

Attention costs, economies of scale and markets for information

Tommaso Denti Kristoffer Nimark

Cornell University

Information as a commodity

Fixed cost of production but **negligible cost of dissemination**

⇒ Economies of scale and preference externalities

Cost for consumer may be mainly in the form of **attention**

⇒ “Price” to consumer is not separable from quality of good

How do economies of scale, preference heterogeneity, and attention costs interact to determine market structure and equilibrium information provision?

A decision-theoretic perspective on news media

What news media do

Monitoring the world

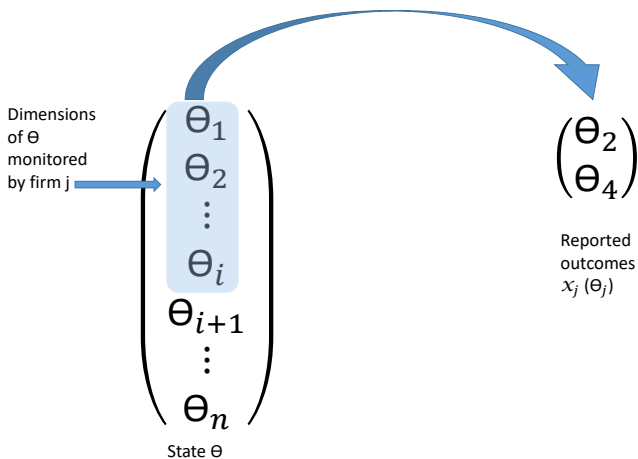
- Where do you send correspondents? To which beats do you assign reporters?

Decide what to report depending on what has happened

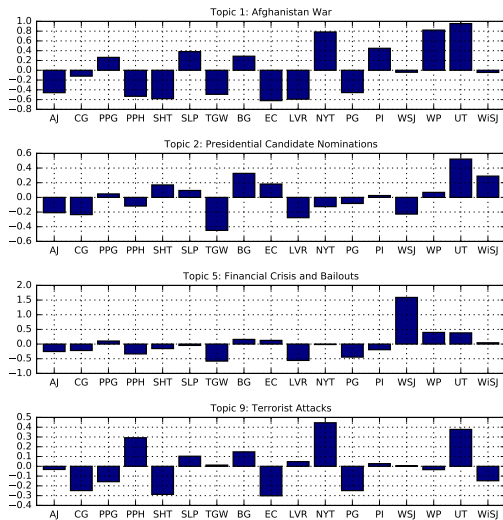
- State dependent editorial decisions

Both types of decisions depend on some notion of newsworthiness that may differ across news outlets

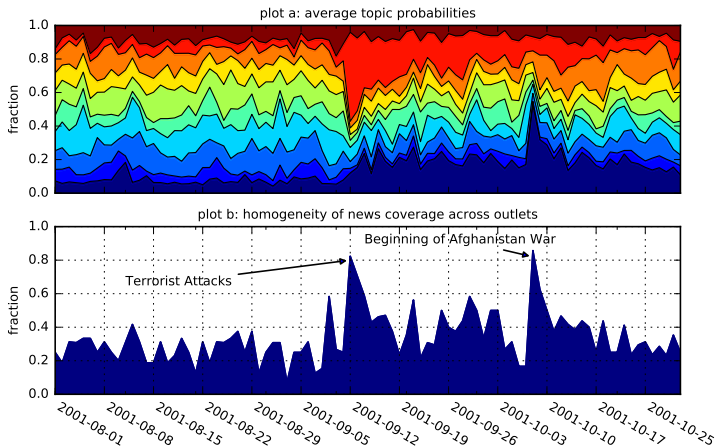
Formalizing monitoring and state dependent reporting



Specialization of newspapers, Nimark and Pitschner (2019)



Editorial decisions around 9/11, Nimark and Pitschner (JET 2019)



This paper

Producers/firms (“newspapers”)

- Monitor, gather and disseminate information about state of the world
- Earn revenue that is increasing in size of readership

Consumers/agents (“readers”)

- Heterogenous preferences
- Choose whether to get information from a firm or not
- Take an action with pay-off that depends on state of the world

Key features of framework

1. **Separate** cost of information gathering and dissemination from attention cost
2. Study **contestable equilibrium** in markets for information
3. Main trade-offs facing agents:
 - **Cheap vs tailored** information
 - **Which firm** to obtain information from

Related literature

Rational inattention

- Studies vertically integrated informational Yeoman farmers
Sims 03, Mackowiak and Wiederholt 09, Matejka and McKay 15, Caplin, Dean, and Leahy 21, Pomatto, Strack and Tamuz 21, Denti, Marinacci and Rustichini 21 ...

