Knowing your Lemon before You Dump it

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IAST

Motivation

- Many situations where decision to "engage" carries info about what's at stake
  - trade
  - partnerships
  - entry
  - marriage
  - ...
- Negative inferences
  - lemons problem (e.g, Akerlof)
- Positive inferences
  - anti-lemons problems (e.g, Spence)

Motivation

- Typical assumption:
  - Exogenous information
- Many problems of interest: **Endogenous information**
  - acquisition
  - attention
  - cognition
- Example: Info asset owner collects depends on mkt price

This Paper

- Generalized lemons (and anti-lemons)
  - **endogenous information**
- Expectation conformity (EC)
  - benefit of acquiring more info higher when expected to acquire more info
- Two forces shaping EC
  - effect of information on severity of adverse selection
  - effect of friendliness of opponent's reaction on value of information
- Expectation traps
- Policy implications
- Flexible info

Literature

- **Endogenous info in lemons problem**
  - Dang (2008), Thereze (2024), Lichtig and Weksler (2023)

    $\rightarrow$ EC, $\neq$ bargaining game, timing, CS
- **Payoffs in lemons problem**
  - Levin (2001), Bar-Isaac et al. (2018), Kartik and Zhong (2024)...

    $\rightarrow$ incentives analysis
- **Policy in mkts with adverse selection**
  - Philippon and Skreta (2012), Tirole (2012), Dang et al (2017)...

    $\rightarrow$ implication of endogeneity of information
- **Private-value bargaining with endogenous info**
  - Ravid (2020), Ravid, Roesler, and Szentes (2021)...

    $\rightarrow$ interdependent payoffs, competitive mkt

Plan

1. Introduction
2. Model
3. Expectation Conformity and Expectation Traps
4. Policy Interventions
5. Flexible Information
6. Equilibrium in Akerlof Model with Entropy Cost
7. Conclusions

Model

Model

- **Players**
  - Leader
  - Follower
- **Choices**
  - Leader:
    - information structure, ρ (more below)
    - two actions:

      - **adverse-selection-sensitive**, $a = 1$ ("engage")

      - adverse-selection insensitive, $a = 0$ ("not engage")
  - Follower:
    - reaction, $r \in \mathbb{R}$ (e.g., price offer)

Model

- **State**
  - $\omega \sim$ prior G
  - mean: ω_0

- **Payoffs**
  - leader: $\delta_L(r, \omega) \equiv u_L(1, r, \omega) - u_L(0, \omega)$

    - affine in ω

    - increasing in r (higher r: friendlier reaction)

    - decreasing in ω

    - benefit of friendlier reaction (weakly) increasing in state: $\frac{\partial^2 \delta_L}{\partial \omega \partial r} \geq 0$

    (benefit of higher r largest in states in which L's value of engagement lowest)

  - follower: $\delta_F(r, \omega) \equiv u_F(1, r, \omega) - u_F(0, \omega)$

    - affine in ω

Akerlof Example

- Leader: seller
  - $u_L(1, r, \omega) = r$ (price)
  - $u_L(0, r, \omega) = \omega$ (asset value)
  - $\delta_L(r, \omega) = r - \omega$

- Follower: competitive buyer
  - $u_F(0, \omega) = 0$
  - $u_F(1, r, \omega) = \omega + \Delta - r$
  - $\delta_F(r, \omega) = u_F(1, r, \omega)$

Model

- **Information structures:** $\rho \in \mathbb{R}_+$
  - cdf $G(m; \rho)$ over posterior mean m (mean-preserving-contraction of G)
  - $C(\rho)$: information-acquisition cost

MPS

Definition

Information structures consistent with **MPS order** (mean-preserving spreads) if, for any $\rho' > \rho$, any $m^* \in \mathbb{R}$,

$$\int_{-\infty}^{m^*} G(m;\rho')dm \geq \int_{-\infty}^{m^*} G(m;\rho)dm$$

with $\int_{-\infty}^{+\infty} G(m;\rho')dm = \int_{-\infty}^{+\infty} G(m;\rho)dm$

- MPS order and Blackwell informativeness:
  - $G(\cdot;\rho)$ obtained from experiment $q_\rho : \Omega \to \Delta(Z)$
  - $G(\cdot;\rho')$ obtained from experiment $q_{\rho'} : \Omega \to \Delta(Z)$
  - If $\rho' > \rho$ means $q_{\rho'}$ Blackwell more informative than q_ρ, then

$$G(\cdot;\rho') \succeq_{MPS} G(\cdot;\rho)$$

(Rotations)

Model

- For any (ρ, r), **leader engages** (i.e., $a = 1$) iff

$$m \leq m^*(r)$$

with

$$\delta_L(r,\, m^*(r)) = 0$$

- Truncated mean:

$$M^-(m^*;\, \rho) \equiv \mathbb{E}_{G(\cdot;\,\rho)}[m | m \leq m^*]$$

- $r(\rho)$: eq. reaction when info is ρ (assumed unique)
- **Assumption (lemons):**

$$\frac{dr(\rho)}{d\rho} \overset{\text{sgn}}{=} \frac{\partial}{\partial \rho} M^- \left(m^*(r(\rho));\, \rho\right)$$

- Anti-lemons:

$$\frac{dr(\rho)}{d\rho} \overset{\text{sgn}}{=} -\frac{\partial}{\partial \rho} M^- \left(m^*(r(\rho));\, \rho\right)$$

Akerlof Example

- Engagement threshold: $m^*(r) = r$
- Equilibrium price $r(\rho)$: solution to

$$r = M^-(r; \rho) + \Delta$$

- Lemons:

$$\frac{dr(\rho)}{d\rho} \overset{\text{sgn}}{=} \frac{\partial}{\partial \rho} M^-(r(\rho);\, \rho)$$

