

Knowing your Lemon before You Dump it

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Motivation

- Strategic situations where decision to “engage” carries information
 - trade
 - partnerships
 - entry
 - marriage
 - ...
- Lemons (Akerlof)
 - *negative inferences*
- Anti-lemons (Spence)
 - *positive inferences*
- **Endogenous information**
 - acquisition
 - attention/cognition

This Paper

- Generalized lemons (and anti-lemons)
 - **endogenous information**
- Information choices
 - type of strategic interaction
 - **opponent's beliefs over selected information** (**expectation conformity**)
 - effect of information on severity of adverse selection
 - effect of friendliness of opponent's reaction on value of information
- **Expectation traps**
- **Disclosure and Cognitive Style**
- **Welfare and policy**

- **Endogenous info in lemons problem**
 - Dang (2008), Thereze (2022), Lichtig and Weksler (2023)
→ EC, \neq bargaining game, timing, CS (gains from interaction, disclosure, policy)
- **Payoffs in lemons problem**
 - Levin (2001), Bar-Isaac et al. (2018), Kartik and Zhong (2023)...
→ incentives analysis
- **Policy in mkts with adverse selection**
 - Philippon and Skreta (2012), Tirole (2012), Dang et al (2017)...
→ endogenous information
- **Endogenous info in private-value bargaining**
 - Ravid (2020), Ravid, Roesler, and Szentes (2021)...
→ lemons problem, competitive mkt
- **Expectation conformity**
 - Pavan and Tirole (2022)
→ different class of games (generalized lemons and anti-lemons)
- **Mandatory disclosure laws**
 - Pavan and Tirole (2023b)
→ endogenous information

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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, $r \in \mathbb{R}$

- **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: $\frac{\partial^2 \delta_L}{\partial \omega \partial r} \geq 0$
- **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**
 - $u_F(0, \omega) = 0$
 - $u_F(1, r, \omega) = \omega + \Delta - r$
 - $\delta_L(r, \omega) = u_F(1, r, \omega)$

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

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 $\int_{-\infty}^{+\infty} G(m; \rho') dm = \int_{-\infty}^{+\infty} G(m; \rho) dm = \omega_0$.

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

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

Definition

Information 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 $m \geq m_\rho$

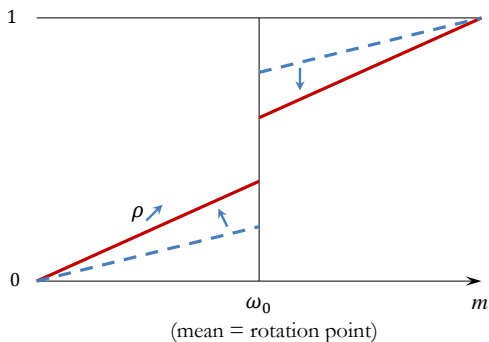
- Diamond and Stiglitz (1974), Johnston and Myatt (2006), Thereze (2022)...

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 examples
 - G Normal and $s = \omega + \varepsilon$ with $\varepsilon \sim N(0, \rho^{-1})$
 - Pareto, Exponential, Uniform $G(\cdot; \rho)$...

Model

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

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

with

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

- $r(\rho)$: eq. reaction in fictitious game with exogenous information ρ (assumed to be unique)
- **Assumption (lemons):**

$$\frac{dr(\rho)}{d\rho} \stackrel{\text{sgn}}{\equiv} \frac{\partial}{\partial \rho} M^-(m^*(r(\rho)); \rho)$$

where

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

Akerlof Example

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

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

- Lemons: $\frac{dr(\rho)}{d\rho} \stackrel{\text{sgn}}{=} \frac{\partial}{\partial \rho} M^-(m^*(r(\rho)); \rho)$
 - always if $G(m; \rho)/g(m; \rho)$ increasing in m

Other applications

- Partnerships
- Entry
- Marriage
- OTC mkts
- ...