Markets for (consumer) information

- Studies information intermediaries in market for consumer characteristics data
Bergemann and Bonatti 19, Galperti, Levkun, and Perego 21, ...

Economics of news media

- Market structure with preference externalities—media is a direct consumption good, e.g. music
- Advertising, marketing and market structure
- Political media slant – voting behavior
Gentzkow and Shapiro 06, George and Waldfogel 2003, 2006, Godes, Ofek, Sarvary 2008, Anderson, Stromberg, and Waldfogel 15, ...

The Plan

1. Set up and equilibrium notion
2. Optimal reporting
3. Duopoly, free entry and specialization in a Hotelling-type model
4. Some additional results

Set up and equilibrium

Set up

States

- Nature draws state vector $\theta \in \Theta$ according to $\pi \in \Delta(\Theta)$

Firms

- Firm $j \in J$ monitors $\theta_j \subseteq \theta$ and produces information structure P_j with message x_j (measurable in θ_j).
- Cost $K(P_j)$ weakly increasing in (Blackwell-) informativeness
- Firm profit is $R(S_j) - K(P_j)$.

Agents

- Agent $i \in I$ choose P_j **ex ante** and take action a_i **ex post**
- Attention cost $C_i(P, x)$
- Value of information P to agent i is

$$V_i(P) = E \left[\max_{a_i} E[u_i(a_i, \theta) | x] \right] - E[C_i(P, x)]$$

Contestable market equilibrium

An **industry configuration** $(P_j, S_j)_{j \in J}$ describes an information structure $P_j \in \mathcal{P}$ and a readership $S_j \subseteq I$ for every firm j .

A configuration is an **equilibrium** if it is

1. **Feasible** - active firms have large enough readerships to cover costs
2. **Agent optimal** - no agent wants to switch firm
3. **Sustainable** - no inactive firm wants to enter the market

Originally proposed by Baumol, Bailey and Willig 77

- Natural competitive benchmark for markets with fixed costs and free entry (e.g., Acemoglu and Azar 20)

A Hotelling-style example

Agents living on a line

State of the world

$$\theta \in \mathbb{R}^2 : \theta \sim N(0, I).$$

Agents and actions

Agent $i \in (0, 1)$ take action $a_i \in \mathbb{R}^2$ with $i \sim \text{Beta}(\alpha, \beta)$

