Welfare and Regulation in Markets for Complex Products

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Background

Standard models of consumer search with imperfect information:

- Consumer(s) (possibly heterogeneous) visit firms in sequence;
- During a visit, they observe prices and match values, or at least information about these things;
- Visits are costly (at least for some consumers), and consumers decide when to stop and purchase;
- Consumers do not control the information they obtain about a firm's product outside of the visit decision.

This Paper

- Some products–insurance plans, e.g.–are difficult to understand;
- Embed a dynamic information acquisition problem into a search model;
- When a consumer is at a firm, she learns about its product at a cost;
- Think cognitive cost or "real cost" of hiring consultants;
- There is also information asymmetry w.r.t. price: consumer learns *before* observing price offer (hidden fees);
- Effect of 3 policy interventions:
  1. Transparent pricing;
  2. Reduce search frictions;
  3. Reduce learning costs.

What We Find

Baseline Setting

- Hold-up problem $\Rightarrow$ No pure strategy equilibria;
- Price dispersion and consumer capriciousness;
- Explicit search costs act as usual (market power for firms);
- U-shaped relationship of (consumer, firm) welfare in information friction.

Beneficial Interventions

- Reduction in search costs (only for consumers);
- Transparent prices (possibly Pareto improving).

Possibly Harmful Interventions

- Reduced information frictions (possibly Pareto worsening).

The Model

- A continuum of consumers with unit demand and a continuum of symmetric firms;
- Random search;
- When at a firm, a consumer acquires information flexibly (next slide);
- When she stops acquiring information at a firm she either stops or continues her search, paying a search cost $c > 0$ to visit another firm (selected at random);
- First visit is free;
- Prices can only be observed by visiting a firm;
- Consumer o.o. is 0.

Dynamic Information Acquisition

- Consumer has an initial value for the product of $\mu > 0$;
- Consumer acquires information by running Brownian motion at a flow cost of $\gamma > 0$;
- Value $v(t)$ evolves according to $dv = \sigma dW$, where W is standardized Brownian motion w/ std.d. σ;
- A consumer faces a stopping problem.

Simplifying the Information Acquisition Problem

- At a firm, a consumer's information acquisition strategy is a stopping time, τ;
- Any such τ generates a distribution over values, u, for the product, F_τ;

$$F_\tau(u) := \mathbb{P}(U_\tau \leq u)$$

- $\mathcal{M}(\mu)$: the set of (Borel) probability measures on $\mathbb{R}$ with mean μ.

Definition

ex-ante cost of distribution $Q \in \mathcal{M}(\mu)$, $C(Q)$, is the minimal cost at which the consumer can generate Q:

$$C(Q) := \inf_{\tau : F_\tau = Q} \mathbb{E}[\gamma\tau]$$

Skorokhod Embedding Problem

Theorem (2.1 in Root 1969)

The *ex-ante* cost of distribution $Q \in \mathcal{M}(\mu)$ over values, $C : \mathcal{M}(\mu) \to \mathbb{R}^+$, is

$$C(Q) = \kappa \int_{-\infty}^{\infty} (x - \mu)^2 \, dQ(x)$$

where $\kappa := \gamma/\sigma^2$.

- See also Georgiadis & Szentes (2020);
- Static reinterpretation: from now on, think of a consumer choosing any distribution over posterior values Q with mean μ subject to a cost proportional to the variance;
- Can write a similar model with a binary state (match value) and Wald problems for Bayesian consumers then use the static equivalence of Morris & Strack (2017).
- Assume $c \leq \frac{1}{4\kappa}$.

Back to the search setting

- A Consumer faces a *static* problem each period;
- Akin to McCall (1970) job search problem;
- Let $g(v)$ be a consumer's payoff from stopping her information acquisition at value v. She solves

$$\max_{Q \in \mathcal{M}(\mu)} \left\{ \mathbb{E}_Q \left[g(v) \right] - C\left(Q\right) \right\} = \max_{Q \in \mathcal{M}(\mu)} \left\{ \int_{-\infty}^{\infty} g(v) dQ(v) - \kappa \int_{-\infty}^{\infty} \left(v - \mu\right)^2 dQ\left(v\right) \right\}$$

- Firms randomizing via H, $g(\cdot)$ is

$$g\left(v\right) = \int_{\underline{p}}^{v-a} \left(v - p\right) dH\left(p\right) + \int_{v-a}^{\bar{p}} a dH\left(p\right)$$

where a is (endogenous) o.o. (continuation value).

Hidden Prices/Fees Equilibrium

Theorem

There is an (essentially) unique symmetric equilibrium. It involves active search if and only if $\mu - \sqrt{c/\kappa} > \underline{p}$*, where the price* $\underline{p}$ *solves*

$$\ln\left\{1 + \frac{1}{2\kappa \underline{p}}\right\} = \frac{1}{\underline{p}}\sqrt{\frac{c}{\kappa}} \ .$$

The empirical distribution over consumer valuations is

$$F(x) := 1 - \frac{\mu - \sqrt{\frac{c}{\kappa}}}{x}, \quad \text{on} \quad \left[\mu - \sqrt{\frac{c}{\kappa}}, \mu - \sqrt{\frac{c}{\kappa}} + \frac{1}{2\kappa}\right] \ ,$$

and the firms choose uniform distributions over prices

$$G(p) := 2\kappa\left(p - \underline{p}\right), \quad \text{on} \quad \left[\underline{p}, \bar{p}\right] \ .$$

