Adverse Selection and Unraveling in Common-Value Labor Markets

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April 2011

Introduction

- The junior job market for economists
  - Interviews, fly-outs, and offers
  - Econjobmarket Wiki

- What are the effects of revealing firm's intermediate decisions?
  - Information sharing through revelation
  - Affects intermediate decisions

- Additional labor settings with similar features:
  - MBAs, medical residents, law interns
  - University applicants

Model Outline

- One worker whose value is common to all firms
- Firms are privately informed about the value of the worker
- The worker has a strict, commonly-known ranking over firms

- Firms pay a small cost to acquire their private information
- Firms pay a small cost to demonstrate interest
- Firms make offers

Motivating Example – Two Firms

- Outside option normalized to 0
- Independent signals, uniform on $[-1/2, 1/2]$
- Value of the worker is sum of signals
- Worker prefers firm 1 to firm 2

- If signal is kept private
  - Firm 1 hires above 0
  - Firm 2 hires above $1/4$ (Firm 2 can overcome the adverse selection)

- The same if true is there is a small cost of obtaining the signal

- If signals become known
  - Firm 1 would hire whenever firm 2 wants to hire
  - Firm 2 stays out if there is a small cost of obtaining the signal

- What if a binary indication of the firm's private information is disclosed?
  - Exogenous coarse indication vs.
  - Interviewing decisions
  - The equilibrium with private decisions is no longer an equilibrium

The Model

- n firms (i), one worker
  - (an extension accommodates multiple workers under sufficient separability)

- The worker is characterized by n signals $s_1,\ldots,s_n$ of his quality (one for each firm)
  - Each signal takes one of a finite number of linearly ordered values
  - Signals are weakly affiliated and have full support (each tuple occurs with positive probability)

- The quality of a worker is a strictly increasing function v of each of the signals, and is common to all firms
  - Firms' outside option is normalized to 0
  - (an extension accommodates some heterogeneity)

- The worker has a commonly-known strict ranking over firms
  - Firm 1 is most preferred, then firm 2 etc.

Timing

- Firms simultaneously decide whether to "enter"
  - Entry costs a small $e_i > 0$ and is observable

- Each entering firm privately observes its signal

- Firms simultaneously decide whether to "interview" the worker
  - The interview does not reveal any new information to the interviewing firm, but is necessary for hiring (an extension allows for informative interviews)
  - Interviewing costs a small $c_i > 0$
  - The ratio between any two firms' interview costs is at most some $M > 0$.

- Firms' interviewing decisions either remain private (*no revelation*) or are revealed (*revelation*)

- Firms simultaneously decide to whether to make the worker an offer

- The worker accepts the highest-ranking offer he has

- We consider sequential equilibria (exist because the game is finite)

Benchmark: One Firm and One Worker

- Suppose there is one firm and one worker

- Conditional on entering, the firm will interview and hire the worker if and only if

$$E[v/s_1=s'_1]-c_1\geq0$$

- From now on, assume the inequality holds strictly for some signal s'_1 when $c_1=0$
  - If not, the firm would not enter for any positive entry and interview costs
- Denote the lowest such signal by T_1

- For small entry and interview costs, the firm enters

No Revelation

- Each firm makes an offer whenever it interviews

- Firm 1 acts as if it were alone in the market, since it is able to hire whenever it makes an offer
  - For low entry and interview costs it is a dominant strategy for firm 1 to enter and interview at all signals greater or equal to T_1

- Other firms face adverse selection: they can only hire when all higher-ranking firms do not make an offer

No Revelation

- Proposition 1: For small entry and interview costs there is a unique equilibrium. In this equilibrium every firm employs a threshold interviewing strategy. The equilibrium can be found by iterated deletion of strictly dominated strategies

