
- 51% of workers use connections to find a new job

[1]Source: Survey of Consumer Expectations,©2013-2018 Federal Reserve Bank of New York (FRBNY)

Motivation

Distinctive features of referrals from other job search methods

- Convey private information
  - Different match quality and wage
- Offers arrive unevenly
  - Inequality and amplification

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- Partial equilibrium: exogenous offer, only unemployed search

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This paper studies a search model with

- Endogenous information transmission through referral
- On-the-job search/Endogenous wage offer/Business cycles

Why Strategic behavior and General equilibrium?

Conveying private information rationalizes referral wage premium

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A referrer responds to incentive $\Rightarrow$ Information distortion

- Why wage premium? How about match quality?

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To what extent information is transmitted?

- Endogenous referral wage premium and match quality
- Payoffs (e.g, wage) is endogenous in the labor market $\rightarrow$ Need a GE

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On-the-job search is essential for understanding referral

- (Data) the effectiveness of referral is different for the employed/unemployed
- (Theory) Endogenous wage dispersion / heterogeneous effect of referral

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Empirical observation motivating the theory

- Referral usage patterns and wage premium

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- Directed search in both formal and referral markets + Match-specific shock
- Formal: a signal / Referral: a signal (exogenous) + a message (endogenous)

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- Conditions under which referral leads to higher wages and match qualities
- Efficiency / Comparative statics on the signal precision

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Quantitative analysis with business cycles

Previous literature

Empirical papers identifying the effects of social connections

- Marmaros & Sacerdote (2002), Cingaro & Rosolia (2012), Kramarz & Skans (2014), Burks et al. (2015), Schmutte (2015), Dustmann et al. (2016) etc.

Theoretical papers study non-strategic information transmission

- Montgomery (1991, 1994), Mortensen & Vishwanath (1994), Calvo-Armengol & Jackson (2004), Galenianos (2013, 2014), Arbex, O'Dea & Wiczer (2018), Chen (2018)

Strategic behavior of referrers

- Field experiment: Bandiera et al. (2009), Beaman & Magruder (2012)
- Empirical approach: Pinkston (2012)

Empirical Motivation

Data

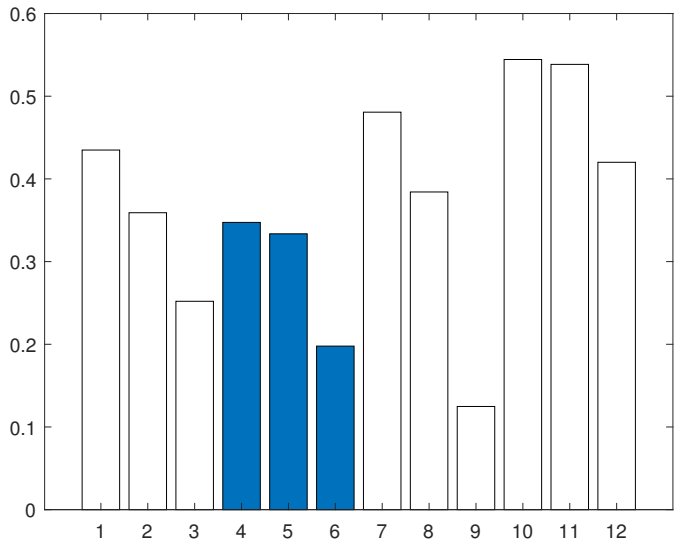
Source: Survey of Consumer Expectations,©2013-2018 Federal Reserve Bank of New York (FRBNY).

