Price Discrimination with Boundedly Rational Consumers: When Do Dominated Offers Pay Off?

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Motivating example

- **Mobile phone plans** (O2, Czech Republic):

<table>
<thead>
<tr>
<th></th>
<th>Bronz</th>
<th>Silver</th>
<th>Gold</th>
</tr>
</thead>
<tbody>
<tr>
<td>fixed fee, CZK</td>
<td>180</td>
<td>555</td>
<td>890</td>
</tr>
<tr>
<td>free minutes</td>
<td>30</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>extra unit price, CZK</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- to own operator</td>
<td>3.1</td>
<td>2.7</td>
<td>2.5</td>
</tr>
<tr>
<td>- to other operators</td>
<td>5.2</td>
<td>4.4</td>
<td>4</td>
</tr>
</tbody>
</table>

- **What is the best plan**: lowest expected cost of consumption
  - expected cost has to be computed = search
Existing Search Models

- **Rational search** (Stigler 1961):
  - consumers know distribution of choice alternatives
  - they can compute expected benefit of search
  - search cost is known
  - they search as long as benefit is higher than cost

- **Satisficing** (Simon 1955):
  - consumers have aspiration level
  - they search as long as aspiration level is not achieved

- **Question not answered**:
  - what is the first considered choice alternative?
Key Idea

- **Search sequence is correlated with consumer type**
  - consumers with higher willingness to pay for quality consider high-quality alternatives first
  - consumers with higher demand for calls consider mobile plans with more included minutes first

- **Implication of search models**
  - different consumer types biased to different choice alternatives
Q: How can firms exploit consumers’ limited search?
A: By offering dominated choice alternatives - those that consumers who fully search never choose.
Consumers

- Consumer $i$ chooses bundle $j$ to maximize net surplus:

$$\max_j V_{ij} = u(\theta_i, q_j) - t_j, \text{ for } i = L, H. \quad (1)$$

- $\theta_i$ ... taste parameter $\theta_H > \theta_L$
- $T_j = (q_j, t_j)$ ... consumption-price bundle $j$
- $u(.)$ ... satisfies all standard properties
Monopolist

- Profit function when consumers fully search:

\[ \pi = \sum_{j=1}^{N} (t_j - cq_j)[\lambda f(V_{Lj}, V_{Lj}) + (1 - \lambda)f(V_{Hj}, V_{Hj})] \]  \hspace{1cm} (2)

- \( \lambda \) ... probability of \( \theta_L \)-type
- \( f(V_{ij}, V_{ij}) = 1 \) if \( \theta_i \)-type chooses \( T_j \), 0 otherwise
- \( N \) ... number of offered bundles
- \( c \) ... constant unit cost
First-Best Outcome

- Monopolist observes consumer type
- Monopolist offers $T_L$ to $\theta_L$-type and $T_H$ to $\theta_H$-type
  - choice rule: $f(V_{ij}, V_{ij}) = 1$ if $V_{ij} \geq 0$ ($PC_i$)
- Profit function:
  \[
  \pi^{FB} = \lambda p_l + (1 - \lambda) p_h,
  \]
  \[
  \text{where } p_l = u(\theta_L, q_l) - cq_l,
  \]
  \[
  p_h = u(\theta_H, q_h) - cq_h.
  \]
- First-best outcome ($j = l$ for $i = L$, $j = h$ for $i = H$):
  \[
  q_j^* = \arg\max_q [u(\theta_i, q) - cq],
  \]
  \[
  t_j^* = u(\theta_i, q_j^*).
  \]
Second-Best Outcome

- Monopolist does not observe consumer type
- Monopolist offers $T_l$ and $T_h$, consumer chooses
  - choice rule: $f(V_{ij}, V_{ij}) = 1$ if $V_{ij} \geq 0$ \((PC_i)\) and $V_{ij} \geq V_{ij}$ \((ICC_i)\)
- Profit function:

\[
\pi^{SB} = \lambda p_l + (1 - \lambda) \left[p_h - V_{Hl}\right].
\]  