  – The threshold of every firm $i>1$ is higher than if the firm were alone in the market

pf

Example – No Revelation

- Independent signals, $s_i\sim$ "uniform grid" on $[-1/2,1/2]$

- $v(s_1,\ldots,s_n)=s_1+\ldots+s_n$

- Suppose entry and interview costs are small

- Benchmark: $T_1=0$

- No revelation: $T_i=1/2-1/2^i$

- All firms enter and hire with positive probability

Unexpected Revelation

- Proposition 3: Suppose firms' interviewing decisions are made assuming no revelation. Then, the effects of revelation are:

  – The set of signals which lead to hiring decreases

  – Workers may shift to lower-ranked firms but not to higher-ranked firms

  – All firms are weakly better off

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Revelation

- Each interviewing firm can condition its hiring decision on the other firms' interview decisions (interview schedule)
  - No-revelation strategies are no longer an equilibrium

- Effects of revelation:
  - Creates option value
  - Leads to more severe adverse selection

- All hiring and interview sets are determined simultaneously
  - Cannot use a sequential method as in no revelation

Revelation with n Firms

- With n firms and independent signals, we have to determine up to 2^{n-1} thresholds for each firm

- With affiliated signals, firms may no longer use threshold interviewing strategies
    - Seeing a firm interview is not necessarily good news

- Mixed strategies
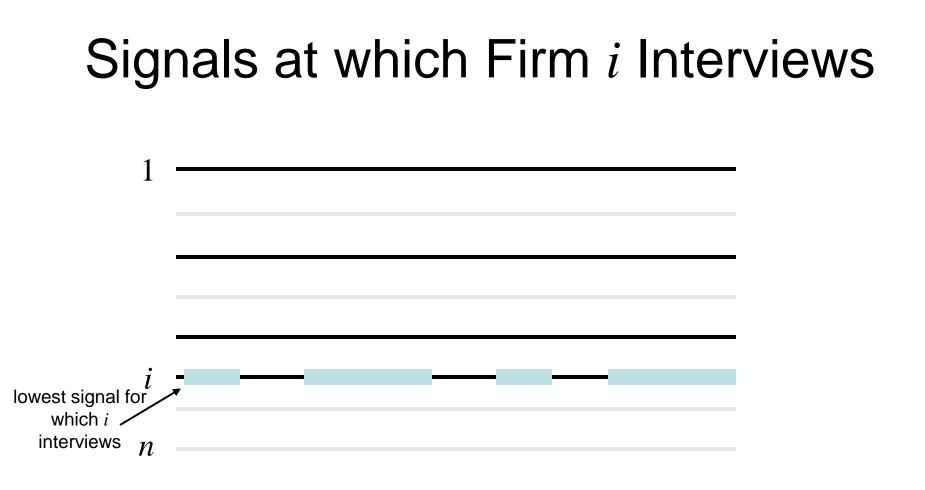
The Main Result

- Theorem 1: For small entry and interview costs, in any equilibrium with revelation only firm 1 enters

  - The outcome is as if firm 1 were the only firm in the market

  - Less information disclosure and usage than with no revelation

  - The result we would expect if every firm's private information was fully disclosed after the interview
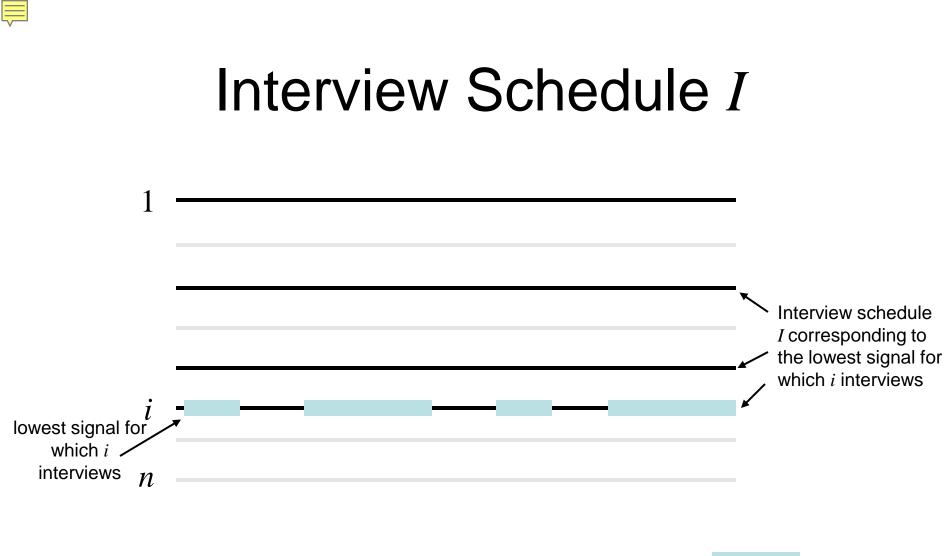
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Proof Idea