- Demographics (age, education, gender), occupation, etc.
- Job search method for the current job / previous job information

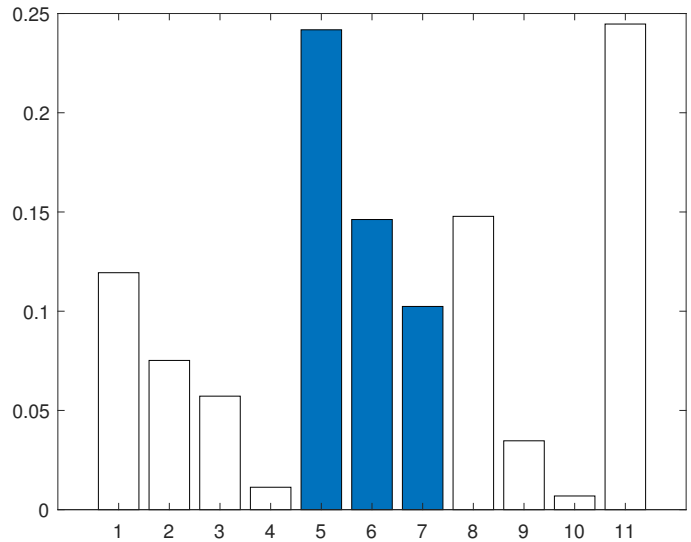
Definition of a referred worker

- Q) "How did you learn about the current job?"
  - Referred by a friend or relative
  - Referred by a former co-worker, supervisor, business associate
  - Referred by a current employee at the company
- Example of other answers
  - Found through the employers website; Found through an employment agency; Found through a school/university/government employment or career center; etc.

Referral and Wage Offer



(a) Job search method



(b) Source of best offer

Figure: Job search method and outcome

- Referral is on average productive

Category(method) Category(Source)

Job Search Methods and Labor Status

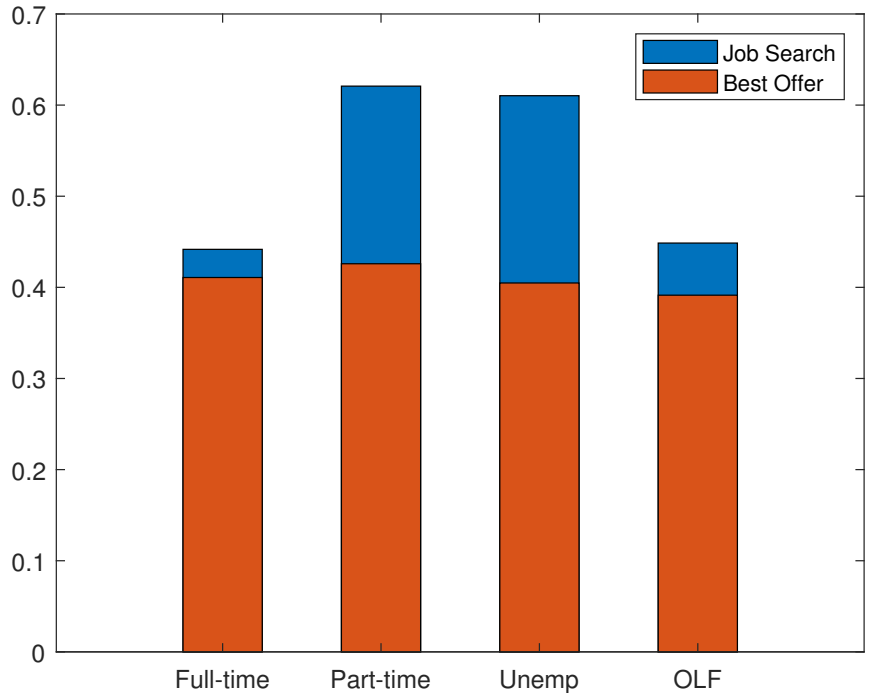


Figure: Referral Usage and Outcome

- Relatively more efficient for the full-time workers

Referral and Wage

	(1)	(2)	(3)	(4)	(5)	(6)
Referral	$.1992^{**}$	$.2331^{**}$	.0575	$.1231^{*}$	$.1271^{\dagger}$	$-.0207$
	(2.43)	(2.64)	(0.32)	(2.05)	(1.85)	(-0.18)
N	362	266	96	630	472	158
Sample	All, $t \leq 1$	EE,$t \leq 1$	UE,$t \leq 1$	All,$t \leq 2$	EE,$t \leq 2$	UE,$t \leq 2$