Utility

$$u_i = 1 - (1 - i)(a_{i,0} - \theta_0)^2 - i(a_{i,1} - \theta_1)^2$$

Attention costs

$$C_i(P, x) = c \dim(x), \quad \text{with } c > 0$$

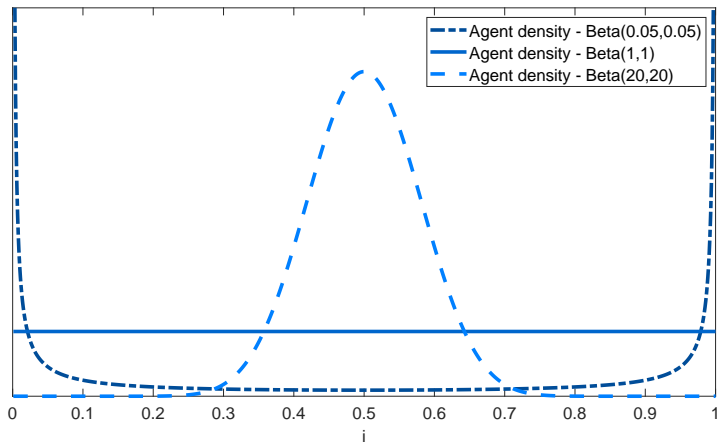
Cost of information gathering

$$K(P_j) = k_0 + k \dim(\theta_j) \quad \text{with } k_0, k > 0$$

Firm revenue

$$R(S_j) = r \int_{S_j} \text{Beta}_i(\alpha, \beta) di : r \in \mathbb{R}_+.$$

Distribution of population and preference heterogeneity



Information structure choice and indirect utility for agent i

Agent i solves

$$P_i = \arg \max_{P_j: j \in J^a} [U_i(P_j) - C(P_j, x_j)]$$

where

$$U_i(P_j) = E \left[\max_{a_i} E[u_i(a_i, \theta) | x_j] \right]$$

so that

$$U_i(P_j) = 1 - (1 - i)\mathbb{V}(\theta_0 | P_j) - i\mathbb{V}(\theta_1 | P_j)$$

Monotonicity of net value $V_i(P)$ in location i

$$\frac{\partial V_i(P')}{\partial i} = \mathbb{V}(\theta_0 | P') - \mathbb{V}(\theta_1 | P')$$

Equilibrium with a single active firm

Equilibrium with a single active firm

Assumption 1: $\frac{1}{2} < \frac{k_0+2k}{r} < 1$

- Information gathering cost large relative to revenue ensures at most one active firm in equilibrium

Assumption 2: $\frac{1}{2} < c < 1$

- Rules out trivial equilibria with no active firms or with perfect information

Optimal symmetric reporting rules

Definition The set \mathcal{P}_{sym} contains all information structures with reporting rules that are symmetric in θ around 0

Proposition The optimal information structure in \mathcal{P}_{sym} for agent i is characterized by the reporting rule

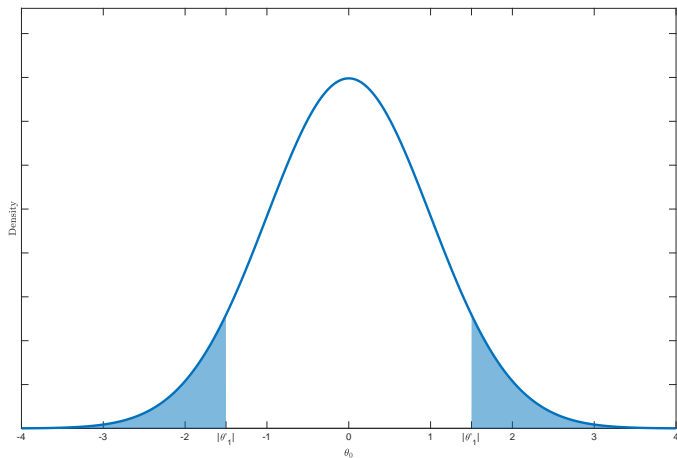
$$P_i^* : x_i = \theta_0 \text{ if } \theta_0^2 > \frac{i}{1-i} \theta_1^2$$

and $x_i = \theta_1$ otherwise.

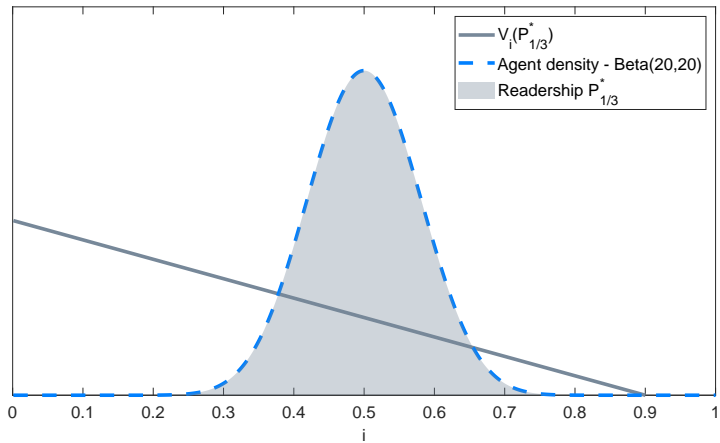
Optimal to report the largest square deviation, weighted by location i