- Consider "Lexicographic Costs": interview costs are 0, and a firm interviews if and only if there is a positive probability that it can hire the worker and that conditional on hiring the worker the firm makes positive profits

- Consider pure strategies

- Suppose firm $i>1$ is the lowest-ranking firm that enters, and denote by J the set of entering firms

Entering Firms J

1 ————————————————————

————————————————————

————————————————————

————————————————————

————————————————————

i ————————————————————

————————————————————

n ————————————————————

Signals at which Firm i Interviews

1

i

lowest signal for which i interviews

n

Interview

Interview Schedule I

1

Interview schedule
I corresponding to
the lowest signal for
which i interviews

i

lowest signal for
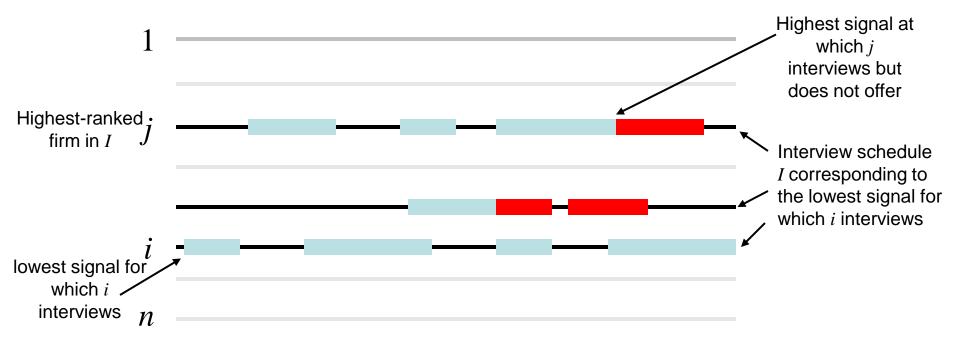which i
interviews

n

Interview

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Interview Schedule I

1

Highest-ranked
firm in I j

Interview schedule
I corresponding to
the lowest signal for
which i interviews

i

lowest signal for
which i
interviews n

Interview

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Offers at Schedule I

1

Highest signal at which j interviews but does not offer

Highest-ranked firm in I j

Interview schedule I corresponding to the lowest signal for which i interviews

i

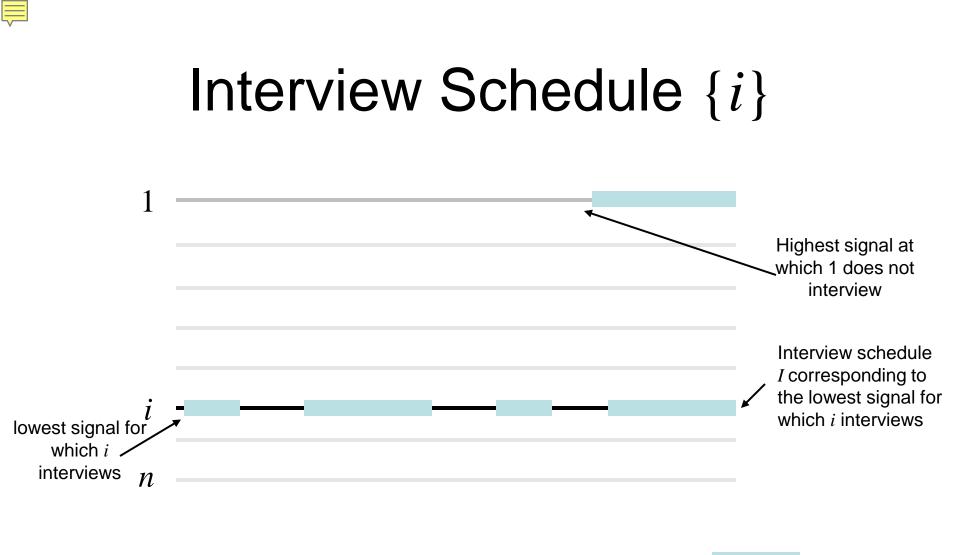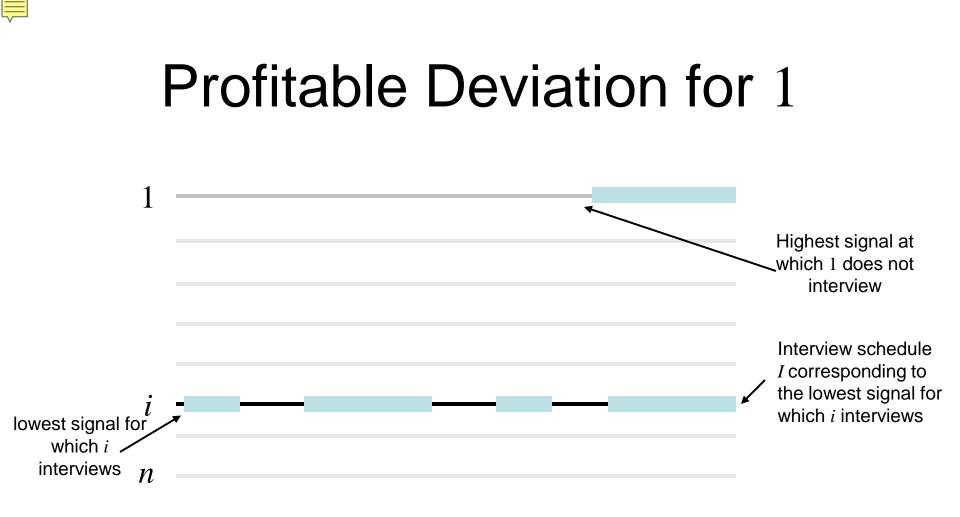lowest signal for which i interviews

n

Interview

Offer at schedule I

Profitable Deviation for Firm j

Highest signal at which j interviews but does not offer

Interview schedule I corresponding to the lowest signal for which i interviews

Highest-ranked firm in I — j

lowest signal for which i interviews

1

i

n

If firm i is willing to offer at the lowest signal for which it interviews, then firm j should deviate and offer at the highest signal for which it interviews but does not offer

Interview

Offer at schedule I

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Interview Schedule $\{i\}$

1

Highest signal at which 1 does not interview

i

lowest signal for which i interviews

n

Interview schedule I corresponding to the lowest signal for which i interviews

Interview

Profitable Deviation for 1

1

Highest signal at which 1 does not interview

Interview schedule I corresponding to the lowest signal for which i interviews

i

lowest signal for which i interviews

n

If firm i is willing to offer at the lowest signal for which it interviews, then firm 1 should deviate, interview at the highest signal for which it does not interview, and offer if i is the only other firm that interviews

Interview

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Complicating Factors

- Costs are not lexicographic
- With positive interview costs, the probability of interview schedules arising and of firms making offers given interview schedules must be taken into account
- Different firms see different probabilities
  - This is why we need the restriction on the ratio of interview costs
- Mixed strategies

