Price Discrimination in the Information Age: Prices, Poaching, and Privacy with Personalized Targeted Discounts

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No longer a face in the crowd – firms know what you like.
Our premise: perfect targeting (at a cost)

Mark placed women’s underwear in his Amazon shopping cart. WTP: $75 for Victoria’s Secret.
Our premise: perfect targeting (at a cost)

Victoria’s Secret can tell Google:

**Advertise this customized price to consumers like Mark.**

“Like Mark” means…

- In current practice: matched on thousands of characteristics & behaviors.
- In our model: same willingness-to-pay profile.

Mark likes discounts, but also likes his tastes kept private.

Mark placed women’s underwear in his Amazon shopping cart.  

WTP: $75 for Victoria’s Secret
1. Does laissez-faire targeting benefit or harm consumers?

Our Setting:
Oligopoly firms purchase consumer data in order to send personalized discounts.

Consumer welfare trade-off:
- Discount savings.
- Lost privacy. (For its own sake.)
- “General equilibrium” effects on list prices.

Main Result:
Under broad conditions, a targeting ban improves CS:
- On average.
- For every consumer.
2. Privacy policy: does opt-in benefit or harm consumers?

New Policy Regime (GDPR-ish):
Only opt-in consumers may be targeted. Opt-outs give up discounts but preserve privacy.

How attentive are consumers to privacy settings?
Three cases for timing of consumer’s opt in/out decision:

Alert After seeing list prices.

Inattentive Before seeing list prices.

Rawlsian Before seeing own preferences or list prices. (Akin to a single choice that applies to many markets.)

Main Results. An opt-in requirement:

- Typically* improves CS. (Lower prices + more choice.)
  [*Alert, Rawlsian, for plausible demand systems.]

- But not always. CS may ↓ if consumers are inattentive.
  (Need better data on consumer behavior to guide policy.)
Key Mechanisms

1. Targeted discounting typically* softens list price competition.

2. Individual privacy choices create (pecuniary) externalities for other consumers.
   - Greater opt-out typically** sharpens list price competition.

*For empirically plausible demand. (Convex “captive” demand.)
**But not if consumers are inattentive.
Related Literature (not exhaustive!)

**Present company** (Apologies, but we will get up to speed...)
**Targeting** (Different info and/or prices to different market segments.)

- Homogeneous products (Galeotti and Moraga-González (2008), Roy (2000))
- Differentiated (Iyer et al. (2005), Chen et al. (2001), and Esteves and Resende (2016))

**Personalized pricing / 1st-degree price discrimination**


**Two-stage price competition** (list prices and discounts)


**Price discrimination with opt-out from tracking**

Model Overview: Two-Stage Price Competition

Stage 1
List Prices

Firms set $p_1, p_2, ..., p_n$.
- Products and list prices are public.

Stage 2
Targeted Discounting

Firm can target any consumer with a customized discount.
- Ad cost $A$ per consumer.
  (Data broker?)

Covered Market

Consumers accept best offer (list or discount).
Adding an Opt-In Policy

Alert Consumers
Condition on own tastes and actual list prices.

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Firms set \( p_1, p_2, \ldots, p_n \).
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Opt-in Decision

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Firm can target any consumer \textit{taste profile} with a customized discount.
• Ad cost \( A \) per consumer.
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Adding an Opt-In Policy

Inattentive Consumers
Condition on own tastes, expected prices.

Opt-in Decision
Firms set $p_1, p_2, \ldots, p_n$.

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“Set and Forget” Consumers

- Choose privacy setting before realizing own tastes.
- Equivalent* to a single opt in/out choice applied to all markets.

*Equivalent* to a single opt in/out choice applied to all markets.

**Opt-in Decision**

- Market 1
- Market 2
- Market 3

...
Consumer tastes and the demand system

- *n* symmetric* single-product firms (*MC = 0*).
- *Taste profile*: consumer’s vector of valuations (*r₁, ..., rₙ*).
- Some (unspecified) primitive distribution over tastes.