$p^{\dagger} < .1, p^{*} < .05, p^{**} < .01, p^{***} < .001$

- Controls: age, gender, education, part-time, year, previous wage
- On average, the referred earn higher wage
- Effect exists only for the employed
- Results fit with endogenous information provision

Model

Environment

Continuous and infinite time, discount rate $r > 0$

Workers

- Homogeneous, risk-neutral, home production $b > 0$
- Labor market status, $\omega \in \{u, e\}$
- Social connection, $n \in \{0, 1\}$
- n follows a markov process with $Tr(n'|n, \omega) \equiv \psi_n^\omega$

Worker's Job Search

- All workers search for a job by directly applying (without referral)
  - Rate of search λ_u, λ_e
- A socially connected worker can apply to a referral position at rate λ_f
- A vacancy is either a direct applying position or a referral position
  - Workers can simultaneously search in both markets

Productions

- Productions take place by a pair of one employer and one worker
- Productivity $y + \epsilon\phi$
  - y: Aggregate productivity
  - ϕ: Match-specific productivity, where $\phi \sim F(\cdot)$ with $F(0) = 0, F(1) = 1$
- ϕ is independent across time and matches
- Exogenous separation rate $\delta > 0$

Match Creation

- Submarkets are indexed by (w, n) and the position type
  - w is fixed wage rate and commitment
- $\theta \equiv v/u$: Market tightness
  - $p(\theta)$: Meeting probability for a worker
  - $q(\theta)$: Meeting probability for a vacancy
- Before hiring decision, a signal $s \sim F_s(\cdot|\phi)$ (interview) is realized

$$F_s(x|\phi) = \begin{cases} (1-\tau)F(x), & \text{if} \quad x < \phi \\ (1-\tau)F(x) + \tau, & \text{if} \quad x \geq \phi \end{cases}, \quad \tau \in (0,1) : \text{Precision of signal}$$

  i.e, $s = \phi$ w.p τ, and $s \sim F \perp \phi$ w.p $1-\tau$

- Free entry with flow vacancy cost $k > 0$

Match Creation

- A referred worker brings a message m from a referrer
- The expected productivity before hiring
  - A referred: $E(\phi|s, m)$
  - A non-referred: $E(\phi|s)$
- When hiring through a referral, referral bonus $z > 0$ is paid
  - Fixed cost z for a non-referral position $\rightarrow$ equally costly
  - Focus on the case when $z \rightarrow 0$
- z is constant $\rightarrow$ incentive misalignment
  - Intuition can be generalized to $z(\phi)$ case

Timing of Events

1. A referrer observes ϕ and sends $m \in \mathcal{P}[0,1]$ to an employer before the signal s is realized $\rightarrow \sigma(\phi, w)$

$$\phi \in m \quad \text{(i.e, } m \text{ is truthful)}, \quad m = cl(m)$$

2. The employer observes both m and s, and forms a belief $\mu(\phi|m, s, w)$
3. The employer decides whether to hire: $h(m, s, w) \in \{0, 1\}$

Examples of the m

- Transparent/Uninformative: $m = \{\phi\}$, $\quad m = [0, 1]$
- **Pass/Fail**: $m = [\underline{\phi}, 1]$ if $\phi \geq \underline{\phi}$, $m = \{\phi\}$ if $\phi < \underline{\phi}$

Equilibrium Concept

A sequential equilibrium of the game

1. $\sigma(\phi, w)$ is optimal given μ, h
2. $\mu(\phi|m, s, w)$ is consistent with σ (off-the-path: prob. 1 on $\min m$)
3. $h(m, s, w) = 1$ iff the value of the job is weakly positive under b

A referrer preferred equilibrium (σ^*, μ^*, h^*)

- (Referrer Optimality) For all w, if (σ, μ, h) satisfies 1 - 3,

$$\underbrace{\int_0^1 \int_0^1 h^*(\sigma^*(\phi, w), s, w) dF_s(s|\phi) dF(\phi)}_{\textit{en ante}\text{ hiring probability in submarket } w} \geq \int_0^1 \int_0^1 h(\sigma(\phi, w), s, w) dF_s(s|\phi) dF(\phi)$$

