Due Diligence: Endogenous Offer Quality and Information Acquisition in Search and Matching

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Society for Economic Dynamics Meeting, Cartagena — 30 June 2023

Question

1. Modern markets are complex. We study the information frictions inherent in finding a good match in these markets
2. We are interested in how statistics such as:
   - welfare
   - the number of unmatched searchers

   are affected by changes in:
   - searchers' outside options
   - match values

   in equilibrium in the presence of endogenously incomplete information

Contribution

1. We model endogenous information acquisition in an otherwise standard equilibrium search and matching model, which allows for due diligence about match quality
2. We allow for the distribution of offer quality to respond to information acquisition of searchers
3. We use the rational inattention approach to endogenize information acquisition, which admits analytically tractable equilibrium computation
4. We show that endogenous and exogenous information acquisition have different comparative static predictions for key variables (rational attention per se not essential).

Benchmark Models (obviously not exhaustive)

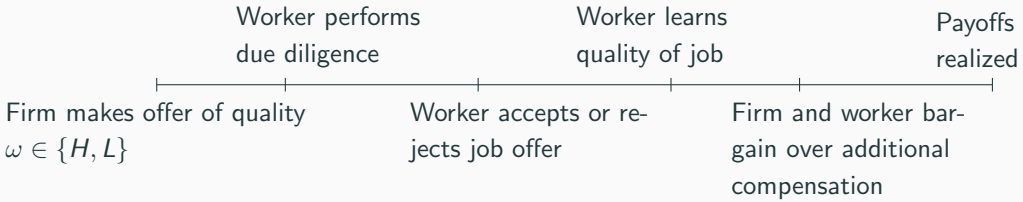
	Decision Problem	**Equilibrium Problem**
Complete Information	McCall (1970)	Diamond (1982), Pissarides (1985), Mortensen and Pissarides (1994)
Exogenous Learning	Burdett and Vishwanath (1988), Conlon et al. (2018)	Jovanovic (1979), Moscarini (2005), Pries and Rogerson (2005)
Endogenous Learning		Acharya and Wee (2020), **This Paper**

The Static Model

Static Model - Outline

- Presentation focuses on static model for exposition, paper has dynamic model
- For concreteness, focus on labor search model with homogeneous workers searching for a job and firms offering jobs of 2 possible qualities
  - Could also think of adverse selection in asset sales as in Guerrieri-Shimer (and Wright) papers
- Compute closed form expressions for unique "interior" equilibrium in which firms post both high and low quality jobs and workers perform due diligence and sometimes accept and sometimes reject job offers
- Perform comparative statics on unemployment benefits and on worker utility from working a low-quality job

Static Model - Timing



- Job quality is a catch-all for anything utility relevant to worker that is costly to firm to offer and that is not negotiated during hiring process
- Quality may capture elements that are hard to know before accepting the job (e.g., quality of coworkers)

Static Model - Payoffs

1. Let the worker's **gross** payoffs be:
   - $W_\omega = u_\omega + w_\omega$ if he accepts an ω-quality job
   - where u_ω is quality component and w_ω is negotiated component
   - $W_\emptyset = b$ if he rejects
   - Assume: $u_H > b > u_L > 0$

2. Let the firm's payoffs be:
   - $J_\omega = \pi_\omega - w_\omega$
   - where π_ω is exogenous component of profits and we assume $\pi_L > \pi_H > 0$

Note:

- If w_L is low enough, worker has incentive to perform due diligence to find a good job and not just accept any job offer that arrives
- Providing high quality jobs is costly, but if w_H is not too high it can still be profitable for firms to offer such jobs

Static Model - Cost of Attention

Degree of worker "confusion" is measured using Shannon entropy.