  - always if $g(m; \rho)/G(m; \rho)$ decreases in m (**Monotone Hazard Rate**)

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Expectation Conformity and Expectation Traps

Effect of information on adverse selection

- Truncated mean

$$M^{-}(m^{*};\rho) \equiv \frac{\int_{-\infty}^{m^{*}} m dG(m;\rho)}{G(m^{*};\rho)}$$

Definition

Information

- **aggravates adverse selection** if $\frac{\partial}{\partial \rho} M^{-}(m^{*};\,\rho) < 0$
- alleviates adverse selection if $\frac{\partial}{\partial \rho} M^{-}(m^{*};\,\rho) > 0$

Effect of information on adverse selection

- Let

$$G_\rho(m;\rho) \equiv \frac{\partial}{\partial \rho} G(m;\rho)$$

- **Effect of info on AS**:

$$\frac{\partial}{\partial \rho} M^-(m^*;\,\rho) \overset{\text{sgn}}{=} A(m^*;\rho)$$

where

$$A(m^*;\rho) \equiv \left[m^* - M^-(m^*;\,\rho)\right] G_\rho(m^*;\rho) - \int_{-\infty}^{m^*} G_\rho(m;\rho)dm$$

- Two channels through which info affects AS:
  - prob. of trade: $G_\rho(m^*;\rho)$
  - dispersion of posterior mean: $\int_{-\infty}^{m^*} G_\rho(m;\rho)dm$
- **Adverse Selection Effect**: $\mathrm{A}(\rho) \equiv A(m^*(r(\rho));\rho)$

Effect of unfriendlier reactions on value of information

- L's payoff under information ρ and reaction r:

$$\begin{aligned} \Pi(\rho; r) &\equiv \sup_{a(\cdot)} \left\{ \int_{-\infty}^{+\infty} a(m)\, \delta_L(r, m) dG(m; \rho) \right\} \\ &= G(m^*(r); \rho) \delta_L(r, M^-(m^*(r);\ \rho)) \end{aligned}$$

- **Benefit of friendlier reaction** effect
  - ρ: actual choice (by L)
  - $\rho^\dagger$: anticipated choice (by F)

$$B(\rho; \rho^\dagger) \equiv -\frac{\partial^2}{\partial \rho \partial r} \Pi(\rho; r(\rho^\dagger))$$

- Starting from $r(\rho^\dagger)$, reduction in r
  - raises value of info at ρ if $B(\rho; \rho^\dagger) > 0$
  - lowers value of info at ρ if $B(\rho; \rho^\dagger) < 0$

Effect of unfriendlier reactions on value of information

- **Benefit of friendlier reaction**:

$$B(\rho;\rho^{\dagger}) = -\frac{\partial \delta_L(r,m^*(r(\rho^{\dagger})))}{\partial r} G_{\rho}\Big(m^*(r(\rho^{\dagger});\rho\Big) + \int_{-\infty}^{m^*(r(\rho^{\dagger}))} \frac{\partial^2 \delta_L(r(\rho^{\dagger}),m)}{\partial r \partial m} G_{\rho}(m;\rho) dm$$

- Two channels through which, starting from $r(\rho^{\dagger})$, reduction in r affects value of info at ρ:
  - prob. of trade: $G_{\rho}\Big(m^*(r(\rho^{\dagger});\rho\Big)$
  - dispersion of posterior mean: $\int_{-\infty}^{m^*(r(\rho^{\dagger}))} \frac{\partial^2 \delta_L(r(\rho^{\dagger}),m)}{\partial r \partial m} G_{\rho}(m;\rho) dm$

Expectation Conformity

Definition

Expectation conformity holds at $(\rho, \rho^{\dagger})$ iff

$$\frac{\partial^2 \Pi(\rho; r(\rho^{\dagger}))}{\partial \rho \partial \rho^{\dagger}} > 0$$

- Complementarity between anticipated and actual investment in info

Key forces...

- $\mathrm{A}(\rho^\dagger) \overset{\text{sgn}}{=} \frac{\partial}{\partial \rho} M^-(m^*(r(\rho^\dagger)); \rho^\dagger)$: **adverse-selection effect**

- $B(\rho; \rho^\dagger) = -\dfrac{\partial^2 \Pi(\rho; r(\rho^\dagger))}{\partial \rho \partial r}$: **benefit-of-friendlier-reactions effect**

Expectation Conformity

Proposition

Assume MPS.

- *EC at* $(\rho, \rho^\dagger)$ *iff* $\mathrm{A}(\rho^\dagger)B(\rho;\rho^\dagger) < 0$.
- *Info aggravates AS at* $\rho^\dagger$ *(i.e.,* $\mathrm{A}(\rho^\dagger) < 0$*) for Uniform, Pareto, Exponential, or when it reduces prob of trade perceived by F, i.e.,* $G_\rho(m^*(r(\rho^\dagger);\rho^\dagger) < 0$.
- *Starting from* $r(\rho^\dagger)$*, reduction in r raises value for info at r (i.e.,* $\mathrm{B}(\rho;\rho^\dagger) > 0$*) if more info reduces prob of trade perceived by L, i.e.,* $G_\rho(m^*(r(\rho^\dagger);\rho) < 0$.
- *Therefore EC at* $(\rho, \rho^\dagger)$ *if, no matter whose perspective one takes, more info reduces prob of trade:*

$$\max\left\{G_\rho(m^*(r(\rho^\dagger));\rho^\dagger), G_\rho(m^*(r(\rho^\dagger));\rho)\right\} < 0$$

- *Suppose* $M^-(m^*;\rho)$ *decreases in* ρ *(Uniform, Pareto, Exponential) and* $\partial^2\delta_L(r,m)/\partial r\partial m = 0$ *(e.g., Akerlof). Then,* $G_\rho(m^*(r(\rho^\dagger);\rho) < 0$ *NSC for EC at* $(\rho, \rho^\dagger)$.