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Expectation Conformity

Effect of information on adverse selection

- $r(\rho)$: eq. reaction with exogenous information ρ
- $M^-(m^*; \rho) \equiv \frac{\int_{-\infty}^{m^*} m dG(m; \rho)}{G(m^*; \rho)}$

Definition

Information

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

Effect of information on adverse selection

$$\frac{\partial}{\partial \rho} M^-(m^*; \rho) \stackrel{\text{sgn}}{\equiv} A(m^*; \rho)$$

where

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

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

- Two channels through which information affects AS:
 - **prob. of trade**, $G_\rho(m^*; \rho)$
 - **dispersion of posterior mean**, $\int_{-\infty}^{m^*} G_\rho(m; \rho) dm$
- $A(\rho) \equiv A(m^*(r(\rho)); \rho)$: **adverse-selection effect**

Effect of unfriendlier reactions on value of information

- L 's payoff under signal 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 information choice
- ρ^\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 information at ρ if $B(\rho; \rho^\dagger) > 0$
 - lowers value of information at ρ if $B(\rho; \rho^\dagger) < 0$

Effect of unfriendlier reactions on value of information

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

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

Expectation Conformity

- L 's value function when actual information is ρ and F expects information ρ^\dagger :

$$V_L(\rho; \rho^\dagger) \equiv \Pi(\rho; r(\rho^\dagger))$$

Definition

Expectation conformity holds at (ρ, ρ^\dagger) iff

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

Key forces...

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

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

Expectation Conformity

Proposition

Assume MPS order.

(i) EC at (ρ, ρ^\dagger) iff $A(\rho^\dagger)B(\rho; \rho^\dagger) < 0$.

(ii) Information aggravates AS at ρ^\dagger (i.e., $A(\rho^\dagger) < 0$) for Uniform, Pareto, Exponential $G(\cdot; \rho)$, or, more generally, when $G_\rho(m^*(r(\rho^\dagger)); \rho^\dagger) < 0$.

(iii) Lower r raises incentive for information at (ρ, ρ^\dagger) (i.e., $B(\rho; \rho^\dagger) > 0$) if $G_\rho(m^*(r(\rho^\dagger)); \rho) < 0$.

(iv) Therefore EC at (ρ, ρ^\dagger) if

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

(v) Suppose, for any m^* , $M^-(m^*; \rho)$ decreasing in ρ (e.g., 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 (ρ, ρ^\dagger) .

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

Non-directed search in Akerlof model

- Large Δ : $r(\rho^\dagger) > \omega_0$
- Increase in anticipated information ρ^\dagger
 - seller **engages more selectively**, $G_\rho(m; \rho^\dagger) < 0$
 - **exacerbated AS** (lower $M^-(m^*(r(\rho^\dagger)); \rho^\dagger)$)
 - **lower price**
 - higher cost for S of parting with valuable item
 - **higher value in learning state**

Non-directed search in Akerlof model

- Small Δ : $r(\rho^\dagger) < \omega_0$
- S engages only when **informed** and $\omega < r(\rho^\dagger)$
- anticipated information $\rho^\dagger \rightarrow$ no effect on AS
- No EC

Gains from Engagement

Proposition

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

- EC more likely when gains from engagement are large.

Gains from Engagement

- Previous result driven by AS
- Fixing r ,

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

- Hence, marginal value of information **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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Expectation Traps

Expectation Traps

Proposition

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

Expectation Traps: Non-direct search in Akerlof model

- ρ : prob Seller learns state
- 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:

$$\begin{array}{ll} \rho_1 \approx 0.48 & r_1 \approx 0.69 \\ \rho_2 \approx 0.88 & r_2 \approx 0.58 \end{array}$$

- For any $m^* > \omega_0$, $G_{\rho^\dagger}(m^*; \rho^\dagger) < 0 \Rightarrow \Lambda(\rho^\dagger) < 0$ (info aggravates AS)
- Seller better off in low-information-intensive eq.

Expectation Traps

- **Expectation traps**
 - driven by AS effect
 - friendliness of F 's reaction decreasing in L 's information
 - expectation traps emerge **even if information is free**
- Contrast to private values + screening (Ravid et al. 2022)
 - equilibria Pareto ranked
 - eq. payoffs increasing in informativeness of signal

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Policy Interventions

Subsidies to Trade

- Welfare (competitive F):

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

where

- s : subsidy to trade
 - λ : cost of public funds (DWL of taxation)
-
- Subsidy impacts:
 - engagement, m^*
 - friendliness of F 's reaction, r
 - information, ρ

Subsidies: Akerlof

- Subsidies optimal in Akerlof model when
 1. Small cost λ of public funds
 2. Information aggravates AS ($A(\rho) < 0$)
 3. CS of eq. same as BR: Subsidies reduce information

- Proposition 6 (in paper) identifies precise conditions for optimality of subsidies/taxes in generalized lemons/anti-lemons problems.

