Warm up by Revelation to Cool down in Competition: Strategic Provision of Relationship-sensitive Information

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January 05-07, 2024

A Motivating Example

Multi-purchase in Hotelling Model

Microsoft vs. Apple. Consumers hold heterogeneous preferences over Surface vs. iPad.

- Single-purchase: each consumer buys **either** “Windows” **or** “iOS” — price competition for the brand-switching consumer.
  - Duopolists **compete** in prices
- Multi-purchase: some consumers may be willing to buy **both**.
  - For those who are going to use both products, a (unilateral) price cut of Surface encourages more iPad-customers to buy Surface as an additional tablet PC — without affecting the demand for Apple.
  - Prices are adjusted **independently**.

Question: How do firms offer prices when they cannot specify their relationship? Will an informed firm has an incentive to share such “relationship-information” to its rival?

Background

- In platform markets, compared with individual sellers, the digital platform (as a marketplace), is better informed about consumers' purchase behavior.
  - Product complementarity; Variety-seeking preferences.
- Data services like Amazon Brand Analytics or Google Play Console, provide patronized firms a plenty of raw data about their own business, but only a tiny part of the whole picture of the entire market, especially the interactions among competitors.
- The reluctance in sharing data that contains relevant information about competitors, is accused of "self-preferencing," e.g., the competition between third-party sellers vs. marketplace controller retail verticals.

An investigation conducted by Gineikytė, Barcevičius and Cibaitė (2021) shows that 52% of the patronized sellers in Amazon cannot access the information about the competitions in the entire market. They complained that the information provided is
"*simply not enough considering what access to data Amazon Retail has.*"[1]

TABLE 3. TYPES OF DATA AND ANALYTICS ACCESSIBLE BY AMAZON MARKETPLACE SELLERS

AMAZON	USER IDENTIFICATION DETAILS	DATA ON TRANSACTIONS BETWEEN BUSINESSES AND CUSTOMERS		BUSINESS PERFORMANCE		USER BEHAVIOUR		ANALYSES OF MARKET TRENDS/ DEVELOPMENTS
		Own	*Competitor*	*Own*	*Competitor*	*Own*	*Competitor*	
Raw data	Some	Yes	No	Yes	No	No	No	NA
Analytics	NA	Some	No	Yes	No	Some	Some	Some
Insights/ Actionable guidelines	NA	Some		Yes		Some		Some

[1] Gineikytė, V., Barcevičius, E., Cibaitė, G. (2021). Business user and third-party access to online platform data : analytical paper 5, European Commission, Directorate-General for Communications Networks, Content and Technology, Publications Office.

Outline

We study the equilibrium pricing and information sharing incentives between an informed platform (first-party) vs. uninformed third-party seller, when the information about brand complementarity is asymmetrically endowed.

1. What are their optimal pricing strategies?
2. Will the informed seller be willing to share the information with its competitor and on what grounds?
   - with commitment (information design approach)
   - unverifiable without commitment (cheap talk approach)
   - verifiable without commitment (this paper)
3. What is the socially optimal provision of relationship-sensitive data?

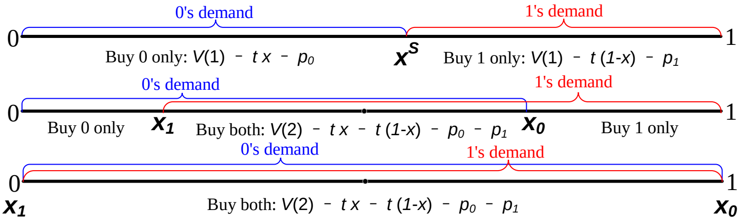
Main Results

1. In contrast to the general insights that the platform may avoid data openness that would allow patronized sellers to become competitors, the information will be revealed in an upcoming competition, in order to prevent the rival from charging a low price.
    - Concealing information itself could be informative.
    - Provide distinct explanations/suggest new strategies for platform data services.
2. It is socially optimal to make the information about complementarity public.