EC under non-directed search in Akerlof model

- Akerlof model under non-directed search (ρ=prob. seller learns state)

$$G(m;\rho) = \begin{cases} \rho G(m) & \text{for } m < \omega_0 \\ \rho G(m) + 1 - \rho & \text{for } m \geq \omega_0 \end{cases}$$

Corollary

EC holds holds at $(\rho, \rho^\dagger)$ iff $r(\rho^\dagger) > \omega_0$, i.e., iff gains from trade Δ large.

EC under non-directed search in Akerlof model

- Large Δ : $r(\rho^\dagger) > \omega_0$
- Increase in info $\rho^\dagger$ (anticipated by F)

  $\rightarrow$ seller **engages more selectively**
  (when uninformed: always; when informed: iff $\omega \leq r(\rho^\dagger)$)

  $\rightarrow$ lower prob. of trade perceived by F: $G_\rho(r(\rho^\dagger); \rho^\dagger) < 0$

  $\rightarrow$ aggravation of AS: $\mathrm{A}(\rho^\dagger) < 0$

  $\rightarrow$ **lower price**

  $\rightarrow$ higher cost for S of parting with valuable item

  $\rightarrow$ higher value in learning state at ρ: $B(\rho; \rho^\dagger) > 0$

- Hence, $\mathrm{A}(\rho^\dagger)B(\rho; \rho^\dagger) < 0$

  $\rightarrow$ **Expectation conformity!**

EC under non-directed search in Akerlof model

- Small Δ: $r(\rho^\dagger) < \omega_0$
- S engages only when **informed** and $\omega < r(\rho^\dagger)$
- Variations in info anticipated by $F \rightarrow$ no effect on truncated mean

$$M^-(r(\rho^\dagger);\rho) \equiv \frac{\int_{-\infty}^{r(\rho^\dagger)} m dG(m;\rho)}{G(r(\rho^\dagger);\rho)} = \frac{\int_{-\infty}^{r(\rho^\dagger)} \omega dG(\omega)}{G(r(\rho^\dagger))}$$

  invariant in ρ

- **Adverse selection effect:** $\mathrm{A}(\rho^\dagger) = 0$
- **No expectation conformity**

(Gains from Engagement)

Expectation Traps

Proposition

Suppose ρ_1 *and* $\rho_2 > \rho_1$ *are eq. levels and info aggravates AS (i.e.,* $\mathrm{A}(\rho) < 0$ *for all* $\rho \in [\rho_1, \rho_2]$*). Then L better off in low info-intensity eq.* ρ_1*. Converse true when info alleviates AS, i.e.,* $\mathrm{A}(\rho) > 0$*.*

(Example: Akerlof-non-directed-search)

(Disclosure)

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Policy Interventions

Subsidies to Trade

- Welfare (competitive F):

$$W \equiv \int_{-\infty}^{m^*} (\delta_L(r, m) + s)\, dG(m; \rho) - C(\rho) - (1 + \lambda) s G(m^*; \rho)$$

  where

  - s: subsidy to trade
  - λ: **cost of public funds** (DWL of taxation)

- Subsidy impacts:
  - friendliness of F's reaction: r
  - engagement threshold: $m^* = r + s$
  - information: ρ

Subsidies: Akerlof

- **Eq. with subsidy** s: $(r^*(s), \rho^*(s))$
- Engagement threshold: $m^*(s) = r^*(s) + s$
- Optimality of subsidizing/taxing trade?

Proposition

Subsidizing trade optimal when

$$\frac{\partial}{\partial m^*} M^-(r^*(0); \rho^*(0)) + \frac{\partial}{\partial \rho} M^-(r^*(0); \rho^*(0)) \frac{d\rho^*(0)}{ds} > \lambda.$$

Taxing trade optimal when inequality reversed.

Subsidies: Akerlof

- Subsidies optimal when
  1. Small cost λ of public funds
  2. Information aggravates AS ($\mathrm{A}(\rho) < 0$)
  3. CS of eq. same as BR: Subsidies disincentivize info acquisition

Subsidies: Double Dividend

- Optimal subsidy w. endogenous info: s^*
- Eq. with optimal subsidy: $(\rho^*(s^*), r^*(s^*))$
- Optimal subsidy under exogenous info $\rho = \rho^*(s^*)$: s^{**}
- Question: $s^{**} >? < s^*$

Proposition

Assume that, when $\rho = \rho^*(s^*)$, distribution of posterior mean has MHR:

$$\frac{g(m;\rho)}{G^*(m;\rho)} \qquad \text{decreasing in } m.$$

Further assume info reduces prob of trade and hence aggravates AS: when $m^* = r^*(s^*) + s^*$ and $\rho = \rho^*(s^*)$,

$$G_\rho(m^*;\rho) < 0.$$

Then larger subsidy with endogenous info:

$$s^{**} < s^*.$$

Subsidies: Double Dividend

- Same conditions as for EC:
  - **larger** subsidy **when info reduces prob. of trade**
- **Double dividend** of subsidy
  - more engagement ($\Rightarrow$ less AS $\Rightarrow$ higher r $\Rightarrow$ more trade)
  - less info acquisition ($\Rightarrow$ less AS $\Rightarrow$ higher r $\Rightarrow$ more trade)
- Implication for Gov. asset buyback programs: **more generous terms**
  - **Gov should offer to purchase assets at higher price!**

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Flexible Information

Flexible Information

- Purpose of extension:
    1. Robustness
    2. Alternative order over investments when experiments not rankable
    3. Eq. analysis
        1. expectation traps
        2. **(novel form of) mkt breakdown**