Justification

Value Function

The value of employed

$$\begin{aligned} rV(w,1) &= w + \lambda_f R_\rho(w) + \lambda_e R(w,1) + \delta(U(1) - V) \\ &\quad + \psi_1^e(V(w,1) - V(w,0)) + \Pi \end{aligned}$$

where

$$\begin{aligned} R_\rho(w) &= \max_{w'} \left[p(\theta_\rho(w')) H_\rho(w') (V(w',1) - V(w,1)) \right] \\ H_\rho(w) &= \int_0^1 \int_0^1 h(\sigma(\phi, w), s, w) dF_s(s|\phi) dF(\phi) \end{aligned}$$

For a non-referred worker, the hiring probability is

$$H(w) = \int_0^1 \int_0^1 h(s, w) dF_s(s|\phi) dF(\phi)$$

Market Tightness, Free Entry Condition

The value of a filled-position

$$\begin{aligned} r^*(w,1)J(w,1,\phi) &= y + \epsilon\phi - w + \psi_1 J(w,0,\phi) \\ r^*(w,1) &= r + \delta + \lambda_e p^* H^* + \lambda_f p_\rho^* H_\rho^* \end{aligned}$$

Expected value of a filled-position given s in the formal market

$$r^*(w,1)\underbrace{E(J(w,1,\phi)|s)}_{=J(w,1,E(\phi|s))} = y + \epsilon E(\phi|s) - w + \psi_d E(J(w,0,\phi)|s)$$

where $E(\phi|s) = \tau s + (1-\tau)E(\phi)$

Market tightness function $\theta(w,n)$

$$\begin{aligned} k &\geq q(\theta)\left[\int_0^1 h(s,w)\left(J(w,1,E(\tilde{\phi}|s)) - z\right) dF_s(s|\phi)dF(\phi)\right] \\ &= q(\theta)\left[\int_0^1 \left(J(w,1,E(\tilde{\phi}|s)) - z\right)^+ dF_s(s|\phi)dF(\phi)\right] \end{aligned}$$

Market Tightness, Free Entry Condition

Expected value of a position given s, m: $J(w, 1, E(\phi|m, s, w))$

Example: $m = [m_l, m_h]$ and $\mu|_m \propto F|_m$,

$$\begin{aligned} E(\phi|m, s, w) &= I_{\{s \notin m\}} \cdot \bar{m}(m, w) + I_{\{s \in m\}} \cdot \left(\tau' s + (1 - \tau')\bar{m}(m, w)\right) \\ \tau' &= \frac{\tau}{(F(m_h) - F(m_l))(1 - \tau) + \tau} \\ \bar{m}(m, w) &= \frac{1}{F(m_h) - F(m_l)} \int_{m_l}^{m_h} \phi dF(\phi) \end{aligned}$$

Market tightness function $\theta_\rho(w)$

$$k \geq q(\theta) \left[\int_0^1 \left(J(w, 1, E(\tilde{\phi}|\sigma(\phi, w), s, w)) - z \right)^+ dF_s(s|\phi) dF(\phi) \right]$$

Steady-State Equilibrium

A steady-state equilibrium consists of value functions (V_U, V, J), market tightness (θ, θ_ρ), sequential equilibrium of the referral game (σ, b, h), aggregate variable Π, and aggregate distribution $G_{w,\omega,n}$ such that

- (V_U, V, J) are proper value functions
- (θ, θ_ρ) satisfies the free entry
- (σ, b, h) is the referrer preferred equilibrium
- Π is consistent with $G_{w,\omega,n}$
- $G_{w,\omega,n}$ is a steady-state distribution.