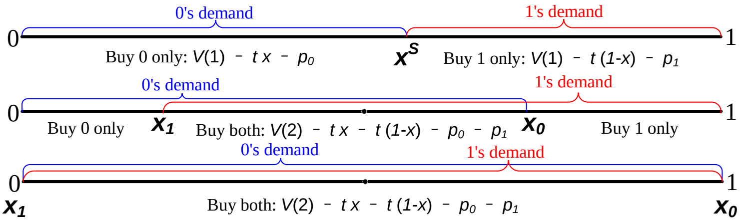
Related Literature

- IO literature on multi-purchase (Gabszewicz and Wauthy, 2003; Zeithammer and Thomadsen, 2013; Kim and Serfes, 2006; Jeitschko et al., 2017; Anderson et al. 2017; Dou and Ye, 2018; Ambrus et al., 2016; among others)
- IO literature on information revelation, acquisition, and disclosure (Liu and Serfes, 2006; Kim and Choi, 2010; Chen et al., 2001; Wang and Zheng, 2022; among others)
- Type of revelation (information design; cheap talk; information disclosure)
- Type of information in IO literature (market demand, firm-specific characters; consumer information)
- Platform economics and privacy regulations

Preliminaries



- Two brand owners, 0 and 1. One mass of consumers hold horizontally heterogeneous preferences.
- Brand-specific preferences: $-tx$ if buying 0; $-t(1-x)$ if buying 1.
- Consuming one brand gives $V(1)$. Consuming both brands gives $V(2)$. Assume $V(2) = V(1) + \beta$, where β is the marginal utility from consuming a different brand.



Single-purchase (S) no consumer makes multi-purchase:

$$\hat{x}^S = \frac{1}{2} + \frac{p_1 - p_0}{2t}$$

Multi-purchase (M) some but not all consumers make multi-purchase:

$$\hat{x}_1 = 1 - \frac{\beta - p_1}{t}, \ \hat{x}_0 = \frac{\beta - p_0}{t}$$

A boundary case (B) all consumers make multi-purchase:

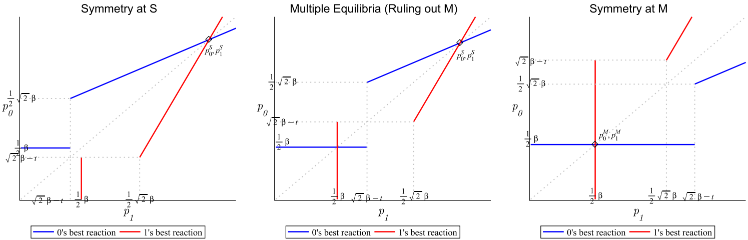
$$\hat{x}_1 = 0, \ \hat{x}_0 = 1$$

"Full information" about β (Benchmark F)

- When β is low relative to $p_0 + p_1$ such that nobody makes multi-purchase, firms compete for the brand-switching consumer $\hat{x}^S$:
  - They respond to each other $p_i^{BR} = \frac{p_{-i}+t}{2}$.
  - Profit is increasing in rival's price $\pi_i^S = \frac{(p_{-i}+t)^2}{8t}$.
- When β is of a moderate size such that $\hat{x}_1 < \hat{x}_0$, some consumers make multi-purchase
  - Firm 0's payoff is $p_0\hat{x}_0$; Firm 1's payoff is $p_1(1-\hat{x}_1)$.
  - Each seller solves its own problem independently as a local monopoly: $p_i^M = \arg\max_{p_i} p_i\frac{\beta - p_i}{t} = \frac{\beta}{2}$
  - The payoff $\pi_i^M = \frac{\beta^2}{4t}$ is orthogonal to the rival's actions.
- When β is high enough such that $\hat{x}_1 \leq 0 < 1 \leq \hat{x}_0$, all consumers make multi-purchase.
  - A boundary case. The demand of each seller is fixed to be 1.
  - $p_i^B = \beta - t$; $\pi_i^B = \beta - t$.

Symmetric Nash Equilibrium

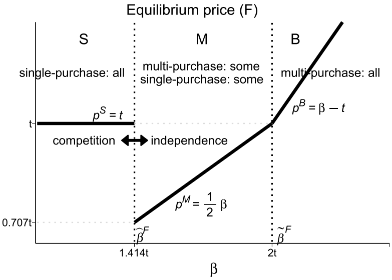
Intersections of best responses:



The symmetric equilibrium price:

$$\begin{cases} p_i^S = t, \quad \beta < \sqrt{2}t \text{ (single-purchase \& strategic complements)} \\ p_i^M = \frac{\beta}{2}, \quad \sqrt{2}t \leq \beta \leq 2t \text{ (multi-purchase \& independence)} \\ p_i^B = \beta - t, \quad 2t \leq \beta \text{ (boundary case for multi-purchase)} \end{cases}$$

Equilibrium Prices: Conditional on Firms' Relationship



S (competition) price is a function of differentiation t.

