Online Privacy and Information Disclosure by Consumers

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Question

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▶ Model:
  ▶ Consumer discloses information
  ▶ Seller makes a product recommendation

▶ A key trade-off:
  ▶ Benefit: Recommend/advertise appropriate products
  ▶ Cost: (Potential) price discrimination
# Related Literature

## Consumers’ Personal Data
- Calzorari and Pavan (2006)
- Bergemann and Bonatti (2011, 2015)

## Behavioral Price Discrimination
- Fudenberg and Tirole (2000)
- Taylor (2004)
- Acquisti and Varian (2005)

## Endogenous Privacy Choice
- Conitzer, Taylor, and Wagman (2012)
- Braghieri (2017)

## Information Design
- Bergemann, Brooks, and Morris (2015)
- Condorelli and Szentes (2017)
- Roesler and Szentes (2017)
Roadmap

1. Model
2. Results
3. Extension
Model: Primitives

Players:
- Seller sells products 1 and 2
- Consumer with unit demand
- \((u_1, u_2)\): value of each product, IID

Preferences:
- Consumer: value \((u_k)\) — price, or zero
- Seller: revenue
Two Pricing Regimes

Nondiscriminatory & discriminatory pricing
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Nondiscriminatory & discriminatory pricing

Pricing (Nondisc.)
Two Pricing Regimes

Nondiscriminatory & discriminatory pricing

Consumer discloses information

Pricing (Nondisc.)
Two Pricing Regimes

Nondiscriminatory & discriminatory pricing

Consumer

discloses

information

Pricing

(NoDisc.)

Seller

recommends

a product
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Consumer
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Seller
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Pricing (Disc.)
Before observing \((u_1, u_2)\), Consumer chooses a disclosure level \(\delta \in \left[\frac{1}{2}, 1\right]\).

Seller observes \(\delta\) and a signal realization.
Timing of the Game

Nondiscriminatory & discriminatory pricing

Pricing (Nondisc.)

Consumer chooses $\delta$

Pricing (Disc.)

Seller recommends a product

Consumer’s purchase decision
Recommendation & Purchase

After Seller updates its belief:
Recommendation & Purchase

After Seller updates its belief:

Seller recommends one product
Consumer learns value & price
Consumer decides whether to buy it
Recommendation & Purchase

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- Assumption: Consumer cannot buy non-recommended product
Recommendation & Purchase

After Seller updates its belief:

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- Assumption: Consumer cannot buy non-recommended product
- Limited attention: Consumer fails to consider all available products
  (Salant and Rubinstein [2008], Eliaz and Spiegler [2011], etc)
Recommendation & Purchase

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- Assumption: Consumer cannot buy non-recommended product
- Limited attention: Consumer fails to consider all available products
  (Salant and Rubinstein [2008], Eliaz and Spiegler [2011], etc)
- Seller can influence what consumers pay attention to
Timing of Game & Solution Concept

Consumer chooses $\delta$

Seller recommends a product

Consumer’s purchase decision

Pricing (Nondisc.)

Pricing (Disc.)

Solution: SPE with Seller and Consumer’s tie-breaking
Roadmap

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Equilibrium Recommendation

\[ u_1 \geq u_2 \quad \delta \quad \text{signal 1} \rightarrow \text{Product 1} \]

\[ u_1 \leq u_2 \quad \delta \quad \text{signal 2} \rightarrow \text{Product 2} \]
Equilibrium Recommendation

\( u_1 \geq u_2 \rightarrow \text{signal 1} \rightarrow \text{Product 1} \)

\( u_1 \leq u_2 \rightarrow \text{signal 2} \rightarrow \text{Product 2} \)

- More disclosure \(\rightarrow\) better product match
Equilibrium Pricing

As Consumer increases $\delta$ under discriminatory pricing,

- Seller is more likely to recommend the best product $\max(u_1, u_2)$
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- Pricing
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  - “less elastic” demand
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  - Lower hazard rate (stronger than FOSD)
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- Pricing → Monopolist sets a higher price
Theorem

In the unique equilibrium, Seller is better off and Consumer is worse off under nondiscriminatory pricing.