Discussion

- With no revelation, it may be that all firms enter (the first example)

- Revealing a firm's interview decision reveals only a coarse measure of a firm's private information

- With revelation, each firm gains valuable information from the interview decisions of all other entering firms

- A worker's quality is not assumed symmetric in firms' signals: the impact of one firm's signal on the worker's quality may be high, while that of another firm is low
  - How informative a firm's signal is may vary across firms
  - When the number of firms is large, it may seem that at least some firms' interview decisions are not very informative
- All firms and workers are weakly worse off compared to no revelation
  - Any hiring firm $2,\ldots,n$ and its hired workers are strictly worse off

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Sequential Interviews

- Firms interview in sequence

- Each firm observes preceding firms' interview decisions

- The ordering is given exogenously

- Theorem 2: For small entry and interview costs, every ordering of firms leads to a unique equilibrium outcome when firms interview in sequence

Proof Idea

- An interviewing firm cannot profitably hire if followed by a higher-ranked entering firm

- An interviewing firm cannot profitably hire if preceded by a higher-ranked interviewing firm

- This pins down behavior conditional on entry (subgame) and leads to the iterative process of identifying the entering firms (backward induction)

Equilibrium Characterization

- Begin with an ordering and the set N
- Choose the subsequence of firms that are ranked higher than all firms that follow
    - (2, 1, 3, 5, 6, 4) gives (1,3,4)
    - (2, 1, 3, 5, 6) gives (1,3,5,6)
- For each firm in the subsequence, suppose the firms interviews at a signal if the expected value is positive conditional on all preceding firms not interviewing
- Remove from N the highest-ranking firm that does not interview for any signal
    - Suppose firm 3 interviews when firm 1 does not interview, but firm 4 does not interview when firms 1 and 3 do not interview
    - $N\setminus\{4\}$
    - Suppose firm 5 interviews when 1 and 3 do not interview, and firm 6 interviews when firms 1,3, and 5 do not interview
- Iterate
- Denote by K the final subsequence
    - (1,3,5,6)
- Firms in $N\setminus K$ do not enter
- Firms in K enter and interview as described above

Implications

- The ordering $(1,\ldots,n)$ leads to the same hiring as the no-revelation setting
  - The subsequence in each stage is the entire set
- Interview expenditures are lower
  - Every interview is followed by successful hiring
- So revelation and the right sequencing improves (slightly) upon no revelation

- The ordering $(n,\ldots,1)$ leads to the same outcome as the revelation setting
  - The subsequence includes only firm 1
  - Only firm 1 enters

Extensions

- Incentives to reveal
  - It is an equilibrium for all to reveal

- Multiple workers
  - If there is enough separability

- Interviews generate additional information
  - All interviewing firms learn the same thing

- Quality is not pure common-value
  - The value of the worker to a firm is higher than to every lower-ranked firm

Conclusion

- Multi-stage hiring process

- No revelation

- Unexpected revelation

- Revelation
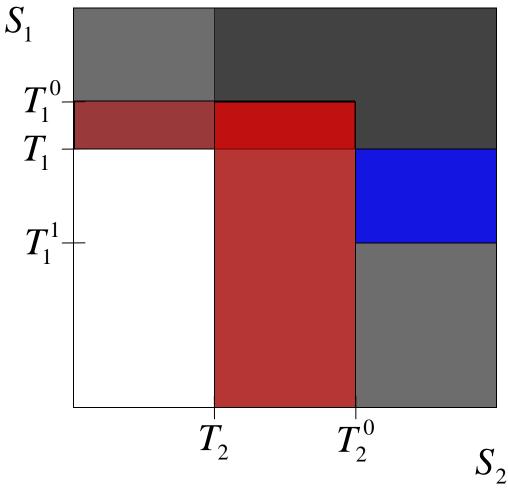
- Sequential interviews

Thank You!