M (independence) price is a function of complementarity β; low prices for "demand-expansion."

B (independence) all consumers are "captive" leading to high prices.

"Asymmetric information" about β (Benchmark A)

- Assume: firm 0 (Shipped and sold by Amazon) is informed about β, whereby firm 1 (third-party seller) is not. Firm 1's prior about β is uniformly distributed over $[0, \overline{\beta}]$.
  - That "firm 0 knows β and firm 1 does not" is common knowledge.
- Pricing patterns:
  - Firm 1 charges a flat price conditional on prior ($\overline{\beta}$).
  - By observing the true β, firm 0 is able to choose between: (1) responding to firm 1's flat price to induce single-purchase; (2) pricing independently to induce multi-purchase (according to the true β)

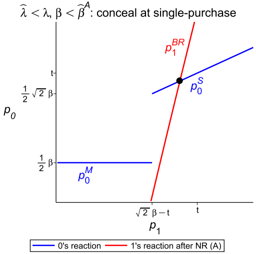
The Whole Plan of the Informed Firm

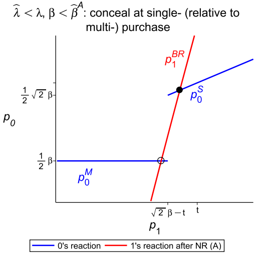
- Assume firm 1 charges p_1. Given p_1 and the true β, firm 0 has three choices:
  1. Under $\hat{x}_1 > \hat{x}_0 \Rightarrow$ single-purchase, firm 0 responds to firm 1 by charging $p_0^S = \frac{p_1+t}{2}$ as a best response.
  2. Under $0 < \hat{x}_1 < \hat{x}_0 < 1 \Rightarrow$ multi-purchase (interior), firm 0 charges $p_0^M = \frac{\beta}{2} \Rightarrow \pi_0^M$ independently.
  3. Under $1 \leq \hat{x}_0 \Rightarrow$ multi-purchase (boundary), firm 0 charges $p_0^B = \beta - t \Rightarrow$ independently.
- The options (1) and (2) are equally profitable evaluated at $p_1 = \sqrt{2}\hat{\beta}^A - t$. That is
  - If $\beta < \hat{\beta}^A$, firm 0 charges p_0^S to compete.
  - If $\beta > \hat{\beta}^A$, firm 0 charges p_0^M or p_0^B independently.
- The above plan can be commonly inferred by both firms.

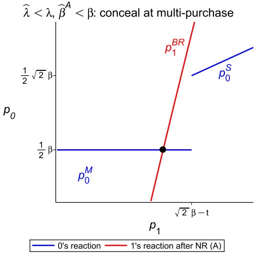
- Given firm 0's whole plan, firm 1 solves

$$\max_{p_1} \underbrace{\int_0^{\hat{\beta}^A} \frac{1}{\beta} p_1 (1-\hat{x}^S)\, d\beta}_{S} + \underbrace{\int_{\hat{\beta}^A}^{p_1+t} \frac{1}{\beta} p_1 (1-\hat{x}_1)\, d\beta}_{M} + \underbrace{\int_{p_1+t}^{\overline{\beta}} \frac{1}{\beta} p_1\, d\beta}_{B}.$$

- The equilibrium consists of 5 unknowns $(p_1^A, p_0^S, p_0^M, p_0^B, \hat{\beta}^A)$, which are solved by the conditions given above.







Strategic Revelation (Benchmark R)

- The informed firm can choose whether to reveal the true β to its rival.
  1. Firm 0 can choose to reveal or to keep silent.
  2. Firms offer prices simultaneously.
  3. Consumers make purchase decisions.
- The information is verifiable, i.e., reporting a false β is not allowed.
- If firm 0 reveals, then the equilibrium reduces to that under complete information; otherwise, for firm 1:
  - Withholding information for the purpose of inducing a price in the interests of firm 0.
  - Firm 1 updates its belief about β and charges a flat price.
  - Firm 0 may not necessarily charge a price according to the true β, but also responds optimally to firm 1's revised belief.