Hidden Prices

Theorem (Continued)

The payoffs are

$$\hat{\Pi} = \underline{p}, \quad \text{and} \quad \hat{\Phi} = \mu - \underline{p} + c - \sqrt{\frac{c}{\kappa}}\,.$$

If $\mu - \sqrt{c/\kappa} \leq \underline{p}$*, the unique equilibrium is the monopoly equilibrium with* $a = 0$*.*

- Price dispersion, despite consumer homogeneity;
- Consumers are capricious, mercurial: some stop right away, others look longer;
- Why no p.s. equilibria?
  - An informational hold-up problem;
  - Deterministic price $\Rightarrow$ consumers' learning is deterministic $\Rightarrow$ secretly raise price.

Comparative Statics (in One Slide)

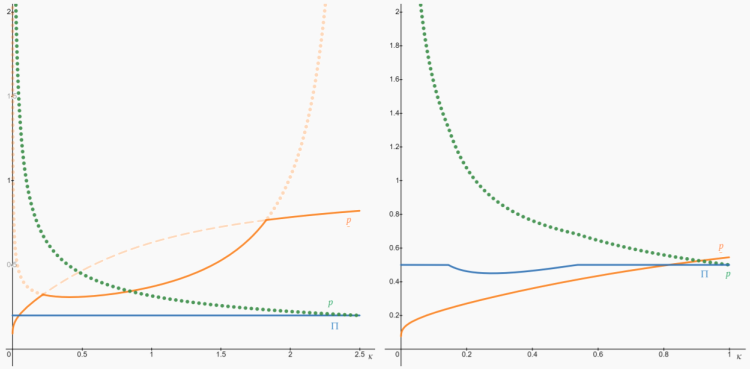
- Increasing μ does not affect prices or profits, increases consumer payoffs;
- Increasing c benefits firms, hurts consumers, $\underline{p} \uparrow$, & price distributions $\uparrow$ in FOSD;
- $\underline{p}$ and consumer payoff are u-shaped in κ: region of (strict) Pareto improvement in κ!

Transparent Prices (Also in One)

- Each firm sets a price p (focus on symmetric equilibria);
- Consumers only observe prices when they visit; for now, before learning;
- Consumers conjecture market price $\tilde{p}$;
- At equilibrium, $\tilde{p} = p$.
- There exists a unique symmetric equilibrium:

$$p_I = \sqrt{\frac{c}{\kappa}}, \quad \Phi_I^* = \mu + \frac{1}{4\kappa} + c - 2\sqrt{\frac{c}{\kappa}} \quad \text{and} \quad \Pi_I^* = 2c$$

Hidden Versus Visible

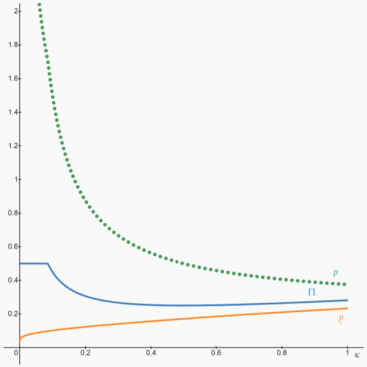


(a) **Case 1:** $\mu > 0$ and $c \leq \mu/4$.

(b) **Case 2:** $\mu > 0$ and $\mu/3 \geq c \geq \mu/4$.

Figure 5: Profit with observable prices (solid blue), price with observable prices (dotted green), and profit and price lower bound with hidden prices (solid orange) as functions of κ.

Hidden Versus Visible II



(c) **Case 3:** $\mu > 0$ and $c \geq \mu/3$.

Figure 5: Profit with observable prices (solid blue), price with observable prices (dotted green), and profit and price lower bound with hidden prices (solid orange) as functions of κ.

In Sum

Proposition

Consumer welfare when prices are observed before learning is strictly higher than when prices are observed after learning.

Firms prefer that consumers observe prices before learning if and only if μ is sufficiently low.

Related Work

- Monopoly pricing with flexible information acquisition: Branco, Sun, and Villas-Boas (2012); Lang (2017); & Pease (2018).
- Dynamic information acquisition about multiple produces: Ke, Shen, and Villas-Boas (2016).
- Markets with rational inattention: Matějka & McKay (2012) prices are increasing in the information friction; Zhong (2015); De Clippel, Eliaz, & Rozen (2014) "staying under the radar;" Eliaz & Spiegler (2011, 2011);
- Simultaneous search: Liu & Dukes (2015);
- Persuasion: Brocas & Carrillo (2007), Gentzkow & Kamenica (2014), Henry & Ottaviani (2019);
- Informational Holdup in Monopoly Problem: Ravid, Roesler & Szentes (2022).

Summing Things Up

- (Explicit) search frictions and information frictions are completely different;
- No advertised prices $\Rightarrow$ search frictions transfer surplus from consumers to firms;
- With information frictions, consumers have more scope to react to price deviations $\Rightarrow$ information frictions may benefit consumers (regardless of whether prices are hidden);
- Consumers always prefer transparent prices, firms may prefer hidden.

That's All!