A consumer’s *value advantage* for Firm 1 is:

\[ y₁ = r₁ - \max_{j \neq 1} r_j \]

If *y₁ > 0*, consumer is on Firm 1’s turf. Market outcomes depend on primitive tastes only via

*Captive demand function*: \[ 1 - G(y₁) \]

where \( G(y₁) \) is cdf of a firm’s value advantage.
Convex captive demand is empirically plausible

Matters because demand curvature drives the policy conclusions. All statements are about \( 1 - G(y) \) restricted to \( y > 0 \).

1. Convexity means extreme tastes are rarer than moderate tastes \((g(y) \downarrow \text{in } y)\).

2. Captive demand \textit{must} be convex if derived from i.i.d. tastes!*

* Assuming primitive dist. is logconcave. Hotelling is special case: negatively correlated tastes \(\rightarrow\) linear captive demand.
Targeted discount competition under laissez-faire

For illustration: two-firm Hotelling.

Stage 2 following list prices $p_1$ and $p_2$. 
Which consumers will be targeted?

Either firm can pay $A$ to reach any 'location' with a discount ad.

**Marginal captive consumer:**

$$y_1^* = p_1 - A$$

Consumer $y_1^*$ is the most distant type that F2 can poach with a discount.
Captive consumers

Consumers $y_1 > y_1^*$ are captive:

- Never targeted.
- Pay Firm 1’s list price.
- Suffer no privacy cost.*
Contested: every individual is a battleground

Consumers $y_1 < y_1^*$ are contested:

- F1 and F2 compete individual by individual with customized discounts.*
- Mixed strategies. (Ad cost $A +$ Bertrand undercutting.)
- But Bertrand-like net expected profits:

$$\pi_1 = \max(y_1, 0)$$

*General case: contested by one’s top two firms only.
Welfare of a contested consumer

**Gain:** Expected discount

\[ \Delta(y_1; p_1) \]

**Loss:** Suffer ‘lost privacy’ cost

\[ c \sim H(c) \]

Later, under privacy choice policy, consumer opts in if

Alert: \( \Delta(y_1; p_1) > c \)

Inattentive: \( \Delta(y_1; p_1^e) > c \)

Rawlsian: \( E_{y_1}(\Delta(y_1; p_1^e)) > c \)

*Anticipated* list price \( p_1^e \).

Discount competition is inefficient (ad costs & misallocation). Efficiency cost \( L(y_1, p_1, A) \) is borne by consumer.
Horse Race 1: unrestricted targeting vs. a ban

**No-targeting (ban)** Symmetric list price $p^{NT}$ solves eqm FOC:

$$
\frac{d\Pi_1}{dp_1} = 1 - G \left( p_1 - p^{NT} \right) - p_1 g \left( p_1 - p^{NT} \right) = 0 \quad \text{(Standard oligopoly)}
$$

**Laissez-faire (unrestricted) targeting** Symmetric list price $p^T$ solves eqm FOC:

$$
\frac{d\Pi_1}{dp_1} = 1 - G \left( p_1 - A \right) - Ag \left( p_1 - A \right) = 0 \quad \text{(Quasi-monopoly)}
$$

**Result**

*Banning targeted discounts reduces list prices iff. captive demand is convex.*
Why targeted discounting inflates list prices

Evaluate Firm 1’s marginal profit at $p^{NT}$ under both regimes:

\[
\begin{align*}
\text{NT} & & \Pi_1'(p^{NT}) & = & 1 - G(p^{NT} - p^{NT}) - p^{NT} g(p^{NT} - p^{NT}) & = 0 \\
\text{T} & & \Pi_1'(p^{NT}) & = & 1 - G(p^{NT} - A) - A g(p^{NT} - A) & > 0
\end{align*}
\]

Effect of switching to laissez-faire:

**Negative** List price sales contract.

(Marginal captive is deeper in F1’s turf.)

**Positive** Losing a marginal list price sale is less costly.

(Win back with an ad.)