Candidate Equilibrium

For each w, there exists $\phi^*(w)$ such that

$$h(m,s,w)=1 \iff E(\phi|m,s,w) \geq \phi^*(w)$$

A conjecture of the referrer preferred equilibrium

$$\sigma(\phi,w)=\begin{cases}[\underline{\phi},1], & \text{if} \quad \phi \geq \underline{\phi} \\ \{\phi\}, & \text{otherwise}\end{cases}, \quad \text{where} \quad E(\phi|[\underline{\phi},1],\underline{\phi},w)=\phi^*(w)$$

Intuition

- Whenever $\phi \in [\underline{\phi},1]$, $\forall s, h(\underline{\phi},s,w)=1 \rightarrow$ No incentive to deviate
- Better than revealing as $\underline{\phi} < \phi^*$
- As $h([\phi-\epsilon,1],\phi-\epsilon,w)=0$, thus $\phi > \phi^*$ deviates to $\{\phi\}$ if pooling $[\phi-\epsilon,1]$

Referrer Optimal Message

Proposition

The referrer optimal strategy $\sigma(\phi, w)$ is 'pass/fail' strategy. The threshold level $\underline{\phi}(w)$ is increasing in w. $\underline{\phi}(w) \to \phi^*(w)$ as $\tau \to 1$.

The proposition is a corollary of the following

- In any sequential equilibrium,

  : $\phi \geq \phi^*(w)$ is hired, and $\phi < \underline{\phi}(w)$ is not hired

Referrer Optimal Message

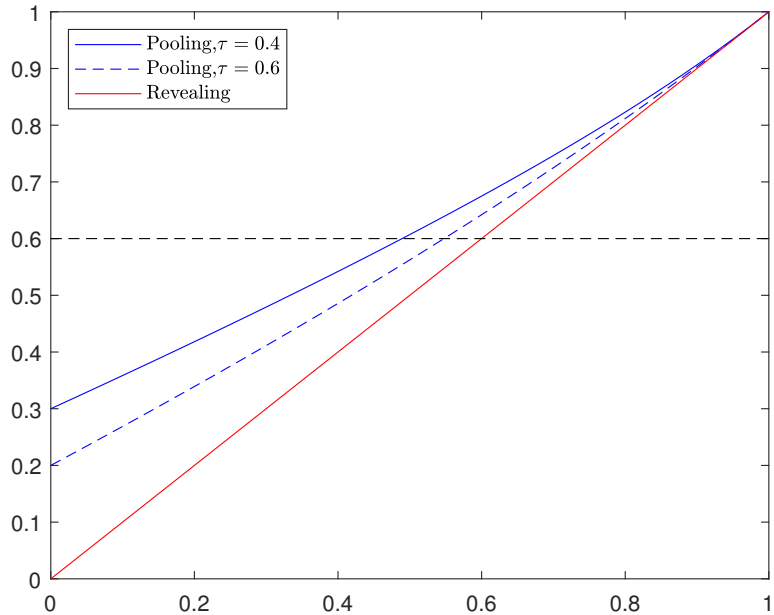


Figure: Expected productivity under pooling and revealing

- Pool: $E(\phi|m = [x, 1], x, w) = \min_s E(\phi|m = [x, 1], s, w)$
- Reveal: x

Discussions

Why not revealing?

- m affects the payoff only through h, not directly through b
- h is bounded by 1, thus no incentive to deviate if $h = 1$ for all s
- If payoff is directly increasing in the posterior belief $\rightarrow$ always incentive to reval high quality