- With prior μ that job is good, Shannon entropy H is given by:

$$\mathbb{H}(\mu) = -\mu \ln \mu - (1-\mu)\ln(1-\mu)$$

- It is symmetric, concave and single-peaked, with domain $[0, 1]$ and $\mu = 0.5$ representing maximal confusion
- Optimal to choose to receive as many signals as actions, so signal structure involves one signal that recommends accept and one recommending reject
- γ is belief job is high quality after receiving accept signal and ν is belief job is high quality after receiving reject signal
- Let P be probability of "accept" signal. Then expected confusion after due diligence is

$$P\mathbb{H}(\gamma) + (1-P)\mathbb{H}(\nu)$$

Static Model - Optimal Due Diligience

- Choosing amount of due diligence means choosing P, γ, and ν
- Change in confusion from prior to posterior is

$$\mathbb{H}(\mu) - [P\mathbb{H}(\gamma) + (1-P)\mathbb{H}(\nu)]$$

- Cost of reducing confusion is controlled by parameter λ:

$$\lambda S(\gamma, P) = \lambda(\mathbb{H}(\mu) - [P\mathbb{H}(\gamma) + (1-P)\mathbb{H}(\nu)])$$

- Let P_ω be probability of accepting conditional on job type ω
- Note Bayes' rule imposes:

$$\mu = \gamma P + \nu(1-P)$$
$$P = \mu P_H + (1-\mu)P_L$$

Static Model - Bargaining after Accepting

- Nash bargaining (complete information) with threat to dissolve match
- Impose: no unemployment if choose to dissolve match after accepting
- Impose: additional compensation cannot be negative
- Bargaining problem

$$w_\omega \in \arg\max_{w \in \Re_+} \left(W_\omega - \left(W_\emptyset - b\right)\right)^\theta \left(J_\omega\right)^{1-\theta}$$

Static Model - Equilibrium

1. When posting a vacancy, a firm chooses mixing prob of high/low quality jobs:

$$\mu^* \in \arg\max_{\mu} \quad \mu P_H^* J_H + (1-\mu) P_L^* J_L$$

2. Given prior μ, workers choose information strategy and follow signal advice

$$(\gamma^*, P^*) \in \arg\max_{(\gamma,P)} \quad P\left(\gamma W_H + (1-\gamma) W_L\right) + (1-P)\, W_\emptyset - \lambda S(\gamma, P)$$

3. RI Bayesian Nash Equilibrium is $(\gamma^*, P^*) \in [0,1] \times [0,1]$, $\mu^* \in [0,1]$, and $w_H^*, w_L^* \in \Re_+$, where workers prior is consistent with firm behavior ($\mu = \mu^*$), workers and firms optimize, and additional compensation is determined by Nash bargaining

Static Model - Assumptions for Interior Equilibrium

- Want: $\mu^* \in (0,1)$ and $P^* \in (0,1)$
  - Not interested in corner equilibrium with $P^* = 0$
- To simplify algebra, define: $z_\omega = \exp\left(\frac{W_\omega}{\lambda}\right)$ and $z_\emptyset = \exp\left(\frac{W_\emptyset}{\lambda}\right)$
- Assumption 1: $\frac{\pi_L}{\pi_H} < \frac{z_H}{z_L}$
  - Worker benefit from good job high enough relative to benefit to firms to posting bad jobs
- Assumption 2: $u_H > \theta(\pi_H + u_H)$
  - Worker bargaining power low enough

Static Model - Equilibrium Outcomes

- The unique interior RIBNE is

$$\gamma^* = \frac{z_H}{z_\emptyset}\left(\frac{z_\emptyset - z_L}{z_H - z_L}\right)$$

$$P^* = \frac{z_\emptyset(z_H J_H - z_L J_L)}{z_\emptyset\,(z_H J_H - z_L J_L) + z_H z_L (J_L - J_H)}$$

$$\mu^* = \frac{z_H J_H (z_\emptyset - z_L)}{z_\emptyset\,(z_H J_H - z_L J_L) + z_H z_L (J_L - J_H)}$$

$$w_H^* = 0$$

$$w_L^* = \begin{cases} 0 & \text{if} \quad \theta\pi_L \leq (1-\theta)u_L \\ \theta\pi_L - (1-\theta)u_L & \text{if} \quad \theta\pi_L > (1-\theta)u_L \end{cases}$$