Restrictions on "Independence"

- Consider for some reasons, keeping to be independent is optimal. Then, the revelation action is irrelevant. If the revelation actions are conducted completely randomly, firm 1's belief cannot be well defined.
- To restrict firm 0's behavior at independence, assume that revelation brings about a cost $\lambda > 0$.
  - The data sharing process is not entirely free: legal barriers/revision of back-end code/interoperability and portability, etc.
- Therefore, firm 0's revelation strategy can be described along two dimensions
  - The information β (private information)
  - Revelation cost λ (common knowledge)

A high $\beta \Rightarrow$ multi-purchase; A low $\beta \Rightarrow$ single-purchase; A high $\lambda \Rightarrow$ conceal; A low $\lambda \Rightarrow$ reveal.

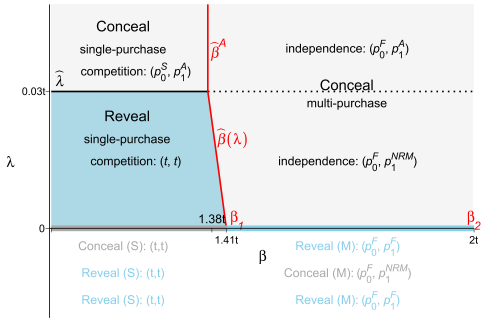
RS (reveal at single-purchase) : $\beta < \hat{\beta}^R$ and $\lambda < \hat{\lambda}$.

NRS (conceal at single-purchase) : $\beta < \hat{\beta}^R$ and $\lambda > \hat{\lambda}$.

NRM (conceal at multi-purchase) : $\beta > \hat{\beta}$.

RM (reveal at multi-purchase) : Strictly dominated due to $\lambda > 0$.

- Under single-purchase, $p_0^S = \frac{p_1+t}{2}$ and hence the equilibrium is orthogonal to β.
  - Indifferent between (RS) and (NRS): $\pi_0^S(\text{conceal}) = \pi_0^S(\text{reveal}) - \hat{\lambda}$.
  - At single-purchase, a higher p_1 benefits firm 0.
- Between single- and multi-purchase:
  - Indifferent between (RS) and (NRM): $\pi_0^S(\text{reveal}) - \lambda = \pi_0^M(\text{conceal}) \Rightarrow \hat{\beta}(\lambda)$.
  - Indifferent between (NRS) and (NRM): $\hat{\beta}^R$ is equivalent to $\hat{\beta}^A$ as in "asymmetric information"

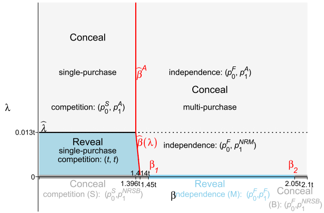


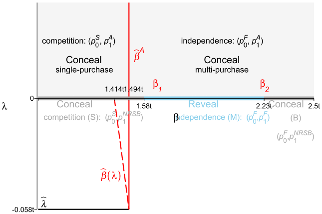
- Upon "concealment" is observed:
  - If $\lambda > \hat{\lambda}$: firm 1 charges p_1^A (benchmark A).
  - If $\lambda < \hat{\lambda}$: firm 1 revises its belief by eliminating "S," and solves

$$p_1^{NRM} = \arg\max_{p_1} \underbrace{\int_{\hat{\beta}(\lambda)}^{p_1+t} \frac{1}{\overline{\beta} - \hat{\beta}(\lambda)} p_1 (1 - \hat{x}_1) d\beta}_{M} + \underbrace{\int_{p_1+t}^{\overline{\beta}} \frac{1}{\overline{\beta} - \hat{\beta}(\lambda)} p_1 \, d\beta}_{B}.$$

“Partial Revelation” vs. “Never Reveal”

- At single-purchase, firm 0’s payoff is increasing in p_1.
- At multi-purchase, revealing β is unnecessary.
- There are two reasons not to reveal at single-purchase:
  - A high λ, or
  - If concealing β induce a p_1 that is higher than revealing β.
- Without revealing, p_1^A is increasing in $\overline{\beta}$. Hence a greater $\overline{\beta}$ combined with a high λ leads to “never reveal” $\Rightarrow$ Asymmetric information is a special case.