**Positive if** $g' < 0$ Marginal captive is less price-sensitive.

First two effects cancel.
Main Result 1: Do consumers benefit from targeting?

Proposition

Targeted discounts reduce aggregate consumer surplus, $CS^T < CS^{NT}$, if captive demand is sufficiently convex (for any dist. of privacy costs).

If the ad cost is high, every consumer is strictly worse off.

Example: Multinomial logit

For any logit demand system, consumers are worse off with targeted discounting than without it.

Proof strategy: Bound list-price hike below, bound discount gains above.
Opt-in Policy

Choose IN  Known utility loss $c \sim H(c)$. [Lost privacy.] Any firm can acquire your data and target you.

Choose OUT  No privacy loss, no targeted discounts.

Alternative timing assumptions for opt-in choice:

Alert  Evaluate $E(\text{discount}) - c$ based on market-specific tastes and actual list prices.

Inattentive  Same criterion, commit to choice before learning list prices.

Rawlsian  Commit before drawing tastes or learning list prices.
Alert consumers who prefer Firm 1’s product
Alert consumers who prefer Firm 1’s product

\[ \begin{align*}
    y_1 &= p_1^I - p_2^I \\
    c &= \Delta(y_1; p_1^I)
\end{align*} \]
Incentive to hike list prices: almost* a blend of NT and T

Marginal profit is an expectation over consumer privacy types.

- \( \Pi'_1| c_H \): Like standard oligopoly on most private consumers.
- \( \Pi'_1| c_L \): Closer to laissez-faire targeting on the least private.
Main Result 2: Opt-in can benefit alert consumers

**Proposition**
If captive demand is sufficiently convex*, switching from laissez-faire to opt-in makes every consumer better off.

**Example: Multinomial logit**
In any logit demand system with at least three firms, every consumer benefits from an opt-in policy.

**Logic**  Lower list prices (which help contested consumers too), plus freedom of choice.

**But!**  Opt-in looks less rosy if consumers are inattentive.

*\(\rho\)-convex with \(\rho < \frac{2}{3}\), plus a hazard rate condition.
Inattentive consumers are vulnerable to hold-up

If Firm 1’s list price is higher than expected:

- **Black margin**: Switch to Firm 2’s list price.
- **Red margin**: Held up. *Ex post*, should have opted in to get discounts.
Only the ‘black margin’ consumers discipline prices

In a symmetric equilibrium, price discipline comes from the consumers

- most indifferent between products (hence at the margin.)
- who opt out.

But perversely, it is these consumers who gain most by opting in.
Opt-in policy may backfire if consumers are inattentive

CEPR WP Example*

- Opt-in policy → price level 43% above either laissez-faire targeting or a ban.
- Almost all consumers worse off than laissez-faire. (Despite the gains to privacy.)

Moreover, with inattentive consumers this statement is not true:

An opt-in policy benefits consumers in Country X. Country Y cares more about privacy (FOSD shift of $H(c)$). Therefore opt-in would also benefit Country Y.

Composition matters. Opt-in may induce larger price hikes in Y than X if the additional opt-outs in Y pay list prices but don’t discipline them.

*Hold-up also makes a general eqm analysis messy.
Rawlsian consumers (preliminary)

**Motivation**  Consumer makes a single opt-in/out choice to cover many markets. In some she has a strong product preference (large \( y \)); in others she is more biddable.

**Equilibrium: consumer side**
Expected average benefit from discounts \( E_y (\Delta (y, p^e)) \).

- Opt-in if \( c < E_y (\Delta (y, p^e)) \).
- Fraction opting in: \( \lambda (p^e) = H (E_y (\Delta (y, p^e))) \).
- \( \lambda' (p^e) > 0 \). (Higher expected list prices \( \Rightarrow \) deeper discounts.)

**Equilibrium: firm side**

- Profit FOCs are convex comb. of T, NT cases.
- Eqm price level \( p (\lambda) \) is an increasing function.*

**Overall Equilibrium:** solves fixed point \( p = p (\lambda (p)) \).
Rawlsian equilibrium with an opt-in policy

Policy benefits all consumers (vs. laissez-faire).