Static Model - Analyzing the Equilibrium

- Conditional acceptance probabilities are

$$P_H^* = \frac{z_H - z_L\left(J_L/J_H\right)}{z_H - z_L}$$
$$P_L^* = P_H^*\left(J_H/J_L\right)$$

- For firms to have mixed strategy $\mu^* \in (0,1)$ they must be indifferent between posting high and low quality jobs: $P_H J_H = P_L J_L$
- Key tradeoff for firms: $J_L > J_H$ by Assumption 1, so $P_L < P_H$
- Among continuum of $\{P_L, P_H\}$ that satisfy, $P_H J_H = P_L J_L$, only one firm mixing rate μ^* generates a $\{P_L^*, P_H^*\}$ from worker problem that makes $P_H J_H = P_L J_L$
  - Worker optimal posterior beliefs independent of prior

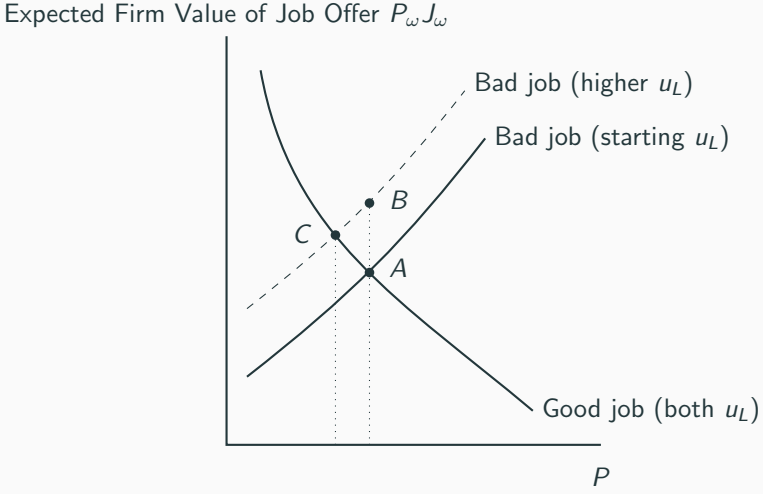
Static Model - Comparative Statics

- Study marginal increase in u_L and b on unemployment and welfare
- Unemployment: $\mathcal{U} = 1 - P$
- Gross Welfare:

$$\begin{aligned}\mathcal{W} &= P(\gamma W_H + (1-\gamma)W_L) + (1-P)W_\emptyset \\ &= \mu P_H W_H + (1-\mu)P_L W_L + (1-P)W_\emptyset\end{aligned}$$

Static Model - Increase in Quality of Bad Jobs

In the unique interior RIBNE, an increase in u_L leads to an increase in $\mathcal{U}$ and a decrease in $\mathcal{W}$