Flexible Information

- **Entropy**:
  - ρ parametrizes MC of entropy reduction
  - L invests in ability to process info (larger investment $\rightarrow$lower ρ)
  - then chooses experiment $q : \Omega \rightarrow \Delta(Z)$ at cost

$$C(\rho) + \frac{1}{\rho} I^q$$

    where I^q is mutual information between z and ω

- **Max-slope**:
  - ρ: max slope of stochastic choice rule $\sigma : \Omega \rightarrow [0, 1]$ with

$$\sigma(\omega) = \Pr(a = 1|\omega)$$

  - L chooses ρ at cost $C(\rho)$
  - then selects experiment $q : \Omega \rightarrow \Delta(Z)$ and engagement strategy $a : Z \rightarrow [0, 1]$ among those inducing stochastic choice rule with slope less than ρ

- Key insights similar to those under MPS order

(Prop-FI)

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Equilibrium in Akerlof Model with Entropy Cost

Seller's problem

- Fix ρ (can be endogenized)
- Without loss: binary experiments/recommendations, $q(1|\omega) = \Pr(a = 1|\omega)$
- L's problem

$$\sup_{q(1|\cdot):\Omega\to[0,1]} \int (r - \omega) q(1|\omega) dG(\omega) - \frac{I^q}{\rho}$$

where

$$I^q = \int \phi(q(1|\omega)) dG(\omega) - \phi(q(1))$$

is **entropy reduction**, with

$$\phi(q) \equiv q \ln(q) + (1 - q) \ln(1 - q)$$

- $q(1) \equiv \int q(1|\omega) dG(\omega)$ is total prob of engagement

Optimal Signal

- When interior, $q(1|\cdot)$ solves **functional equation**:

$$r - \omega = \frac{1}{\rho}\left[\ln\left(\frac{q(1|\omega)}{1-q(1|\omega)}\right) - \ln\left(\frac{q(1)}{1-q(1)}\right)\right]$$

  with $q(1) \equiv \int q(1|\omega)dG(\omega)$

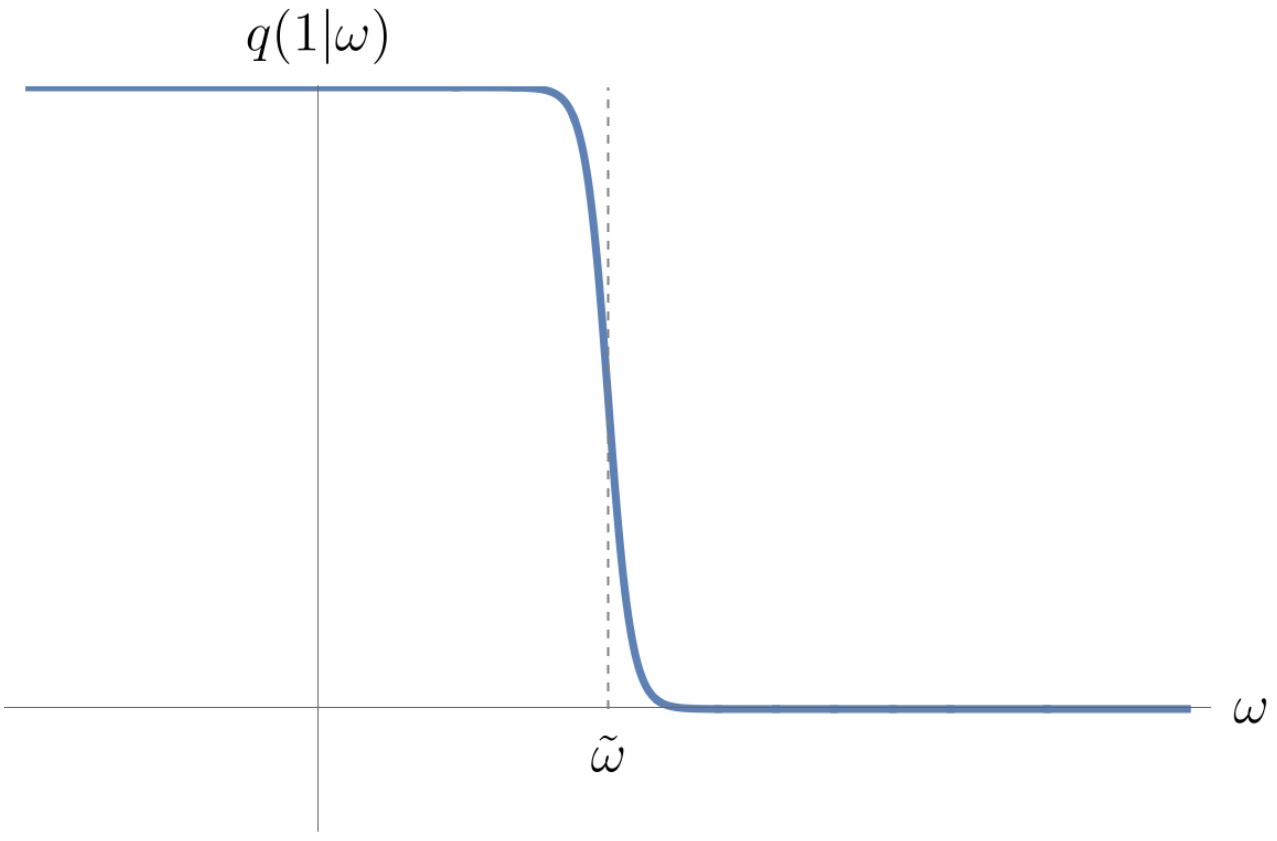
- Let $\tilde{\omega} \in \mathbb{R}$ solve the **(non-functional) equation**

$$\tilde{\omega} = r + \frac{1}{\rho}\ln\left(\frac{\int \frac{1}{1+\exp(\rho(\omega-\tilde{\omega}))}dG(\omega)}{1-\int \frac{1}{1+\exp(\rho(\omega-\tilde{\omega}))}dG(\omega)}\right)$$