Subsidies: Double Dividend

Corollary

*In Akerlof model, endogeneity of information calls for **larger** subsidy when information reduces prob. of trade.*

- Same condition for EC
- **Double dividend** of subsidy
 - more engagement
 - less information acquisition
- **Implication for Gov. asset repurchases programs: more generous terms**

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Flexible Information

- **Entropy cost:**

- ρ parametrizes MC of entropy reduction (alternatively, capacity)
- L invests in ability to process info (MC or capacity)
- then chooses experiment $q : \Omega \rightarrow \Delta(Z)$ at cost

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

where I^q is mutual information between z and ω

- **Max-slope cost:**

- ρ parametrizes max slope of stochastic choice rule $\sigma : \Omega \rightarrow [0, 1]$ specifying prob. L engages
- 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

Equilibrium under Entropy Cost

- **Seller's problem**

$$\int_{\omega} (r - \omega)q(1|\omega)dG(\omega) + \mathbb{E}[\omega] - \frac{I^q}{\rho}$$

where

$$I^q = \int_{\omega} \phi(q(1|\omega))dG(\omega) - \phi(q(1))$$

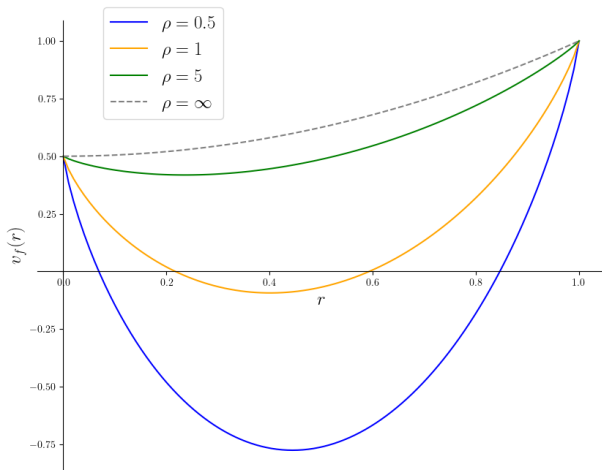
is entropy reduction, with

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

$$q(1) \equiv \int_{\omega} q(1|\omega)dG(\omega)$$

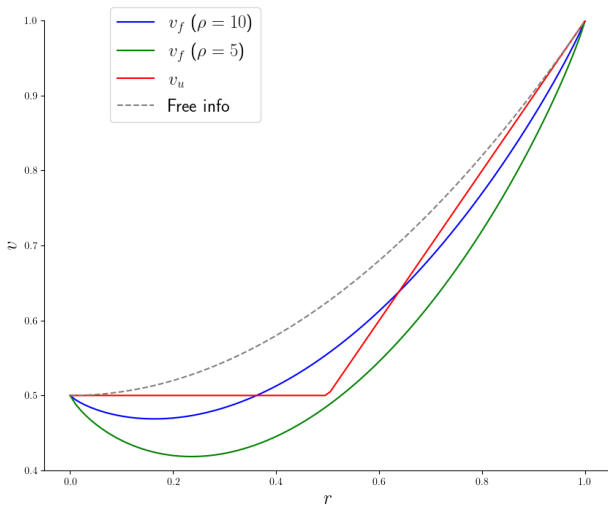
Value of “Full Information”

$$q(1|\omega) = \mathbb{I}\{\omega \leq r\}$$



$$\omega \sim U[0, 1]$$

Value of Information



$$\omega \sim U[0, 1]$$

Full info better than no info for intermediate r and low MC

Seller's Optimality

- If

$$\int_{\omega} e^{\rho(r-\omega)} g(\omega) d\omega \leq 1, \quad \int_{\omega} e^{-\rho(r-\omega)} g(\omega) d\omega > 1$$

never engage $\rightarrow q(1) = 0$

- If

$$\int_{\omega} e^{-\rho(r-\omega)} g(\omega) d\omega \leq 1, \quad \int_{\omega} e^{\rho(r-\omega)} g(\omega) d\omega > 1$$

always engage $\rightarrow q(1) = 1$

- If

$$\int_{\omega} e^{\rho(r-\omega)} g(\omega) d\omega > 1, \quad \int_{\omega} e^{-\rho(r-\omega)} g(\omega) d\omega > 1$$

interior solution with some information acquisition

Seller's Optimality - Interior Solution

- Interior $q(1|\omega)$ solves functional eq.