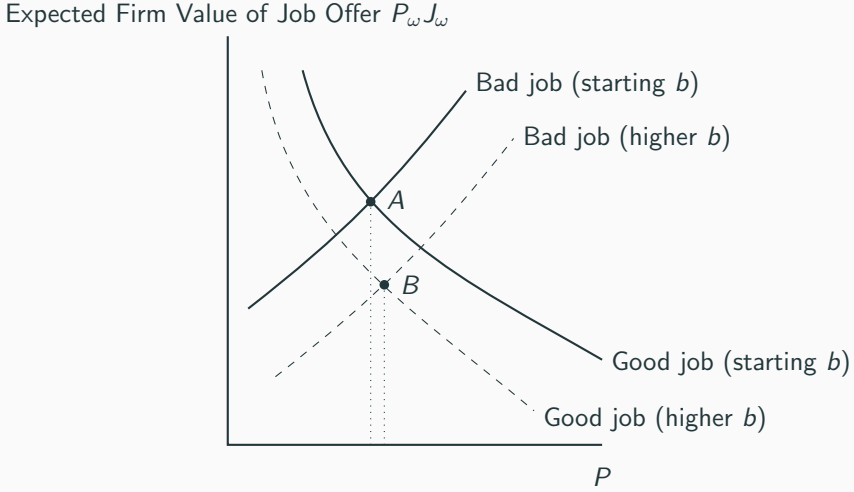


Static Model - Increase in Quality of Bad Jobs

- Searchers become less concerned about accepting a bad offer
- So workers do less due diligence and pay less attention overall
- So firms offer more worse quality jobs in eqm., which lowers the overall acceptance rate
    - So equilibrium interaction of information acquisition and offer quality erodes welfare gain

Static Model - Increase in Unemployment Benefit

In the unique interior RIBNE, an increase in b leads to a decrease in $\mathcal{U}$ and an increase in $\mathcal{W}$



Static Model - Increase in Unemployment Benefit

- Searchers are less concerned about rejecting an offer they are not confident about
- All else equal, would decrease overall acceptance rate
- Assumption 1: workers become more worried about mistakenly accepting low quality offers than mistakenly rejecting high quality offers
- So firms post more high quality offers, which increases the overall acceptance rate
  - So equilibrium response further boosts welfare gain

Static Model - Comparison to Exogenous Learning Models

Think Jovanovic (1979) and Pries-Rogerson (2005)

Outcome	Due Diligence	Fixed Ex-Ante Signal	Fixed Ex-Post Signal
$\mathcal{W}$	$-$	$+$	$+$
$\mathcal{U}$	$+$	*constant*	*constant*

Table 1: The Effects of $\Delta W_L > 0$

Outcome	Due Diligence	Fixed Ex-Ante Signal	Fixed Ex-Post Signal
$\mathcal{W}$	$+$	$+$	$+$
$\mathcal{U}$	$-$	*constant*	*constant*

Table 2: The Effects of $\Delta b > 0$

- Exogenous comparison models don't allow for such a fine adjustment in learning, so no continuous change in searcher behavior (so no change in offer quality on the margin)

Static Model - Normal Learning instead of Rational Inattention

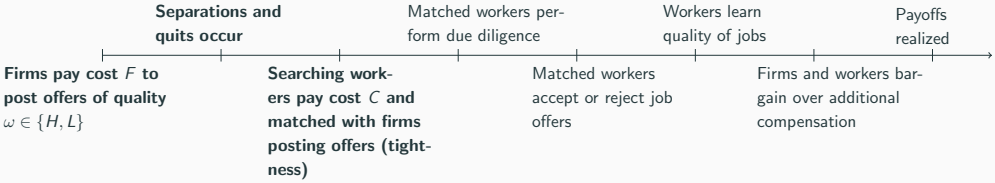
1. Can write the endogenous information acquisition problem so that the worker receives a normal signal and chooses its precision at a cost (details in paper)

2. Comparative statics in normal learning model similar to rational inattention model

3. This implies our results are driven by endogenous information acquisition rather than rational inattention

4. Rational inattention gives clean analytical expressions that elucidate mechanisms

Dynamic Model - Setup



- In equilibrium, workers who mistakenly take bad jobs quit after 1 period and those with good jobs remain until exogenously separated
- Similar logic leads to similar results as in static model
- Still working to see which theorems can be proven vs. demonstrating results via numerical methods

Conclusion

- Incomplete information and endogenous information acquisition are self-evident features of many decentralized markets
- Incorporating endogenous information acquisition has first-order implications on how policy and technology changes effect key behaviors and outcomes in search and matching models (sometimes reversing conventional wisdom)
- Key mechanism is the endogenous response of offer quality to how much searchers scrutinize offers (which itself respond to expected offer quality distribution)
- Endogenous information acquisition and offer quality can easily be added to search and matching models by using the rational inattention framework