Competitive Targeted Advertising with Price Discrimination

Rosa-Branca Esteves and Joana Resende
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Outline

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Motivation

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Main questions

- What are the competitive effects of price discrimination through targeted informative advertising?
- How does TA affect the firms’ optimal marketing mix (pricing and advertising)?
- Do firms advertise more to its strong (own) market or to the weak (rival’s) market?
- Do firms benefit from TA and PD?
- What are the welfare and consumer effects of PD by means of TA?
More relevant literature

- **Competitive Price Discrimination and Customer Recognition:**
  - Thissse and Vives (1988, AER); Bester and Petrakis (1996, IJIO); Corts (1988, RJE); Fudenberg and Tirole (2000, RJE); Villas-Boas (1999, RJE); Chen (1997, JEMS); Chen and Zhang (2009, IJIO); Esteves (2009, JIE), Esteves (2010, IJIO)

- **Informative Advertising**
  - Targeted Advertising: Roy (2000, JIE), Iyer et al. (2005, MS); Galeotti and Moraga-Gonzalez (2008, IJIO)

- **Mixed Pricing in Oligopoly**
Model

- Two firms, A and B are launching two new products.
- \( c = 0 \)
- Large number of potential buyers, with mass normalized to one.
- Consumers are initially uninformed about the existence and the price of the goods.
- Firms need to invest in advertising to generate awareness and demand
- Two segments of consumers with equal size, segment a and segment b.
Model

- Consumers in segment $i$ prefer product $i$ over product $j$ by a degree equal to $\gamma > 0$.
- $\gamma$: minimum difference between the prices of the two competing products necessary to induce consumers to buy the least preferred product.
- After firms have sent their ads independently, in each segment of the market ($a$ and $b$), there will be:
  - Captive consumers to $A$, $a$: buy $A$ iff $v - p_A \geq 0$; $b$: buy $A$ iff $v - p_A - \gamma \geq 0$.
  - Captive consumers to $B$, $a$: buy $B$ iff $v - p_B - \gamma \geq 0$; $b$: buy $B$ iff $v - p_B \geq 0$.
  - Selective consumers, $a$: buy $A$ iff $v - p_A < v - p_B - \gamma$; $b$: buy $A$ iff $v - p_A - \gamma < v - p_B$. Otherwise, buy $B$.
  - Non-informed consumers
Marketing strategies

Static game where firms choose advertising intensities and prices simultaneously and non-cooperatively.

- **Mass advertising and no price discrimination**
  - Firm $i$ chooses its advertising level to the entire market (denoted by $\phi_i$), and a price $p_i$ to be quoted in all ads.

- **Targeted advertising and price discrimination**
  - Firm $i$ chooses the levels of advertising to be targeted to its own and to the rival’s market ($\phi_i^o$ and $\phi_i^r$, respectively) and the prices to be quoted in ads tailored to each group of consumers ($p_i^o$ and $p_i^r$, respectively).
  - Perfect Targeting:
    \[
    \Pr(\text{fall in } i \mid \text{targeted to } i) = 1 \\
    \Pr(\text{fall in } i \mid \text{targeted to } j) = 0
    \]
Advertising technology:

- $A(\phi) = \lambda \eta(\phi)$: Cost of reaching a fraction $\phi$ of consumers.
- $A_\phi > 0$ and $A_{\phi\phi} \geq 0$.
- No fixed costs in advertising, i.e. $A(0) = 0$.
- Quadratic technology: $\eta(\phi) = \phi^2$.
- $\lambda$ can be identified with the cost per ad.
Mass advertising and no discrimination

- Firm $i$ chooses its advertising level to the entire market (denoted by $\phi_i$), and a price $p_i$ to be quoted in all ads.
- When $p_i < v - \gamma$, $\forall i = A, B$:

\[
D_i = \phi_i \left(1 - \phi_j\right) + \phi_i \phi_j \left[\frac{1}{2} \Pr (p_i - \gamma < p_j) + \frac{1}{2} \Pr (p_i + \gamma < p_j)\right]
\]

- Firm $i$'s expected profit is:

\[
E \pi_i = p_i D_i - A (\phi_i).
\]
Mass advertising and no discrimination

- When $v < 2\gamma$ then a pure strategy equilibrium exists with $p_i = p_j = v$.
- When $2\gamma < v < 3\gamma$, there is a symmetric price equilibrium in pure strategies with $p_i = p_j = v - \gamma$, as long as $\phi_j < 1 - \frac{\gamma}{v - \gamma}$.
- When $v > 3\gamma$ then there is no pure strategy equilibrium in prices. There is however a mixed strategy Nash equilibrium in prices.
Proposition 2. In the benchmark case, with a mass advertising technology and no price discrimination, as long as $p_{\text{max}} < v - \gamma$