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

with

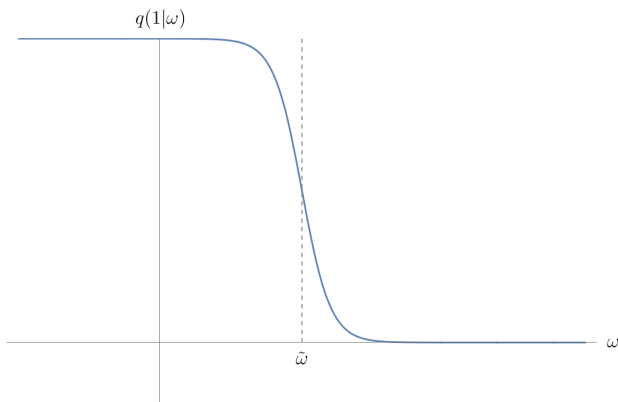
$$q(1) = \int_{\omega} q(1|\omega) dG(\omega)$$

- Let $\tilde{\omega} \in \mathbb{R}$ solve

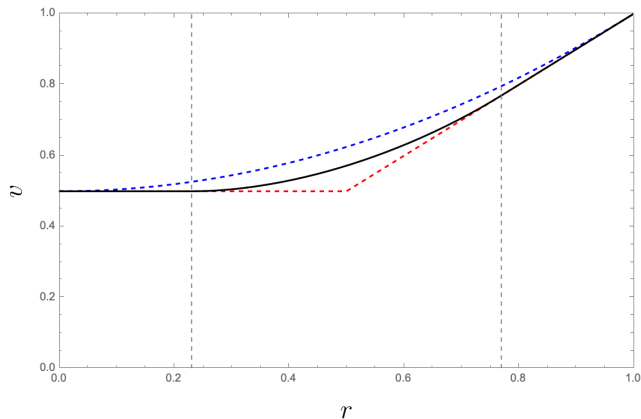
$$\tilde{\omega} = r + \frac{1}{\rho} \ln \left(\frac{\int_{\omega} \frac{1}{1 + e^{\rho(\omega - \tilde{\omega})}} dG(\omega)}{1 - \int_{\omega} \frac{1}{1 + e^{\rho(\omega - \tilde{\omega})}} dG(\omega)} \right)$$

Seller's Optimality - Interior Solution

$$q(1|\omega) = \frac{1}{1 + e^{\rho(\omega - \tilde{\omega})}}, \quad \tilde{\omega} = r + \frac{1}{\rho} \ln \left(\frac{q(1)}{1 - q(1)} \right)$$



Seller's Optimality - Value of Information



$$\omega \sim U[0, 1], \quad \rho = 10, \quad \underline{r} \approx 0.23, \quad \bar{r} \approx 0.77$$

- Dashed blue line: free full information
- Dashed red line: no information
- Black line: optimal signal

Equilibrium

There exists \underline{r} such that seller's optimality:

$$q(1|\omega) = \begin{cases} 0 & \forall \omega \text{ if } r \leq \underline{r} \\ \frac{1}{1+e^{\rho(\omega-\bar{\omega})}} & \text{if } r \in (\underline{r}, \bar{r}) \\ 1 & \forall \omega \text{ if } r \geq \bar{r} \end{cases}$$

Buyer's optimality:

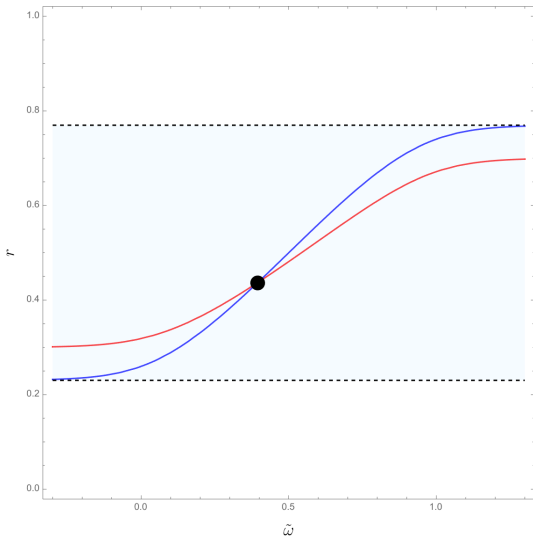
$$r = \int_{\omega} \omega \frac{q(1|\omega)}{\int_{\omega} q(1|\omega) dG(\omega)} dG(\omega) + \Delta$$