A Refinement for $\lambda = 0$

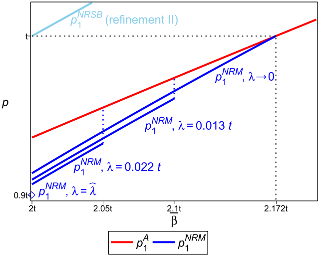
- One possible refinement for $\lambda = 0$, is to assume that at independence, firm 0 conceals. Then the above analysis is also valid for all $\lambda \geq 0$.
- Actually, at $\lambda = 0$, firm can 0 do better!
  - Indeed at independence, revealing or not does not make a difference.
  - However, at price competition, firm 0's problem can be transformed as maximizing the rival's price p_1.
  - The equilibrium price is relatively high when β is either "too low" or "too high."
  - Therefore, in order to maximize p_1, firm 0 can conceal for a relatively low and a relatively high β, and reveal only when β is neither too high nor too low.
- Such type looks reasonable and can be consistent with firm 1's belief.

- When it is costly to share information, the informed seller reveals information for an upcoming competition to achieve a win-win outcome supporting high prices.
- When sharing information is completely costless, the informed seller conceals information for an upcoming competition, whereas reveals information when it looks "unnecessary" to do so.
- Consistent with the common beliefs from the third-party users who feel that "they are put into a disadvantageous position," and the claimant from the informed platform insisting that "no intention to harm their business users." The platform indeed provides some "data insights" that are thought to be uninformative when there is no conflicts of interests, but such insights could be interpreted as a signal for "being ready to compete."

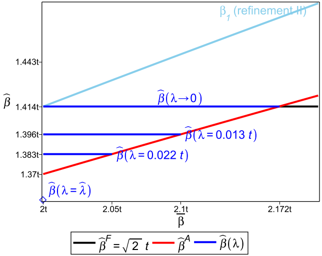
Optimal Data Regulations

- Total surplus is the sum of consumers' utilities and firms' profits. For the Hotelling model, in particular:
  1. At single-purchase equilibrium, total surplus is maximized when the sum of travel disutilities is minimized $\Rightarrow$ symmetric prices are optimal.
  2. At multi-purchase equilibrium, total surplus is increasing in the market coverage $\Rightarrow$ a lower sum $p_0 + p_1$ is socially desirable.
  3. Multi-purchase equilibrium generates a greater volume of transactions than that under single-purchase equilibrium.

Equilibrium prices and competition-independence thresholds



(a) Equilibrium prices

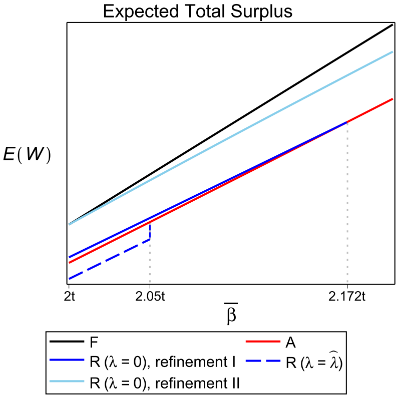


(b) Equilibrium thresholds

- Allowing information sharing whereby increasing the sharing cost gives the lowest price; But it incurs a cost under single-purchase.
- The competition-independence threshold is the lowest when the informed seller is not allowed to reveal or chooses never to reveal; But it results in asymmetric prices under single-purchase.

Comparing the Expected Welfare

The authority sets a rule chosen from: F, A, R by comparing expected welfare.



- "Full information" is the most socially efficient policy unconditionally.
- At complete information, the transition from single- to multi-purchase is symmetric, where prices of both sellers exhibit a downward jump simultaneously, bringing about a huge gain in expanding the market coverage.
- Under asymmetric information, the uninformed seller has to charge a constant price that is "smoothed" by expectation, restricting the market-expansion effect.

Summary

- We fully characterize the pricing equilibrium of a duopoly market where firms' information regarding consumers' variety seeking preferences is asymmetric.
- We examine the informed firm's strategic information revelation behavior.
- We solve for the socially optimal information disclosure policy.

Directions for future work

- Strategic information acquisition by firms
- Information design with commitment
- Consumer preferences for privacy
- Alternative settings regarding information rent
- Experimental test of the theory

Thank You for Listening!!