(i) each firm’s price is randomly chosen from the cdf given by

\[
F^m(p) = \begin{cases} 
0 & \text{if } p < p_{\text{min}} \\
1 - \frac{2}{(\phi^m)^2} \left( \frac{p}{\phi^m} - \phi^m (1 - \phi^m) \right) & \text{if } p_{\text{min}} \leq p \leq p_{\text{max}} - \gamma \\
2 - \frac{2}{(\phi^m)^2} \left( \frac{p - \gamma}{\phi^m} - \phi^m (1 - \phi^m) \right) & \text{if } p_{\text{max}} - \gamma \leq p < p_{\text{max}} \\
1 & \text{if } p \geq p_{\text{max}} 
\end{cases}
\]

with

\[p_{\text{min}} = p_{\text{max}} - 2\gamma \text{ and } p_{\text{max}} = \frac{2k^m}{\phi^m (2 - \phi^m)} + \gamma < v - \gamma.\]

For the mixed strategy price equilibrium in which firms compete for selective consumers to exist, it must be the case that $p_{\text{max}} < v - \gamma$, implying:

\[v > \gamma \left( \frac{2 - \phi^m}{\phi^m} \right) \left( 1 + \sqrt{1 + \left( \frac{\phi^m}{2 - \phi^m} \right)^2} \right) + 2\gamma\]

From $k^m = \frac{\phi^m}{2} (p_{\text{max}} - \gamma) (2 - \phi^m)$ we obtain that:

\[k^m = \frac{\gamma}{2} (2 - \phi^m)^2 \left( 1 + \sqrt{1 + \left( \frac{\phi^m}{2 - \phi^m} \right)^2} \right).
\]

(ii) Each firm chooses an advertising reach $\phi^m \in [0, 1]$, implicitly given by:

\[
\frac{1}{2} (p_{\text{max}} - \gamma) (2 - \phi^m) = A_{\phi}(\phi^m)
\]

(iii) Each firm earns an overall expected profit equal to

\[E\pi^m = \phi^m A_{\phi}(\phi^m) - A(\phi^m)\]
Mass Advertising and no discrimination

- Welfare:

\[ W^m = v \left[ 1 - (1 - \phi^m)^2 \right] - EDC^m - 2A(\phi^m). \]

- Expected Desutility Cost:

\[ EDC^m = \gamma \left[ \phi^m (1 - \phi^m) + \frac{1}{2} (1 - q^m) \right]. \]

- Expected Consumer surplus:

\[ ECS^m = W^m - \pi^m_{ind}. \]
Perfect targeted advertising and price discrimination

- Firm $i$'s chooses an intensity of advertising to be targeted to its own and to the rival’s market ($\phi_i^o$ and $\phi_i^r$, respectively) and the prices to be quoted in ads tailored to each group of consumers ($p_i^o$ and $p_i^r$, respectively).
- Perfect target: no leakage between segments.
Perfect targeted advertising and price discrimination

- Firm $i$’s expected profit in its own segment:

$$E \pi_i^o = p_i^o \frac{\phi_i^o}{2} \left[ \left(1 - \phi_j^r\right) + \phi_j^r \Pr(p_i^o < p_j^r + \gamma) \right] - A(\phi_i^o).$$

- Firm $i$’s expected profit in the rival’s market:

$$E \pi_i^r = p_i^r \frac{\phi_i^r}{2} \left[ \left(1 - \phi_j^o\right) + \phi_j^o \Pr(p_i^r + \gamma < p_j^o) \right] - A(\phi_i^r).$$
Proposition 6. When target is perfect there is a symmetric Nash equilibrium in which:

(i) In its own market segment each firm \( i, i = A, B \) chooses a price randomly from the distribution \( F_i^o(p) \) given by

\[
F_i^0(p) = \begin{cases} 
\frac{1}{\phi_i^o} \left[ 1 - \frac{(v-\gamma)(1-\phi_i^o)}{p-\gamma} \right] & \text{if } p \leq p_j^r \min + \gamma \\
1 & \text{if } p_j^r \min + \gamma \leq p \leq v \\
1 & \text{if } p \geq v 
\end{cases}
\]

where \( p_j^r \min = (v - \gamma)(1 - \phi_i^o) \). The advertising level \( \phi_i^o \) is implicitly given by

\[
\frac{1}{2} v - \phi_i^o (v - \gamma) = A_{\phi_i^o} (\phi_i^o) \tag{15}
\]

or equivalently,

\[
p_i^o \min - \frac{1}{2} v = A_{\phi_i^o} (\phi_i^o) \]

with \( A_{\phi_i^o} (0) < \frac{1}{2} v \). Equilibrium profit in its own market is:

\[
E \pi_i^o = \phi_i^* A_{\phi_i^*} (\phi_i^*) + \frac{1}{2} (\phi_i^*)^2 (v - \gamma) - A (\phi_A^*). \tag{16}
\]
Equilibrium price and advertising decisions

(ii) In the rival's market segment each firm chooses a price randomly from the distribution \( F_r^i (p) \) given by

\[
F_r^i (p) = \begin{cases} 
\frac{1}{\phi^{r^*}_i} \left( 1 - \frac{v(1-\phi^{o*}_j)+\gamma \phi^{o*}_j}{p+\gamma} \right) & \text{if } p \leq p^r_{j \text{ min}} \\
1 & \text{if } p^r_{j \text{ min}} \leq p \leq v - \gamma \\
1 & \text{if } p \geq v - \gamma 
\end{cases}
\]