Equilibrium - Interior

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

$$\left\{ \begin{array}{l} \tilde{\omega} = r + \frac{1}{\rho} \ln \left(\frac{\int_{\omega} \frac{1}{1+e^{\rho(\omega-\tilde{\omega})}} dG(\omega)}{1 - \int_{\omega} \frac{1}{1+e^{\rho(\omega-\tilde{\omega})}} dG(\omega)} \right) \quad (S) \\ r = \int_{\omega} \omega \frac{\frac{1}{1+e^{\rho(\omega-\tilde{\omega})}}}{\int_{\omega} \frac{1}{1+e^{\rho(\omega-\tilde{\omega})}} dG(\omega)} dG(\omega) + \Delta \quad (B) \end{array} \right.$$

Equilibrium - Example



$$\omega \sim U[0, 1], \quad \rho = 10, \quad \Delta = 0.2, \quad r^* \approx 0.44, \quad \tilde{\omega}^* \approx 0.4$$

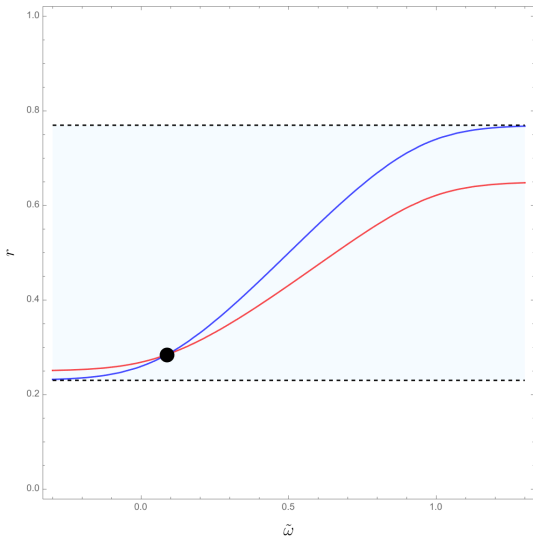
Multiple Equilibria: Corner and Interior

- Interior solutions can coexist with corner solutions with **no information acquisition** and **no engagement**
- Need to specify buyer's *off-path* beliefs

$$q^\dagger(1|\omega) = \begin{cases} 1 & \text{if } \omega = 0 \\ 0 & \text{if } \omega \neq 0 \end{cases}$$

- Buyer offers: $\mathbb{E}[\omega|a = 1; q^\dagger] + \Delta = \Delta$
- If $\Delta < \underline{r}$ seller does not deviate
- In previous slide: interior equilibrium with $\tilde{\omega}^* \approx 0.4$ ($q(1) \approx 0.4$) and $r^* \approx 0.44$
- Also have a “corner” equilibrium with $q(1|\omega) = 0 \forall \omega$ and $r^{**} = \Delta = 0.2 < \underline{r} \approx 0.23$

Comparative Statics - Lower Δ



$$\omega \sim U[0, 1], \quad \rho = 10, \quad \Delta = 0.15, \quad r^* \approx 0.28, \quad \tilde{\omega}^* \approx 0.09$$

Endogenous cost of entropy reduction

- Seller first invests in absorbing information
- $C(\rho)$: Cost of ρ
- Given ρ , seller chooses any signal

- Total cost:

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

- Advantage of this formalism: higher ρ plays role similar to “more info” with rigid info
- Interaction between seller's choice and buyer's expectation in (ρ, ρ^\dagger) as in baseline model

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(Anti-lemons)

Conclusions

- Endogenous information in mks with adverse selection
- Expectation conformity
 - prob of engagement decreasing in informativemess of signal
 - large gains from interaction
- Expectation traps
- Welfare and policy implications
 - endogeneous info: larger subsidies

Conclusions

- Ongoing work:
 - bilateral information acquisition
 - public information disclosures
 - ...

THANKS!