- Opt-ins benefit from lower price level. (Even discounts are anchored to lower list prices.)
- Opt-outs could have reaped the same benefits as opt-ins, but chose not to. (Revealed preference.)
Wrap-Up

Privacy policy conclusions

- Consumer-friendly privacy policy depends critically on how consumers behave wrt privacy.
- Greater opt-in choice benefits consumers if they are:
  1. Vigilant. (Monitor price levels, update privacy prefs if necessary.)
  2. Very non-vigilant. (Don’t tune choice to expected benefits in a way that creates hold-up.)
  3. But may harm consumers if they are moderately vigilant.
- Highlights the need for empirical evidence about consumer privacy choice. (Hopefully some post-GDPR studies?)
- Case 3 is not an argument against regulation. Rather, need to look harder for effective regulation.
Some limitations and next steps

A welfare-improving role for targeting  The promise of targeted advertising is better product-to-consumer matching. Absent in our model, but could be added.

No intensive margin  No reason to target ‘captives’ in our model. But firms do a lot of targeting to loyals, presumably to sell more, upsell, & cross-market.

Targeting is noisy  Obviously, targeting based on precise WTP is stylized. But we should be robust to a bit of noise.

Flesh out the data-sales story  We’ve made data brokers into bit players, but they have their own hopes and dreams...

Empirical specification  The model plays well with logit. (Can’t estimate as-is – we’ve “used up” all the errors. But perhaps a revised version...)
(Thanks)
What if firms are asymmetric?

Sources of asymmetry

- Consumer tastes (e.g. vertical differentiation à la Apple)
- Different targeting costs. (A varies by firm, or as a function of consumer type)

Our framework extends to these cases.

- Two-firm case is straightforward.
- More than two firms: harder to characterize equilibrium.
Personalized Pricing

“As data analytics and pricing algorithms become common business practice in the digital era, there are growing concerns about the possibility that companies use such tools to engage in personalised pricing.”
OECD Secretariat, 2018

- Current evidence of overt personalized pricing exists...
  - Mikians et al. (2012), Hannak et al. (2014).
- but is sparse:
  - Partly a measurement issue – confounding explanations for differential pricing.
  - And fear of backlash – firms are still spooked by the 2000 Amazon incident.
  - Strong incentives for firms to camouflage customized pricing.
Disguised personalized pricing can be more palatable

- Pair customized price with a customized product. (Reinhartz et al., 2018).
- Dynamic pricing + dynamic targeting advertising ≈ personalized pricing.
- Price steering (Mikians et al., Hannak et al.)
- Custom discounts. Harder to monitor, and less offensive to consumers.
  - “Sweetener” emails to consumers who browsed a product but didn’t buy.
  - Geofencing: Sears delivers discounts via mobile phone to consumers with a search history at competing stores, but who are near a Sears location now.
  - Geo-conquesting: Consumers near a McDonalds location received mobile app coupons for a $0.01 Whopper at the closest Burger King.
Consumer data privacy

- Increasing scrutiny of harms consumers suffer when their data is collected, stored, and (mis)used. (See Tucker, 2015, Turow et al. 2009, White et al. 2008, Acquisti et al. 2016.)
  - Data breaches (leading to risk of fraud and identity theft): Yahoo (3b), Marriott (500m), Equifax (143m), Target (110m), Facebook/Cambridge Analytica (50m - 87m), ...
  - Consumers place intrinsic value on privacy, for its own sake. Many perceive targeting as invasive, or creepy.
  - Lost surplus when information is used against them in markets.

- Regulators have unleashed a blizzard of white papers. (EC, UK CMA and OFT, Bundeskartellamt, OECD, US White House)

- And data-protection policies are beginning to be implemented: GDPR in Europe (and stirrings from Congress in the US).

- But what is the right policy? Our model gives a framework for thinking about this.