Pooling is robust to any *ex post* incentive provision $z(\phi)$

- It can depend on any *ex post* event, such as job separation

Pooling is the threshold type under mild conditions

- Firms prefer higher ϕ and $z(\phi)$ is non-decreasing

Probability of Hiring

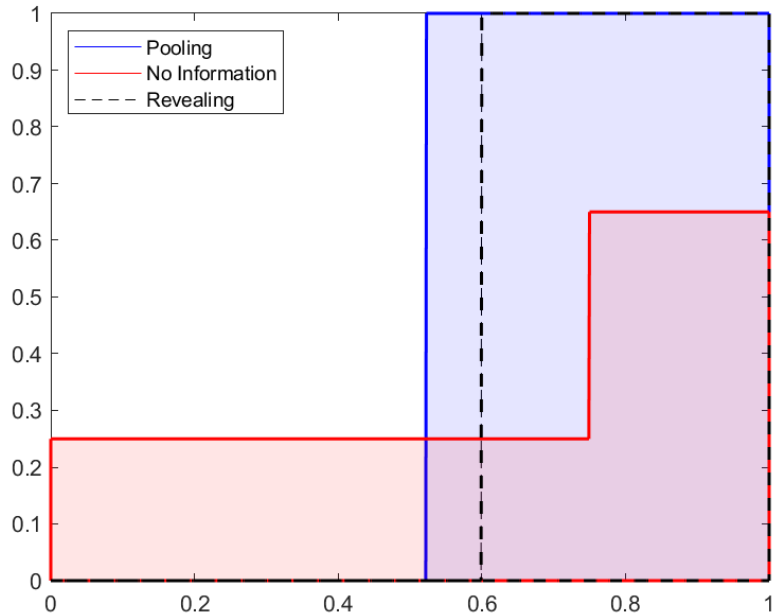


Figure: Hiring probability given ϕ realization

- $s^* = \frac{\phi^* - (1-\tau)E(\phi)}{\tau} > \phi^*$: threshold signal
- Average match quality = integral of hiring probability

Match Creation Probability and Match Quality

Proposition

Whenever $\underline{\phi}(w) > 0$, *conditional on a meeting, the match creation rate is higher in the referral market*

$$1 - F(\underline{\phi}) > 1 - F(s^*)$$

and the ex ante expected value of a job are higher in the referral market

$$(1 - F(\underline{\phi})) \times \left(J(\cdot, \cdot, E(\phi|\phi \geq \underline{\phi})) - z\right) >$$
$$(1 - F(s^*)) \times (J(\cdot, \cdot, \tau E(\phi|\phi \geq s^*) + (1 - \tau)E(\phi)) - z)$$

Under some conditions on F, *the average match quality conditional on a hiring is strictly higher in the referral market.*

Match Quality

When w is above a threshold, as *ex ante* value of a job is higher,

- Market is tighter in the referral market, i.e, $\theta_\rho(w) > \theta(w, 1)$
- Job-finding rate is higher in the referral market

Some notes

- A worker is likely to search a higher wege in the referral market
- The *ex post* match quality becomes higher in the referral market as w increases under any F

Efficiency

Efficient allocation: (θ_e, ϕ_e) that maximizes

$$\max_{\theta,\phi} p(\theta)(1-F(\phi)), \quad \text{s.t} \quad q(\theta)(1-F(\phi))\left(J(w,1,E(\tilde{\phi}|\tilde{\phi}\geq\phi))-z\right)=k$$