- There exists $\underline{r}(\rho), \overline{r}(\rho)$ s.t. seller's **optimal signal**

$$q(1|\omega) = \begin{cases} 0 \quad \forall\omega \quad \text{if } r \leq \underline{r}(\rho) \\ \frac{1}{1+\exp(\rho(\omega-\tilde{\omega}))} \quad \text{if } r \in (\underline{r}(\rho), \overline{r}(\rho)) \\ 1 \quad \forall\omega \quad \text{if } r \geq \overline{r}(\rho) \end{cases}$$

Logistic Signal

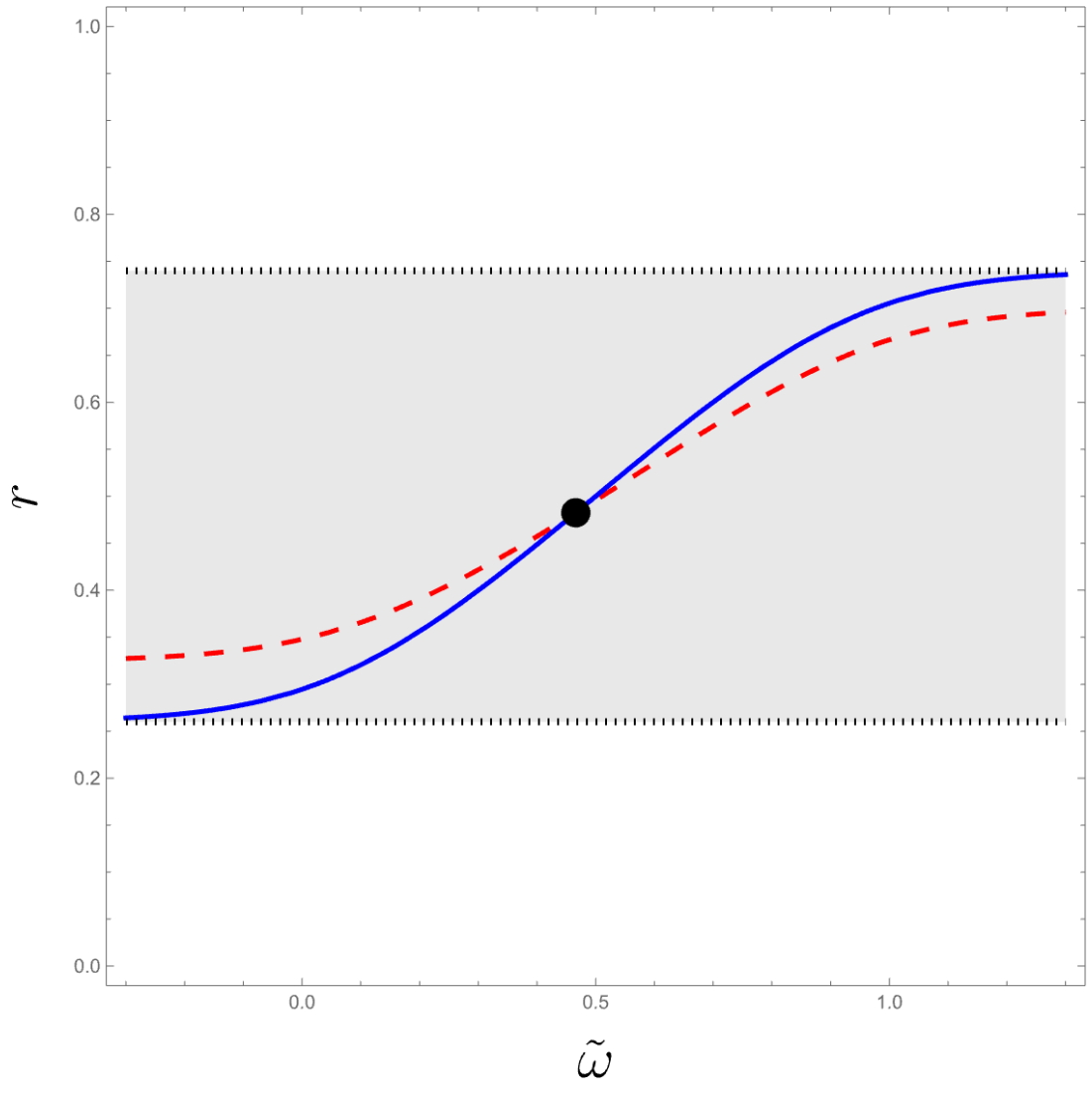


Interior Equilibria

Best-response analysis in $\mathbb{R}^2$

$$\begin{cases} \tilde{\omega} = r + \frac{1}{\rho} \ln \left(\frac{\int \frac{1}{1+\exp(\rho(\omega-\tilde{\omega}))} dG(\omega)}{1-\int \frac{1}{1+\exp(\rho(\omega-\tilde{\omega}))} dG(\omega)} \right) & \text{(seller's reaction)} \\ r = \frac{\int \frac{\omega}{1+\exp(\rho(\omega-\tilde{\omega}))} dG(\omega)}{\int \frac{1}{1+\exp(\rho(\omega-\tilde{\omega}))} dG(\omega)} + \Delta & \text{(buyer's reaction)} \end{cases}$$

Interior Equilibria



Novel Form of Mkt Breakdown

- Mkt breakdown equilibria
  - **no info** acquired
  - no trade

Proposition

Suppose $\underline{\omega} + \Delta < \omega_0$. *There exists* $\underline{\rho}(G, \Delta) > 0$ *s.t. market breakdown equilibria exist iff* $\rho \leq \underline{\rho}(G, \Delta)$.