- Less useful to report mundane outcomes close to prior mean

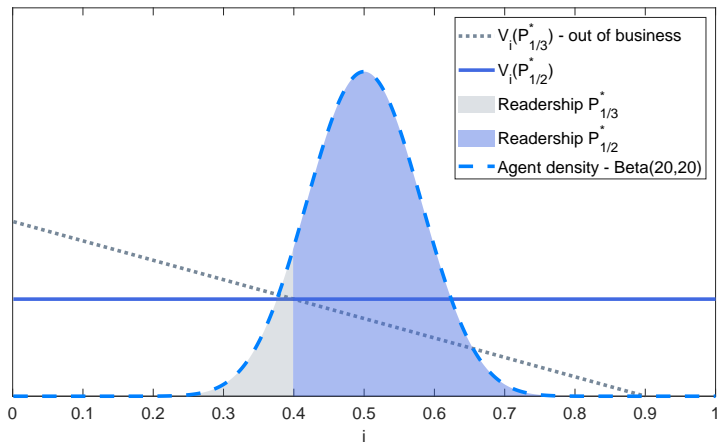
Reporting rule and conditional distribution of unreported variable



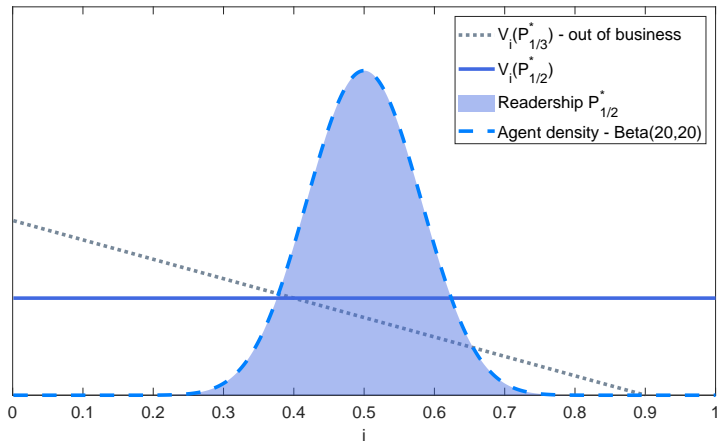
1 active firm



New entrant steals readership



Equilibrium with 1 active firm



Duopoly, free entry and specialization

Assumption 3: $\frac{1}{3} < \frac{k_0+2k}{r} < \frac{1}{2}$

- Ensures at most 2 active firms feasible in equilibrium

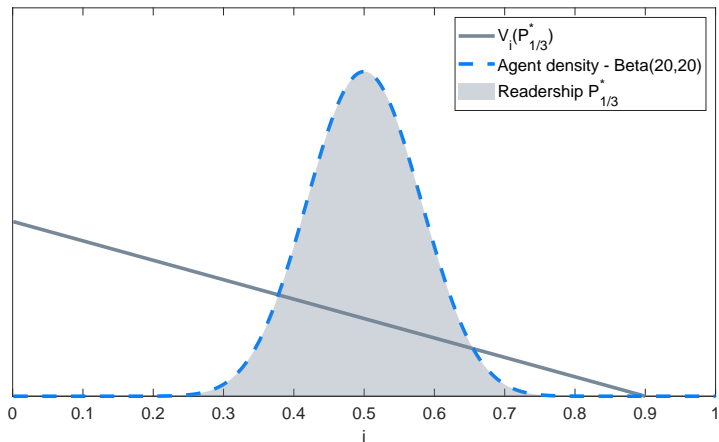
Duopoly

- Universe of 2 firms
- If both firms are active, no threat from new entrants

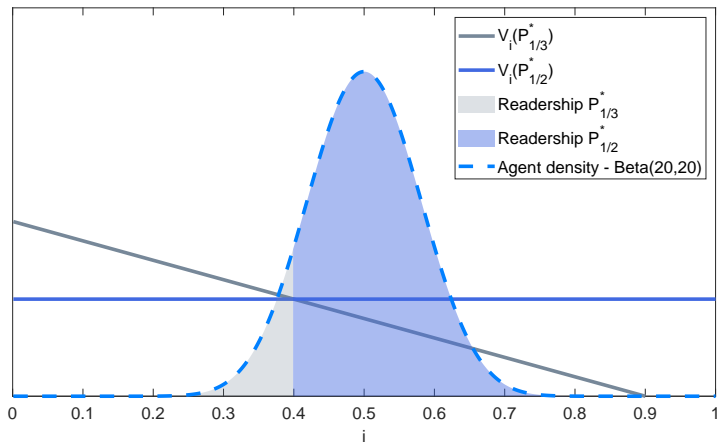
Proposition: In a duopoly, there is minimal specialization in equilibrium and both firms provide $P_{\frac{1}{2} \pm \epsilon}$