- Taking the separation rates p^*, p^*_ρ as given

In general, ϕ_e and $\underline{\phi}$ are different

- ϕ_e depends on the matching function p
- $\underline{\phi}$ depends on τ

Efficiency: A special case $p(\theta) = \theta^{\alpha}$

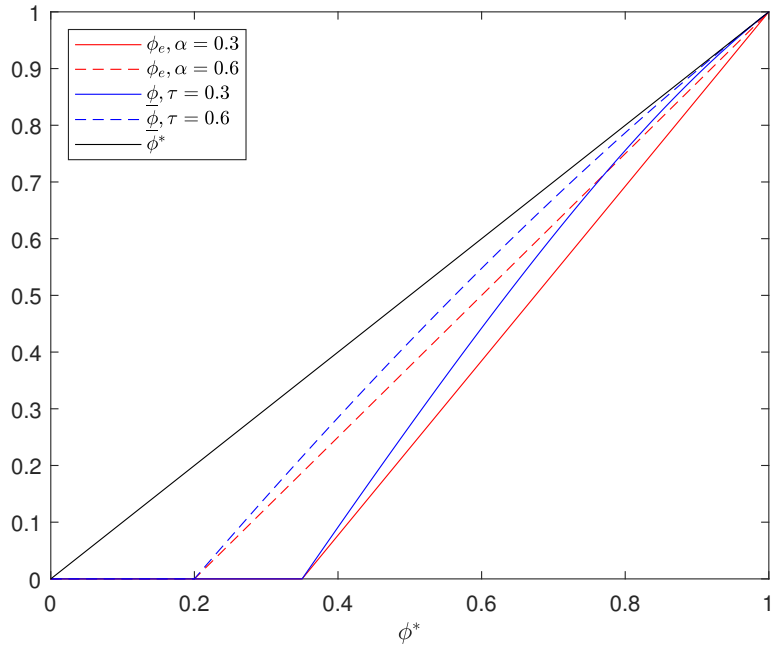


Figure: ϕ_e(Red) and $\underline{\phi}$(Blue) as a function of ϕ^*

- Pooling is more efficient than full-revealing if $\alpha \leq \tau$
  - $\phi_e < \underline{\phi} < \phi^*$ whenever information is non-trivial
- When job-finding rate is (in)elastic to *ex post* profit compared to the precision of the signal, referral provides (more)less information

Block-Recursive Equilibrium

Aggregate distribution appears in the value function only through Π

- The aggregate referral bonus payment $\Pi \propto \int z H_\rho(g_\rho(w)) dG_w(w)$

$\Rightarrow$ The steady-state equilibrium is tractable

The effect becomes negligible as $z \to 0$

- Pooling is the equilibrium for all $z > 0$, and an equilibrium for $z = 0$

I focus on a Block-Recursive Equilibrium where y: stochastic

- How does the job serach method vary across business cycles?
- How about amplification? especially if $Tr(n'|n, e) \neq Tr(n'|n, u)$?

Quantitative Analysis

Functional Forms

Match-specific shock: $\phi \sim Beta(\beta, \beta)$

y follows a three-state markov on $[1-\sigma_y, 1, 1+\sigma_y]$ with transition rate

$$Tr(y'|y) = \begin{bmatrix} \rho^2 & \rho(1-\rho) & (1-\rho)^2 \\ \rho(1-\rho) & \rho^2 + (1-\rho)^2 & \rho(1-\rho) \\ (1-\rho)^2 & \rho(1-\rho) & \rho^2 \end{bmatrix}$$

and arrival rate η

Matching function

$$p(\theta) = (1+\theta^{-\gamma})^{-1/\gamma}, \quad q(\theta) = (1+\theta^{\gamma})^{-1/\gamma}$$

Parameter Setting

Objects	Parameters	Value	Source
Discount rate	r	0.0042	Annual discount 5%
Home production	z	0.5	Standard in literature
Separation rate	δ	0.026	CPS separation rate
Search rate (unemployed)	λ_u	1	Normalization
Arrival rate of y shock	η	1/3	Quarterly shock
Autocorrelation of y	ρ	0.85	GDP autocorr
Size of y shock	σ_y	0.026	GDP stdev
Matching function elasticity	γ	0.2	Menzio and Shi (2010)

Table: Parameters taken from outside

Justification of the referrer preferred equilibrium

Suppose the followings.

- There exists $\epsilon_1 > 0$ cost of sending a non-trivial message $m \neq [0, 1]$
- There exists $\epsilon_2 > 0$ fraction of referrers who commit to use the referrer preferred equilibrium strategy (unobservable)

Then, the referrer preferred equilibrium is the only sequential equilibrium.

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1. Contacted an employer directly online or through e-mail
2. Contacted an employer directly through other means, including in-person
3. Contacted an employment agency or career center, including a career center at a school or university
4. Contacted friends or relatives
5. Contacted former co-workers, supervisors, teachers, business associates
6. Contacted current employees at other companies
7. Applied to a job posting online
8. Applied to a job opening found through other means, including help wanted ads
9. Checked union/professional registers
10. Looked at job postings online
11. Looked at job postings elsewhere, including help wanted ads
12. Posted or updated a resume or other employment information, either online or through other means

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1. Found through the employers website
2. Inquired with the employer directly through other means, including in-person
3. Found through an employment agency or career center
4. A temporary job was converted to permanent job
5. Referred by a friend or relative
6. Referred by a former co-worker, supervisor, business associate
7. Referred by a current employee at the company
8. Found through an online job search engine
9. Found job opening through other means, including help wanted ads
10. Found through union/professional registers
11. Unsolicited contact by potential employer

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