Novel Form of Mkt Breakdown

- Mkt breaks down despite L not possessing private info

- L's deviation to $a = 1$ interpreted as coming from signal recommending $a = 1$ only for ω close to $\underline{\omega}$ (e.g., $q(1|\omega) = \mathbb{I}(\underline{\omega})$)
  - When $\underline{\omega} + \Delta < \omega_0$, F's response satisfies $r \leq \underline{r}(\rho)$
  - optimal for L not to acquire any info and refrain from engaging
  - Because signal $q(1|\omega) = \mathbb{I}(\underline{\omega})$ is costless, equilibria survive most forward-induction refinements such as D1

- Under entropy cost
  - marginal cost of signals recommending $a = 1$ only for low ω close to zero
  - benefit of such signals vanishing faster than cost as $q(1|\omega)$ converges to zero for all ω

Novel Form of Mkt Breakdown

- Mkt breakdown equilibria cease to exist when L chooses a after observing r
- Mkt breakdown equilibria continue to exist when L chooses q after observing $r$and, for any $r \in [\underline{r}(\rho), \bar{r}(\rho)]$,

$$r > \int \omega \frac{\frac{1}{1+e^{\rho(\omega-\tilde{\omega})}}}{\int \frac{1}{1+e^{\rho(\omega-\tilde{\omega})}} dG(\omega)} dG(\omega) + \Delta,$$

with

$$\tilde{\omega} = r + \frac{1}{\rho} \ln \left(\frac{\int \frac{1}{1+e^{\rho(\omega-\tilde{\omega})}} dG(\omega)}{1 - \int \frac{1}{1+e^{\rho(\omega-\tilde{\omega})}} dG(\omega)} \right)$$

and $\bar{r}(\rho) > \omega_0 + \Delta$.

  - In this case,
    - all equilibria feature no trade
    - F offers $r^* < \underline{r}(\rho)$
  - deviations to $r < \underline{r}(\rho)$ inconsequential
  - deviations to $r \geq \underline{r}(\rho)$ lead to losses under any L's rational response

Efficient Equilibria

- Efficient equilibria
  - L does not acquire info
  - trade with certainty

- In these equilibria:
  - $r = \omega_0 + \Delta$
  - optimality of not acquiring any info requires $\omega_0 + \Delta \geq \overline{r}(\rho)$.

Proposition

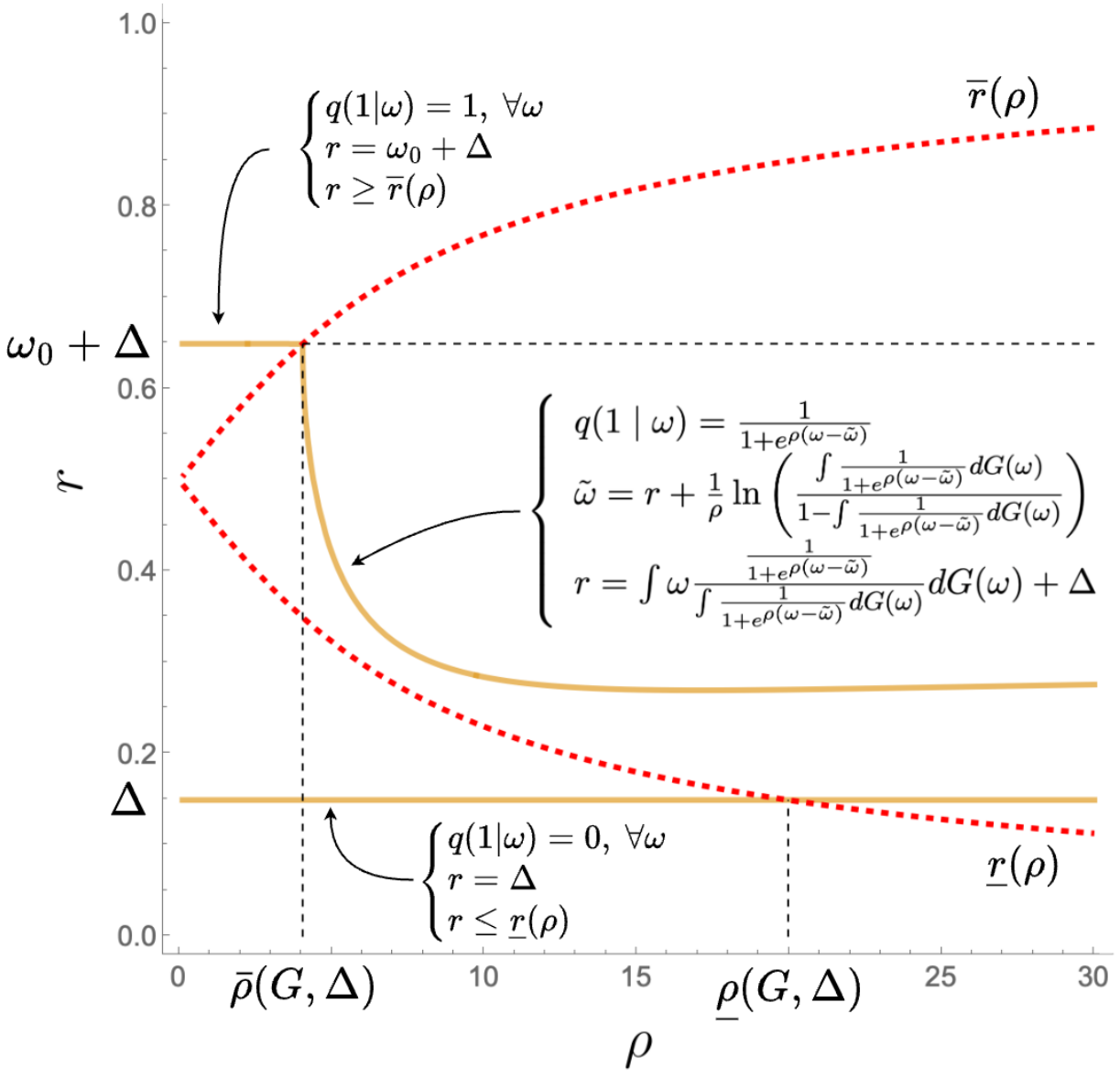
Assume $\omega_0 + \Delta < \overline{\omega}$. *There exists* $\bar{\rho}(G, \Delta) > 0$ *s.t. efficient equilibria exist iff* $\rho \leq \bar{\rho}(G, \Delta)$.