Competition occurs from the center

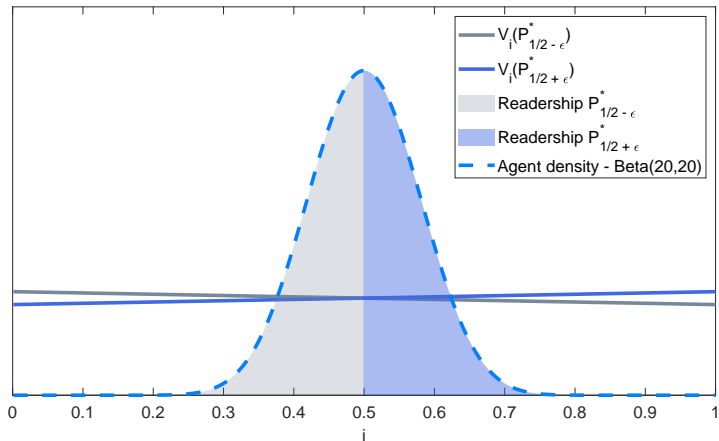
One firm enters



Second firm competes from the center



Duopoly equilibrium without specialization



Free entry and contestable with at most 2 feasible firms

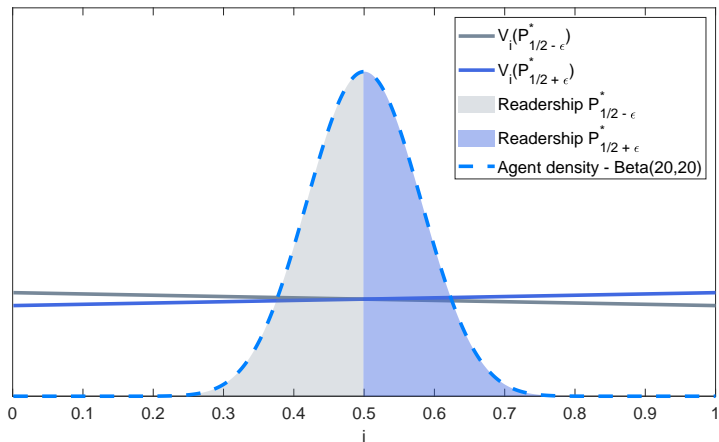
Contestable equilibrium

- Infinite number of potentially active firms
- Firms will enter if profitable, even if 2 firms are already active

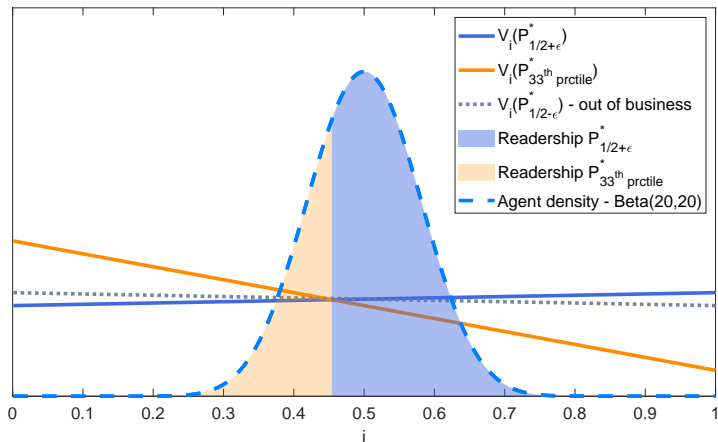
Proposition: With free entry, firms compete from the fringe and equilibrium displays maximal specialization and..

- ...firm 1 offers $P_{\underline{i}}^*$ where \underline{i} is the $100 * \frac{k_0+2k}{r}^{th}$ percentile of i .
- ...firm 2 offers $P_{\bar{i}}^*$ where \bar{i} is the $100 * (1 - \frac{k_0+2k}{r})^{th}$ percentile of i .