Links

Equilibrium

- A sequential equilibrium exists, because the game is finite
- How is on-path behavior supported?

- Each set of entering firms forms a proper subgame
  - For firm 1 "not enter" is never a profitable deviation
  - No firm can unilaterally deviate to a subgame in which two or more firms other than firm 1 enter

- Consider a subgame in which firm 1 and firm $j \neq 1$ enter
  - The proof shows that firm j makes non-positive profits in this subgame (net of entry costs)
  - Firm j will mix between interviewing and not interviewing at every signal for which it interviews with positive probability

return

Two Firms and Independent Signals

S_1

T_1^0

T_1

T_1^1

T_2 T_2^0

S_2

Two Firms and Independent Signals

- Proposition 2: With two firms, independent signals, and small entry and interview costs the effects of revelation are:
  - The set of signals which lead to hiring decreases
  - The set of signals for which firm 1 interviews increases; that of firm 2 decreases
  - Firm 1 is made better off; firm 2 is made worse off
  - Workers may shift from firm 2 to firm 1, or from either firm to unemployment (but not from firm 1 to firm 2)

Example – Two Firms

- Two firms
- Independent signals, s_i ~ "uniform grid" on $[-\frac{1}{2}, \frac{1}{2}]$
- $v_1(s_1,s_2)=s_1+s_2$
- $v_2(s_1,s_2)=s_1+s_2+\frac{1}{2}$

- Benchmark: $T_1=0$, firm 2 in isolation:$-\frac{1}{2}$
- No revelation: $T_1=0$, $T_2=-\frac{1}{4}$

- Revelation: $T_1^1=-\frac{1}{6}, T_1^0=\frac{1}{3}, T_2^0=-\frac{1}{6}$

Example - Three Firms

- Independent signals, $s_i \sim$ "uniform grid" on $[-\frac{1}{2}, \frac{1}{2}]$
- Firm 3's signal is almost non-informative, so for small γ
- $v_1(s_1,s_2)=s_1+s_2+\gamma s_3$
- $v_2(s_1,s_2)=s_1+s_2+\gamma s_3+\frac{1}{2}$
- $v_3(s_1,s_2,s_3)=s_1+s_2+\gamma s_3+w_3$ for some positive $w_3 > \frac{5}{12}$
- No revelation: $T_1=0$, $T_2=-\frac{1}{4}$
  - Firm 3 can hire with probability $\frac{1}{2} * \frac{1}{4} = \frac{1}{8}$
  - Expected value upon hire is $-5/8+\gamma s_3+w_3$
- Revelation: $T_1^1 = -\frac{1}{6}, T_1^0 = \frac{1}{3}, T_2^0 = -\frac{1}{6}$
  - Firm 3 can hire with probability $\frac{5}{6} * \frac{1}{3} = \frac{5}{18} > \frac{1}{8}$

  - Expected value upon hire is $-\frac{1}{12} - \frac{1}{3} + \gamma s_3 + w_3 = -\frac{5}{12} + \gamma s_3 + w_3$

Proof

- With no revelation each interviewed worker is hired by the highest-ranked firm that interviewed him. So
  - Every worker hired with revelation is hired with no revelation
  - If a worker hired with no revelation by firm i is hired by firm $j \neq i$ with revelation, then j interviewed him; but then $j > i$
- Each firm can hire the same set of workers it hires with no revelation by hiring if and only if it is the highest-ranking firm that interviewed
- Firms may also do better by further conditioning their hiring decision on the other firms' interview decisions

Proof Idea

- Consider the lowest signal T_2 for which

$$\Pr(s_1 < T_1 | s_2 = T_2)E[v / s_1 < T_1, s_2 = T_2]$$

  is strictly positive

- Then the expression is strictly positive for any higher signal

- For small entry and interview costs it is uniquely optimal to enter and interview for all signals greater or equal to T_2