Multiple Equilibria

Corollary

Suppose $\underline{\omega} + \Delta < \omega_0 < \overline{\omega} - \Delta$. *For any* $\rho \leq \min\{\underline{\rho}(G, \Delta), \bar{\rho}(G, \Delta)\}$, *efficient eq. coexists with market breakdown equilibria.*

Multiple Equilibria



Endogenous ρ

- Interior equilibrium:

$$q^{\rho,r}(1|\omega) = \frac{1}{1+\exp(\rho(\omega-\tilde{\omega}))} \ \forall\ \omega \qquad \text{(logistic signal)}$$

$$\tilde{\omega} = r + \frac{1}{\rho} \ln\left(\frac{\int \frac{1}{1+\exp(\rho(\omega-\tilde{\omega}))} dG(\omega)}{1-\int \frac{1}{1+\exp(\rho(\omega-\tilde{\omega}))} dG(\omega)}\right) \qquad \text{(position parameter)}$$

$$\frac{I^{q^{\rho,r}}}{\rho^2} = C'(\rho) \qquad \text{(\textbf{optimality} of } \rho\text{)}$$

$$r = \frac{\int \frac{\omega}{1+\exp(\rho(\omega-\tilde{\omega}))} dG(\omega)}{\int \frac{1}{1+\exp(\rho(\omega-\tilde{\omega}))} dG(\omega)} + \Delta \qquad \text{(buyer's break even)}$$

$$r \in (\underline{r}(\rho), \overline{r}(\rho)) \qquad \text{(interior signal)}$$

Conclusions

- Endogenous info in mks with adverse selection
- **Expectation conformity**
  - value of acquiring more info higher when expected to acquire more info
  - key to many phenomena (e.g., expectation traps)
- Policy interventions
  - **more generous programs when info aggravates adverse selection**
- Flexible info
  - Novel mkt breakdowns (with no info acquisition)

Conclusions

- Future work:
  - bilateral information acquisition (**complementarity vs substitutability**)
  - public information disclosures (**stress test design**)
  - ...

Most Important Slide

THANK YOU!

Rotations

Definition

Info structures are **rotations** (or "simple mean-preserving spreads") if, for any ρ, there exists rotation point m_ρ s.t.

- $G(m;\rho)$ increasing in ρ for $m \leq m_\rho$
- $G(m;\rho)$ decreasing in ρ for $m \geq m_\rho$

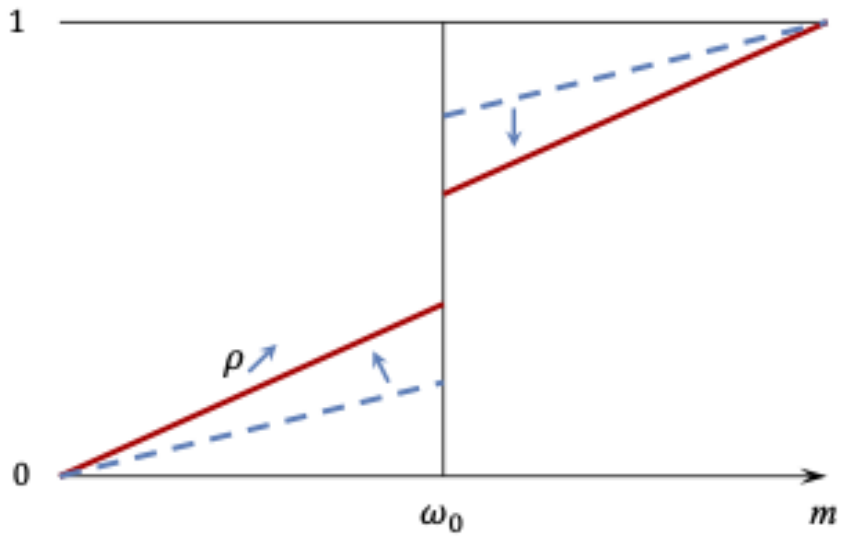
- Diamond and Stiglitz (1974), Johnston and Myatt (2006), Thereze (2022)...

Rotations Example: Non-directed Search

- L learns state with prob. ρ (nothing with prob. $1-\rho$)

$$G(m;\rho) = \begin{cases} \rho G(m) & \text{for } m < \omega_0 \\ \rho G(m) + 1 - \rho & \text{for } m \geq \omega_0 \end{cases}$$

- Rotation point: prior mean ω_0



Rotations

- Combination of rotations need not be a rotation
- But any MPS can be obtained through sequence of rotations
- Other (notable) examples
  - G Normal and $s = \omega + \varepsilon$ with $\varepsilon \sim N(0, \rho^{-1})$
  - Pareto, Exponential, Uniform $G(\cdot; \rho)$...

Go back

Gains from Engagement

Definition

Info structures are **rotations** (or "simple mean-preserving spreads") if, for any ρ, there exists rotation point m_ρ s.t.

- $G(m;\rho)$ increasing in ρ for $m \leq m_\rho$
- $G(m;\rho)$ decreasing in ρ for $m \geq m_\rho$

Proposition

Suppose info structures are rotations and L's payoff is $\delta_L(m,r) = \tilde{\delta}_L(m,r) + \theta$. *For all* $(\rho, \rho^\dagger)$, *there exists* $\theta^*(\rho,\rho^\dagger)$ *s.t., for all* $\theta \geq \theta^*(\rho,\rho^\dagger)$, *EC holds at* $(\rho,\rho^\dagger)$.