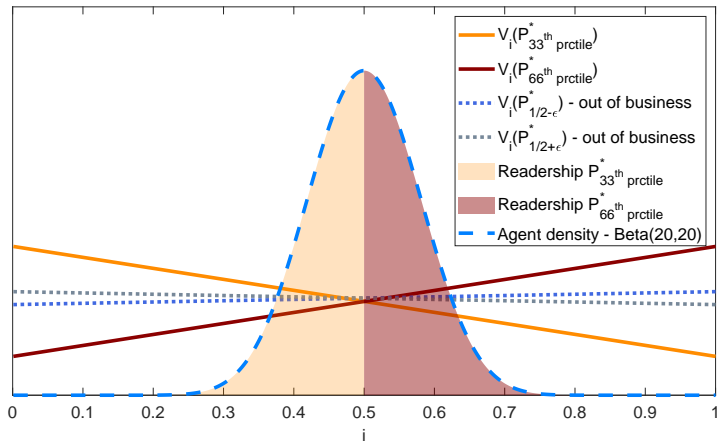
Duopoly equilibrium (again)



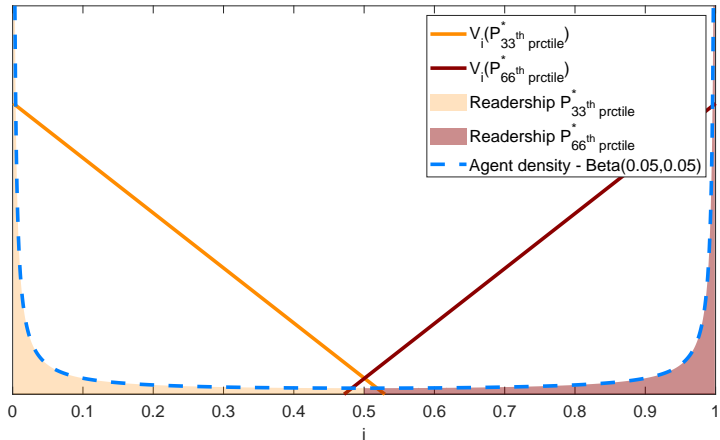
Free entry - competition from the fringe



Free entry - competition from the fringe - equilibrium



Free entry - preference heterogeneity increases specialization



The causes and nature of specialized reporting

Proposition: Specialization is decreasing in concentration $\kappa \equiv \alpha + \beta$, i.e.

$$\frac{\partial |\bar{i} - \underline{i}|}{\partial \kappa} < 0$$

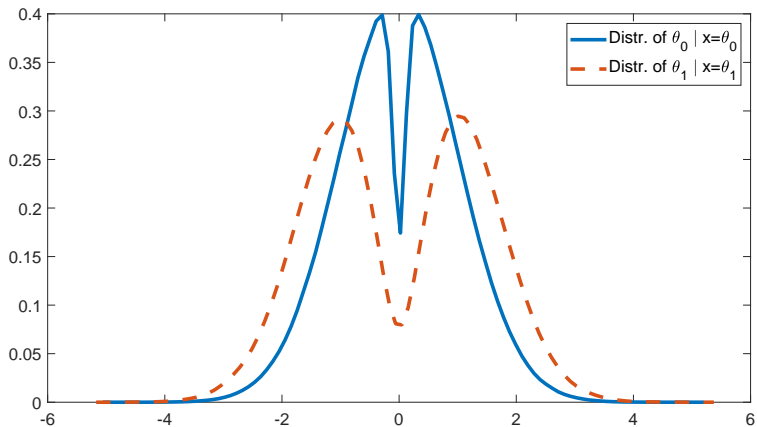
Proposition: The probability that the two firms report about the same event is decreasing in revenue per reader r and increasing in the cost parameter k , i.e.

$$\frac{\partial p(x_{\bar{i}}^* = x_{\underline{i}}^*)}{\partial r} < 0 \text{ and } \frac{\partial p(x_{\bar{i}}^* = x_{\underline{i}}^*)}{\partial k} > 0$$

Proposition: The less frequently a variable is reported, the larger is the variance conditional on being reported, i.e.

$$\frac{\partial \mathbb{V}(\theta_0 \mid x_i^* = \theta_0)}{\partial i} > 0$$

Conditional distribution of news reports P_i^{ast} with $i = 1/10$



Some additional results

Information vs recommended actions: Simple actions

An action is **simple** if it is of lower dimension than the states that enter utility function, e.g.

$$a_i^* = -(1 - i)\theta_0 - i\theta_1$$

- With simple actions, attention cost of advice is lower than equally useful information about the state
- However, with heterogeneous readership, information may allow for exploiting economies of scale.