- assumption: $\theta_L$-type self-selects $T_l$, $\theta_H$-type self-selects $T_h$
- Second-best outcome:

\[
q_{l}^{SB} < q_{l}^*, q_{h}^{SB} = q_{h}^*, \\
t_{l}^{SB} < t_{l}^*, t_{h}^{SB} < t_{h}^*.
\]
Limited Search

- Assume sufficiently large search cost, such that
  - consumer’s consideration set consists of one bundle
- Consumer $i$ accepts the first bundle $j$ if $V_{ij} \geq 0$, no ICC
- Heterogenous search:
  \[
  s_j^L \neq s_j^H,
  \]
  \[
  s_j^i \ldots \text{probability to have } T_j \text{ in consideration set for } \theta_i\text{-type}
  \]
  \[
  \sum_{j=1}^{N} s_j^i = 1 \text{ for } i = L, H
  \]
Monopolist’s New Problem

- Profit function when consumers have limited search:

\[
\pi = \sum_{j=1}^{N} (t_j - c q_j) [\lambda s_j^i f(V_{Lj}) + (1 - \lambda) s_j^i f(V_{Hj})] 
\]  

(7)

- \( f(V_{ij}) = 1 \) if \( V_{ij} \geq 0 \)

- Monopolist’s gain:
  - no information rent to \( \theta_H \)-type

- Monopolist’s loss:
  - \( \theta_L \)-type might be excluded if \( s_j^i > 0 \) and \( V_{Lj} < 0 \)
Optimal Offers

- **Lemma 1**: Every bundle offered by monopolist is first-best for at least one consumer type.
- **Intuition**: no incentive compatibility constraint to be satisfied
Distinct Offers

- **Definition**
  - $T_j, T_k$ both satisfy $PC_H$: they are distinct if $t_j \neq t_k$ or $q_j \neq q_k$
  - $T_j, T_k$ both violate $PC_H$: they are always identical
  - $T_j$ satisfies $PC_H$, $T_k$ violates $PC_H$: they are always distinct

- Making two identical offers is equivalent to advertising them
Optimal Number of Distinct Offers

- **Lemma 2**: Optimal number of distinct offers never exceeds number of consumer types (two)

- **Intuition**:
  - Lemma 1: only first-best offers are optimal
  - there are two distinct first-best offers (one for each type)
Main Result

- **Proposition 1**: It is optimal for monopolist to offer two distinct bundles $T_l$ and $T_h$ only if $s_H^h > s_L^h$.

- i.e. $\theta_H$-type is more likely to start search with $T_h$ than $\theta_L$-type.
Proof of Main Result

By Lemma 1 and 2, only three possible strategies:

- pooling: \( \pi_{T_i}^* = p_i^* \)
- excluding: \( \pi_{T_h}^* = (1 - \lambda)p_h^* \)
- two bundles: \( \pi_{T_i, T_h}^* = (\lambda s_L^i + (1 - \lambda)s_H^i)p_i^* + (1 - \lambda)s_H^hp_h^* \)

\( \pi_{T_i, T_h}^* > \pi_{T_i}^* \) and \( \pi_{T_i, T_h}^* > \pi_{T_h}^* \) simultaneously when:

\[
1 - \lambda \frac{s_H^h - s_L^h}{s_H^h} < \frac{(1 - \lambda)p_h^*}{p_i^*} < 1 + \lambda \frac{s_H^h - s_L^h}{1 - s_H^h}.
\] (8)

**Necessary condition**: \( s_H^h > s_L^h \)

- in special case \((1 - \lambda)p_h^* = p_i^*\), necessary condition is sufficient.
Summary

- **Market observation:**
  - presence of dominated choice alternatives
  - fully rational consumers never choose dominated alternatives

- **Assumption on consumer search behavior:**
  - only subset of offers are in consumers’ consideration set
  - consumer always chooses the best from consideration set
  - heterogenous consumers have heterogenous consideration sets

- **Main result:**
  - monopolist can benefit from dominated offers only if consumers willing to pay more are more likely to consider them