- EC more likely when gains from engagement are large.

Gains from Engagement

- Result driven by AS
- Fixing r,

$$\frac{\partial^2 \Pi}{\partial \theta \partial \rho} = G_\rho(m^*(r, \theta); \rho)$$

- Hence, marginal value of info decreases with gains from engagement under suff. condition for EC

$$G_\rho(m^*(r(\rho^\dagger; \theta), \theta); \rho) < 0$$

- Larger gains $\rightarrow$ **smaller benefit from learning state**

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Example: Akerlof-non-directed-search

- ρ: prob Seller learns state ω
- G uniform over $[0, 1]$
- $C(\rho) = \rho^2/20$
- $\Delta = 0.25$
- Eq. conditions

$$r = M^-(r; \rho) + \Delta$$

$$-\int_r^{+\infty} G_\rho(m; \rho) dm = C'(\rho)$$

- Two equilibria:

$$\rho_1 \approx 0.48 \qquad r_1 \approx 0.69$$

$$\rho_2 \approx 0.88 \qquad r_2 \approx 0.58$$

- For any $m^* > \omega_0 = .5$, $G_\rho(m^*; \rho) < 0$
- Hence, $\mathrm{A}(\rho) < 0$ for all $\rho \in [\rho_1, \rho_2]$ (**info aggravates AS**)
- Seller better off in low info-intensity eq.

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Disclosure

- Suppose L can prove informativeness of her signal exceeds $\hat{\rho}$
  - hard information
- $\hat{\rho}(\rho^*)$: hard information disclosed in eq. supporting ρ^*

Definition (regularity)

Eq. supporting ρ^* regular if, after disclosing $\hat{\rho} < \hat{\rho}(\rho^*)$, informativeness of L's signal expected by F (weakly) below ρ^*

- Monotone equilibrium selection

Disclosure

Proposition

Assume info aggravates AS ($\mathrm{A}(\rho^\dagger) < 0$ *for all* $\rho^\dagger$)

- *Any pure-strategy eq.* ρ *of no-disclosure game also eq. level of disclosure game*
- *Largest and smallest equilibrium levels in regular set of disclosure game also eq. levels of no-disclosure game.*

- Result driven by AS effect
  - disclosing less than eq. level $\rightarrow$ inconsequential
  - disclosing more $\rightarrow$ unfriendlier reactions
- Without regularity, there exist eq. in disclosure game supporting

$$\rho^* > \sup\{\text{eq. } \rho \text{ no disclosure game}\}$$

  - sustained by *F* expecting larger ρ when *L* discloses $\hat{\rho} < \hat{\rho}(\rho^*)$

Cognitive Style

- L's cost $C(\rho;\xi)$ decreasing in ξ

Corollary

Suppose L can acquire info cheaply (ξ_H) or expensively (ξ_L) and can disclose only ξ_H (IQ interpretation) or only ξ_L (work load). Further assume that, in eq., F's reaction is decreasing in posterior that $\xi = \xi_H$. Then L poses as "information puppy dog," i.e., does not disclose in IQ interpretation and discloses in work load one.

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Prop-FI

- $q^{\rho,r}(1|\omega)$: prob. signal recommends $a = 1$ at ω
- $q^{\rho,r}(1)$: tot prob. signal recommends $a = 1$
- Optimal (interior) signal for **entropy**:

$$\delta_L(r,\omega) = \frac{1}{\rho}\left[\ln\left(\frac{q^{\rho,r}(1|\omega)}{1-q^{\rho,r}(1|\omega)}\right) - \ln\left(\frac{q^{\rho,r}(1)}{1-q^{\rho,r}(1)}\right)\right]$$

- Optimal (interior) signal for **max-slope**:

$$q^{\rho,r}(1|\omega) = \begin{cases} 1 & \text{if} \quad \omega \leq m^*(r) - \frac{1}{2\rho} \\ \frac{1}{2} - \rho(\omega - m^*(r)) & \text{if} \quad m^*(r) - \frac{1}{2\rho} < \omega \leq m^*(r) + \frac{1}{2\rho} \\ 0 & \text{if} \quad \omega > m^*(r) + \frac{1}{2\rho} \end{cases}$$

Prop-FI

Proposition

Fix $(\rho, \rho^\dagger)$.

(i) EC holds at $(\rho, \rho^\dagger)$ *iff* $\mathrm{A}(\rho^\dagger)\mathrm{B}(\rho; \rho^\dagger) < 0$.

(ii) Info aggravates AS at $\rho^\dagger$ *if* $q^{\rho, r(\rho^\dagger)}(1|\omega)/q^{\rho, r(\rho^\dagger)}$ *increasing in* ρ *for* $\omega < m^*(r(\rho^\dagger))$, *decreasing in* ρ *for* $\omega > m^*(r(\rho^\dagger))$, *at* $\rho = \rho^\dagger$.

(iii) Reduction in r *at* $r(\rho^\dagger)$ *raises L's value of info at* ρ *if condition in (ii) holds and* $q^{\rho, r(\rho^\dagger)}(1)$ *non-increasing in* ρ.

(iv) Suppose $M^-(m^*(r(\rho^\dagger)); \rho)$ *decreasing in* ρ *at* $\rho = \rho^\dagger$ *and* $\partial^2 \delta_L(r, m)/\partial r \partial m = 0$ *(e.g., Akerlof). Then* $q^{\rho, r(\rho^\dagger)}(1)$ *decreasing in* ρ *at* $\rho = \rho^\dagger$ *NSC for EC at* $(\rho, \rho^\dagger)$.

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