Example 1: New York Times endorsing a presidential candidate is equally useful for a liberal and conservative reader and is less costly than listing every quality of every candidate

Example 2: A newspaper covering both fixed income and stock markets attracts a larger readership than giving a single portfolio recommendation if population have different risk tolerances

Equilibrium profits

In markets with standard goods the price determines both the cost to the consumer and the unit revenue for the firm

⇒ Free entry ensures that profits are zero in equilibrium

Here, profits can be positive in equilibrium in spite of free entry.

- The cost facing the consumer is separate from the unit revenue for firm
- Not possible to lower cost to consumer without altering product

Proposition For low enough k there exists a high enough c and information structures $P' \prec P''$ such that $K(P'') = K(P')$, yet P' is provided in equilibrium and the firm providing P' is making a positive profit.

Even though an information structure P'' exists that (i) would make all agents better informed and (ii) is equally costly as P' to produce, it will not be provided in equilibrium.

Conclusions

- Propose a formal framework to model monitoring and editorial decisions
- Attention costs can explain state-dependent reporting
- Information gathering costs and revenue per reader determine degree of specialization, variance of reported events and probability of commonly observed events
- Economies of scale can explain why most news reports are not in the form of recommended actions

Additional slides

Contestable equilibrium

Industry configuration An industry configuration $(P_j, S_j)_{j \in J^a}$ describes a set $J^a \subseteq J$ of active firms and, for every $j \in J^a$, an information structure P_j and a readership $S_j \subseteq I$.

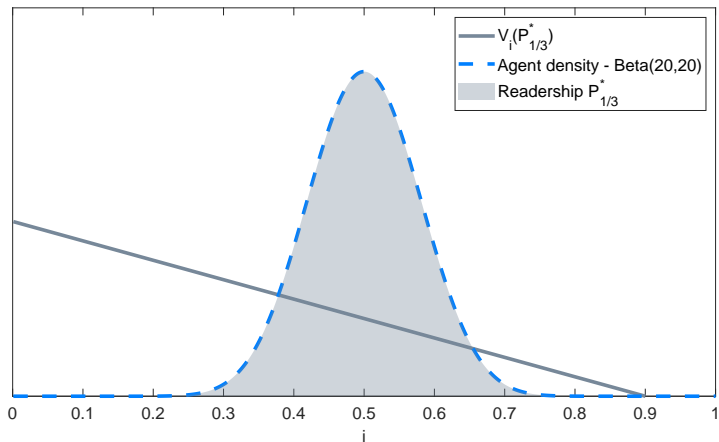
Feasible configuration An industry configuration $(P_j, S_j)_{j \in J^a}$ is feasible if, for all $j \in J^a$, $R(S_j) \geq K(P_j)$.

Agent-optimal configuration An industry configuration $(P_j, S_j)_{j \in J^a}$ is agent-optimal if, for all $j, j' \in J^a$ and $i \in S_j$, $V_i(P_j) \geq V_i(P_{j'})$ and $V_i(P_j) \geq \max_{a_i} E[u_i(a_i, \theta)]$.

Sustainable configuration An industry configuration $(P_j, S_j)_{j \in J^a}$ is sustainable if there is no information structure $P_{j'}$, with $j' \notin J^a$, and associated readership $S_{j'}$ such that (i) $V_i(P_{j'}) > V_i(P_j)$ for all $i \in S_{j'}$ and all $j \in J^a$, and (ii) $R(S_{j'}) > K(P_{j'})$.

Equilibrium configuration An industry configuration is an equilibrium if it is feasible, agent-optimal, and sustainable.

Attention cost and size of readership



Attention cost and size of readership