The advertising level \( \phi^{r^*}_i \) is implicitly given by

\[
\frac{1}{2} (v - \gamma) - \frac{1}{2} \phi^{o*}_j (v - \gamma) = A_{\phi^r_i} (\phi^{r^*}_i), \tag{17}
\]

or, equivalently,

\[
\frac{1}{2} p^r_{j \text{ min}} = A_{\phi^r_i} (\phi^{r^*}_i), \tag{18}
\]

where \( \phi^{o*}_j \) solves condition (15) and \( A_{\phi^r_i} (0) < \frac{1}{2} (1 - \phi^{o*}_j) (v - \gamma) \). Equilibrium profit in the rival's market is:

\[
E \pi_i^{*r} = \phi^{*r}_i A_{\phi^r_i} (\phi^{*r}_i) - A (\phi^{*r}_i). \tag{19}
\]
Perfect Targeted Advertising and price discrimination

- The price equilibrium is always in mixed strategies and the level of advertising to each segment is chosen deterministically.
- Firm $i$ uses a “Hi-Lo” pricing strategy in the rival’s market. To squeeze more surplus from its captive customers, it charges the highest price $\nu - \gamma$, with probability $m_i^r = 1 - \frac{\phi_i^o \cdot \phi_i^r}{\phi_i^o \cdot \phi_i^r} \left( 1 - \frac{\gamma}{\nu} \right)$. However, in order to win the selective customers it announces occasionally a low price.
- When $\phi^r > \phi^o$, then a firm’s profit in its own market is higher than its profit in the rival’s market.
Advertising decisions:

- Regardless the advertising technology considered, when price discrimination is permitted and target advertising is perfect:
  - When advertising is costless, firms do not select full market coverage in its own market.
  - When advertising is cheap, i.e., if \( \lambda \) is such that \( \phi_i^o > \frac{\gamma}{v-\gamma} \), firms advertise more to the rival’s market.
  - When the advertising costs are high, i.e., if \( \lambda \) is such that \( \phi_i^o < \frac{\gamma}{v-\gamma} \), firms advertise more to its own market.
Quadratic technology: Advertising decisions

\[ \phi^r \geq \phi^o \text{ when } \nu \geq \frac{1}{2} \left(3\gamma + \sqrt{\gamma^2 + 16\lambda\gamma}\right). \]

\[ \phi^r < \phi^o \text{ when } 2\gamma < \nu < \frac{1}{2} \left(3\gamma + \sqrt{\gamma^2 + 16\lambda\gamma}\right). \]

When \( \nu \) is high enough firms advertise more to the rival’s market than to its own market!
Quadratic Technology:

- Firm $j$ advertises more aggressively in segment $i$ and faces a higher group of captive consumers than firm $i$. 

![Graph showing different segments](image)
Competitive effects of targeted advertising and price discrimination

Effects on prices

- $F^k > F^m$, $k = o, r$.

- Average prices with TA/ND are above average price with MA/ND.
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- $F^k > F^m$, $k = o, r$.
- Average prices with TA/ND are above average price with MA/ND.
- Challenges the usual finding that PD may reduce all segment prices!
Competitive effects of targeted advertising and price discrimination

Effects on profits

- when $v$ is high enough, equilibrium profit with TA/PD is above equilibrium profit with MA/ND.

- Challenges the usual finding that firms face a Prisoner’s dilemma result when PD is allowed!
Competitive effects of targeted advertising and price discrimination

Market expansion effects

- Price discrimination by means of targeted advertising may increase the number of consumers who stay out of the market in relation to MA/ND.
Welfare effects

- Welfare with TA/PD:

\[ W^t = \nu \left[ 1 - (1 - \phi^o)(1 - \phi^r) \right] \]
\[ - \gamma \left[ \phi^r (1 - \phi^o) + \phi^o \phi^r (1 - \tau) \right] - 2A(\phi^o) - 2A(\phi^r). \]

- Welfare with MA/ND:

\[ W^m = \nu \left[ 1 - (1 - \phi^m)^2 \right] \]
\[ - \gamma \left[ \phi^m(1 - \phi^m) + \frac{1}{2} (\phi^m)^2 (1 - q^m) \right] - 2A(\phi^m). \]

- Expected consumer:

\[ ECS = W - \pi_{ind}. \]
Welfare effects

Table 1. Profits, Consumer Surplus and Welfare

<table>
<thead>
<tr>
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<th>$\lambda = 2, v = 7$</th>
<th>$\lambda = 2, v = 8$</th>
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<td>$EC^S^m$</td>
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<td>3.209</td>
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</tbody>
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- TA/PD can boost industry profit at the expense of social welfare and consumer welfare.
Concluding remarks

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- It is important to take into account different forms of market competition when trying to evaluate the welfare effects of price discrimination based on customer recognition.
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  - It is important to take into account different forms of market competition when trying to evaluate the welfare effects of price discrimination based on customer recognition.
Next steps

- Imperfect targetability.
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- Different advertising costs with mass and targeted advertising.
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- THANK YOU :-(