Disclosure

- Suppose L can prove signal informativeness above $\hat{\rho}$
- **Hard Information**
- $\hat{\rho}(\rho^*)$: information disclosed in eq. supporting ρ^*
- **Regularity**: Equilibrium supporting ρ^* is regular if, after disclosing $\hat{\rho} < \hat{\rho}(\rho^*)$, informativeness of L 's signal lower than ρ^*
- Monotone equilibrium selection

Proposition

Assume information aggravates AS ($A(\rho^\dagger) < 0$ for all ρ^\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, eq. in disclosure game supporting $\rho^* > \sup\{\text{eq. } \rho \text{ no disclosure game}\}$
 - sustained by F expecting large ρ when F discloses $\hat{\rho} < \hat{\rho}(\rho^*)$

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

Corollary

Suppose L can acquire information 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., player 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.

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

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

- Max-slope:

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

Proposition

Fix (ρ, ρ^\dagger) .

(i) EC holds at (ρ, ρ^\dagger) iff $A(\rho^\dagger)B(\rho; \rho^\dagger) < 0$.

(ii) Information aggravates AS at ρ^\dagger if $q^{\rho, r(\rho^\dagger)}(1|\omega)/q^{\rho, r(\rho^\dagger)}(1)$ 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 information 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 (ρ, ρ^\dagger) .

Assumption (anti-lemons). Friendliness of F 's reaction to an increase in L 's information depends **negatively** on impact of L 's information on adverse selection:

$$\frac{dr(\rho^\dagger)}{d\rho^\dagger} \stackrel{\text{sgn}}{=} -\frac{\partial}{\partial \rho^\dagger} M^-(m^*(r(\rho^\dagger)); \rho^\dagger).$$

Anti-lemons: Spencian signaling

- L : agent choosing between enrolling in MBA ($a = 1$) or not ($a = 0$)
- Cost of enrolling ρ
- Disutility from studying: ω
- F : representative of competitive set of employers
- Agent's productivity when employed $\theta = a - b\omega$, $b > 0$
- r : wage offered
- δ_L : $r - (\omega + \rho)$
- Engagement threshold: $m^*(r) = r - \rho$
- Equilibrium $r(\rho)$:

$$r = a - bM^-(m^*(r); \rho)$$

Anti-lemons: Start-up example

- Entrepreneur (L) chooses whether to start a business ($a = 1$) at cost $c_L > 0$
- $1 - \omega$: probability projects succeeds (delivering 1 unit of cash flows)
- L may need to liquidate prematurely with prob. p (as in Diamond and Dybvig (1983))
- r : price offered by competitive investors (F) in case of liquidation
- L 's payoff from engagement

$$\delta_L = (1 - p)(1 - m) + pr - c_L$$

- Hence, L engages iff

$$m \leq m^*(r) = \frac{1 - p + pr - c_L}{1 - p}$$

- Value of assets for F : $1 - \omega$
- E. price $r(\rho)$

$$r = 1 - M^-(m^*(r); \rho)$$

Anti-lemons: Warfare example

- Country L : potential invader
- ω : probability country F wins fight
- r : probability F surrenders without fighting
- L 's payoff in case of victory: 1; L 's cost of defeat: c_L

$$\delta_L(r, m) = r + (1 - r)(1 - m - mc_L)$$

- Hence, L engages iff

$$m \leq m^*(r) = \frac{1}{(1 - r)(1 + c_L)}$$

- F 's payoff from victory: 1; F 's defeat cost c_F drawn from cdf H
- Prob. $r(\rho)$ F surrenders

$$r = 1 - H\left(\frac{M^-(m^*(r); \rho)}{1 - M^-(m^*(r); \rho)}\right)$$

Anti-lemons: Hermalin (1998)'s leadership model

- r : prob F joins leader's project
- $\delta_L(r, m) = (1 - m) + r - c_L$
- $1 - m$: probability project succeeds
- F observes whether L starts project
- F 's payoff from joining: $1 - m - c_F$, with c_F drawn from cdf H
- Equilibrium $r(\rho)$

$$r = H(2 - M^-(1 + r - c_L; \rho))$$

Proposition

Assume MPS order and information aggravates AS at ρ^\dagger (i.e., $A(\rho^\dagger) < 0$). EC holds at (ρ, ρ^\dagger) only if $G_\rho(m^*(r(\rho^\dagger)); \rho) > 0$, which, in the case of rotations, happens iff

$$m^*(r(\rho^\dagger)) < m_\rho.$$

Furthermore, $G_\rho(m^*(r(\rho^\dagger)); \rho) > 0$ necessary and sufficient for EC if $\partial^2 \delta_L(m, r) / \partial m \partial r = 0$ (e.g., Spence).

- opposite of lemons case