

Collective Search with Private Information

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Consider the choice of hiring a worker, investing in a technology, launching a marketing campaign.

Common features of these dynamic choices:

- quality of alternative today is **uncertain**.
- decisions are partially irrevocable.
- quality of future alternatives is also uncertain.

Firms face **optimal-stopping problems** with uncertainty about the quality of both future and **present** options.

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- a) obtain and aggregate information about the present alternative;
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- Academic hiring that vote on hiring decisions.
- Scientific committees that vote on funding proposals.
- VC boards that vote on investment decisions.

How Google Works

Schmidt and Rosenberg (2014):

“hiring should be peer-based, not hierarchical, with decisions made by committees, and it should be focused on bringing the best possible people into the company....The not-so-nice thing is that hiring well takes a lot of work and time. But it is the best investment you can make.”

(thank you, Google)

motivating question

how to design a search committee, if you must?

features of our setting

- i. Optimal stopping where payoff from stopping is uncertain.
- ii. Players obtain private signals.
- iii. Players share *common-values*; focus on differences in information.
- iv. Search costs borne privately by committee members.
- v. **External Disagreement**: Principal cares more about quality, less about search costs.
- vi. **Internal Disagreement**: committee members differ in search costs.

Outline

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② Example

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④ Conclusion

the firm's problem

Firm has single vacancy, and faces a sequence of applicants.

Once an applicant is hired, the game ends.

Payoff from hiring applicant t to each person in firm is $q_t \in \{1, 2\}$, with equal prob.

Fundamental challenge: **quality is unobservable.**

a hiring committee

Hiring choices are made by a committee of 3 players.

In evaluating applicant t , each member receives a **private signal**:

$$\Pr(s_t^i = h | q_t = 2) = \frac{3}{4} = \Pr(s_t^i = l | q_t = 1).$$

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Committee members simultaneously vote  or .

$|\text{thumbs up}| \geq \bar{k} \Rightarrow \text{Applicant is hired.}$

Otherwise, search continues at cost $\frac{1}{4}$ to each player.

Study voting rules $\bar{k} \in \{0, 1, 2, 3\}$.

benchmark: what if all info were public?

Since the value of continuing is independent of the past, an optimal equilibrium takes the form of a **threshold**:

Vote to hire t iff # of h signals is at least k^* .

k^* is generically unique.

In this example, $k^*(3) = 2$, $k^*(2) = 1$, $k^*(1) = 1$.

private info & no communication

committee members recognize that vote matters only when pivotal.

when are committee members willing to vote *fully informatively*?

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Voting Rule	Piv	$U(\text{Hire} \text{Piv}, h)$	$U(\text{Hire} \text{Piv}, l)$	Continue
Unanimity	hh	1.96	1.75	0.82
Majority	hl	1.75	0.25	1.34
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Unanimity: players tempted to vote to hire with negative signals.

- Symmetric mixed equilibrium: $\Pr(\text{👍} | h) = 1$ and $\Pr(\text{👍} | l) > 0$.
- Asymmetric pure equilibrium: 1 votes fully informatively.
 $\Pr(\text{👍} | s) = \Pr(\text{👍} | s) = 1$ for players 2 and 3.

Fact

Informative voting is an eqm for voting rule $\bar{k}$ iff $\bar{k} = k^(n)$.*

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Notes:

- Characterizes when informative voting is compatible with incentives.
- Voting rule + eqm attains **full-information equivalence**: on every sample path, same decisions are made as if all signals were public.
- No communication is needed in this case.
- If informative voting $\neq$ eqm, then there exists symmetric mixed and asymmetric equilibria.

Intuition: assuming others are voting informatively, a pivotal voter is isomorphic to the “social planner” who observes all n signals.

external disagreement

Principal's preferences may differ from search committee:

- He is utilitarian & weigh everyone's benefits from good hires.
- His incentives are linked to the quality of his hires.

Suppose Principal cares *only* about quality: if he could observe signals, his ideal threshold is unanimity.

What committee and voting rule should he choose?

collusion

His answer hinges on the following question:

“What do committee members do after committee design?”

collusion

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Overt collusion: committee members communicate to each other about each applicant.

Tacit collusion: committee engages in *pre-play* communication to coordinate on committee-preferred equilibrium.

No collusion: committee follows Principal-recommended equilibrium.

overt collusion

Committee members communicate about each applicant.

For every voting rule,

1. Committee members truthfully communicate to each other.
2. Vote to hire iff # of h signals is at least $k^*(n)$.

The voting rule that Principal sets is irrelevant.

Only variable for Principal: committee size.

Choose n assuming threshold for hire is $k^(n)$.*

tacit collusion

Committee selects its favorite equilibrium.

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For every committee size and voting rule, the committee-preferred equilibrium is in pure strategies, history-independent, and is generically unique.

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In the committee-preferred equilibrium:

- A subset of players m vote fully informatively.
- The remaining vote uninformatively altogether.

The equilibrium outcome is therefore equivalent to an election with m players and $\bar{k} = k^*(m)$.

principal's response to tacit collusion

For every voting rule, outcome is equivalent to that of committee-optimal voting rule with a sub-group.

Principal's solution:

Choose n assuming threshold for hire is $k^(n)$.*

Notes:

- Identical to Principal's payoff / solution from overt collusion.
- Communication is irrelevant if committee selects its preferred eqm.

no collusion

Suppose Principal can recommend equilibrium.

In this example, the Principal can do no better.

More generally, Principal may prefer SME with a higher voting rule.

- May raises quality of hires and duration of search.
- Optimal voting rule is between committee-optimal and the threshold rule that the Principal would use.

communication vs. delegation

Results assume that Principal commits to election / delegates choice to search committee.

Instead Principal may solicit recommendations, and retain his choice.

⇒ in any *monotone* eqm, Principal (effectively) applies a unanimity rule.

⇒ committee members distort recommendations, noting pivotality.

Fact

Committing to rubber-stamp the decisions of the search committee is better than having the ability to overrule the search committee.

While *pandering to persuade* has been described in prior work, we offer a variant that arises purely from pivot considerations.

internal disagreement

Shift focus from Principal-Agents conflict to internal conflict.

Consider subsidizing player 1's search cost to 0, without changing those of the other players.

Public info $\Rightarrow$ raises quality of hires and search duration.

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Private info:

- Informative Voting $\Rightarrow$ expected quality of hires in future is 1.84.
- $U(\text{Hire}|\text{Piv}, h) = 1.75$.
- Player 1 no longer wishes to vote informatively, and prefers to reject all applicants.

Equilibrium with Internal Disagreement

In equilibrium,

- Player 1 rejects all applicants and Player 2 accepts all applicants.
- Player 3 votes informatively.

Subsidy lowers search duration and quality of hires.

Fact

Committees with lower search costs may make worse search decisions. A homogeneous committee achieves a strictly higher equilibrium average payoff and makes better search decisions than a diverse committee with the same average cost and size.

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Model

More general framework features $q \in [0, 1]$.

Payoff from hiring is $v(q)$.

Information is l or h : $\Pr(h|q) = q$.

We study both voting rules, and optimal mechanisms without transfers.

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Many organizations feature a collective search process.

We study when collective search processes aggregate information, and how conflicts over the process of search impede information aggregation.

Our results clarify the role of collusion in committee design.

Moreover, results offer cautionary lessons on:

- Retaining flexibility rather than committing to rubber-stamp.
- Subsidizing search costs for some but not all players.