Main Result
Main Result

Theorem

In the unique equilibrium, Seller is better off and Consumer is worse off under nondiscriminatory pricing.
Intuition

[Diagram showing a line with annotations]
Intuition

Pricing
(Nondisc.)

Consumer chooses $\delta$

Product recomm.

Purchasing decision

Nondiscriminatory:
I Highest disclosure level ($\delta = 1$) to get best recomm.
I Seller sets a high price ($p(1)$), higher payoff.

Discriminatory:
I Consumer is the Stackelberg leader
I Disclose less info, lower price ($p(\delta^*)$), higher payoff.
Pricing (Disc.)

I Seller sets a high price (p(1))

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Intuition

Consumer chooses δ

Product recomm.

Purchasing decision

Pricing (Nondisc.)

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Intuition

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(Nondisc.)

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Intuition

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Pricing (Nondisc.)

Pricing (Disc.)

Nondiscriminatory:

- Highest disclosure level ($\delta = 1$) to get best recomm.
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Intuition

Consumer
chooses $\delta$

Product
recomm.

Purchasing
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Intuition

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Aside: Second Intuition

Alternative interpretation of the model:

- A *continuum* of consumers
- Seller sets prices after disclosure
  - Discriminatory: Different prices to different consumers
  - Nondiscriminatory: A single price for each product
Aside: Second Intuition

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Equilibrium:

- Consumers are worse off under NDP
- *Negative externality* under NDP: Disclosure hurts other consumers through higher prices
Main Result

**Theorem**

_In the unique equilibrium, Seller is better off and Consumer is worse off under nondiscriminatory pricing._
1. A rationale for nondiscriminatory pricing

Discriminatory pricing → less disclosure → product mismatch

2. Consumers disclose “too much” under NDP

Better by precommitting to withhold information

Regulation to limit disclosure?

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- Consumer can disclose any info. about $(u_1, \ldots, u_K)$
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  - Information design
  - If $K = 1$, Bergemann, Brooks, and Morris (2015)
Result

Unrestricted model with $K \geq 2$
Result

Unrestricted model with $K \geq 2$

Theorem

Seller is better off and Consumer is worse off under NDP.
Result

Unrestricted model with $K \geq 2$

**Theorem**

_Seller is better off and Consumer is worse off under NDP._

- Benefit of accurate rec. $> \text{Loss from no price disc.}$
- Characterize the efficient disclosure policy
- In contrast to $K = 1 \ \text{(BBM, 2015)}$
Total Surplus

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  - NDP $\rightarrow$ accurate recommendation
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**Proposition**

*For a sufficiently large $K$, NDP achieves greater total surplus. (Both in the restricted and unrestricted models)*
Summary

Welfare & price implications of consumers’ privacy?

Model:
- Multi-product Seller
- Consumer with limited attention
- Information affects pricing & recommendation

Results: Committing NOT to price discriminate

1. benefits Seller,
2. hurts Consumer, and
3. may improve total welfare

Extension: Selling data
Market for Data

- Seller can offer financial incentives for collecting info.
  Offer: What Consumer discloses + how much Seller pays
- Consumer accepts → Seller obtains info and makes payment
- Consumer rejects → play the original game
- Again, consider two pricing regimes
Market for Data

How does “market for data” change outcomes?

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  - Seller buys full info and (typically) pays positive amount
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- For some parameters, not only Consumer but Seller prefer discriminatory pricing
Concrete example of disclosure level $\delta$

- With probability 0.5, Consumer is of type $k \in \{1, 2\}$
- Type $k$ values product $k$ more, and visits Website $k$ with prob. 0.6 everyday (non-strategic)
- Seller understands this correlation
- Browsing history (1221212112 · · ·)
- Consumer decides the length of history to share (1 week? 1 year?) without realizing how his browsing history looks like
- If Seller can access a long history, it can more accurately predict Consumer’s type
- Sharing longer history $= \text{Greater} \; \delta$