Consumer Search and Firm Strategy with Multi-Attribute Products

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- **RQ1**: Optimal **menu selection** and **pricing strategy** of a multiproduct monopolist when search is costly
- **RQ2**: Optimal search process with **correlated products** → role of **learning** through shopping

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- Literature: much on **pricing** strategies, less on **menu** selection
- Even less on **interaction** between the two
- In this paper: interaction arises due to correlation of products; menu determines value of inspecting individual products, prices reflect it

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- Products with attributes in common: perfectly correlated in that part of their match value
- Allows for realizations to dictate **direction** of search as it unfolds

Results preview

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  - non-stationary: expectation updating affects stopping rule
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    - search path "reveals preferences" $\rightarrow$ buyer self-selects towards favored options
- Monopolist optimal strategy:
    - possibly different prices for *ex ante* identical products
    - possibly restriction of supply
    - coordinating menu and prices, monopolist can induce specific order of search for consumer

Products

- **Horizontally** differentiated products defined by attributes: A, B (e.g.: A : color, B : fabric)
- Restriction:
  - $A \in \{A_1, A_2\}$ (e.g. "red", "blue"), $B \in \{B_1, B_2\}$ (e.g. "cotton", "polyester")
  - $N = 4$ distinct product: (i, j), $i, j \in \{1, 2\}$ → correlation through shared attributes

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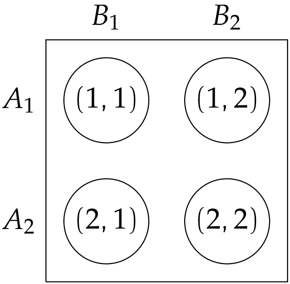

Monopoly seller

- Menu and prices selection before search starts - no adjustments mid-search
- Affects search process through:
  - **menu** $\tilde{N} \subseteq N$ - products available and their relation
  - **posted prices** $\mathbf{p}(\tilde{N})$ of all products (separately)
- Production costs set at 0

Representative consumer

- Unit demand: wants to find the best match in $\tilde{N}$
- consumer observes products' correlation and prices, not his preferences
- i.i.d. attributes: each is a "match" ($V = 1$) with probability α - ex post utility 0 otherwise
- No synergy between attributes: product (i, j) generates utility:

$$u_{i,j} = A_i + B_j$$

- search cost $s > 0$; sequential search with free recall

Timing

1. Consumer and monopolist observe α, s,
2. Monopolist selects $\tilde{N}$, $\mathbf{p}(A)$,
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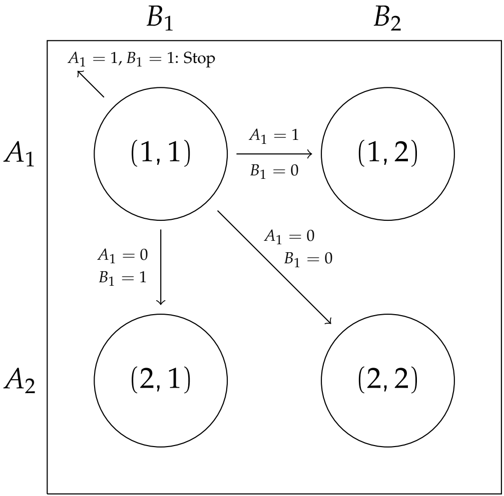
- **Equilibrium concept**: SPNE
- **Returns**: Unique equilibrium in terms of outcome given parameters

Optimal search paths

- Correlation of products allows to trace optimal search paths:
  - after positive realization, consumer wants to keep match
  - after negative one, consumer wants to drop attribute
- Paths found by backward induction: find products optimally inspected given possible realization, then optimal starting point
- All products available ($\tilde{N} \equiv N$), uniform prices normalized at zero $\rightarrow$ straightforward pathing, any starting point W.L.O.G.

Graphically



Search dynamic

- Searching $(1,1)$ (WLOG) lets buyer discover $A_1 \in \{0,1\}$, $B_1 \in \{0,1\}$:

$$E[u_{1,2}]|_{I=\{(1,1)\}} = A_1 + \alpha \quad E[u_{2,1}]|_{I=\{(1,1)\}} = \alpha + B_1$$

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- Going backwards:

$$E[u_{1,1}]|_{I\equiv\varnothing} = \underbrace{2\alpha^2}_{A_1=B_1=1} + \underbrace{(1-\alpha)^2(2\alpha - s)}_{A_1=B_1=0} + \underbrace{2\alpha(1-\alpha)[1+\max(\alpha - s, 0)]}_{A_1 \neq B_1} - s$$

Uniform prices trade-off

- Consider uniform price p for all products in $\tilde{N} \equiv N$:

$$
\begin{aligned}
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- Higher price: higher revenue if sale takes place, but **discourages** inspection of $(2,2)$ after bad first realization: $p^D > p^E$

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- p^E and p^D better for different outcomes of the first search; both can be optimal: high probability of trade vs high per-sale revenue

Equilibrium Menu and Prices

Proposition

Consider a multi-product monopolist selecting optimal menu $\tilde{N} \subseteq N$ and pricing $\mathbf{p}(\tilde{N})$ of multi-attribute products. In equilibrium:

- *Encouraging prices are set for high search costs,*
- *Discouraging prices are set for low search costs and high probability of a match,*
- *All products are introduced if and only if prices are not set uniformly.*

Consumer is always steered towards specific search paths through strategic pricing.

The best of both worlds

- Suppose $p^E \leqslant 1$ is selected; after bad first realization, second search takes place
- If consumer likes an attribute (say, A_1), she searches $(1, 2)$ if:

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- Incentive to increase price of some products to profit off learning of consumer:

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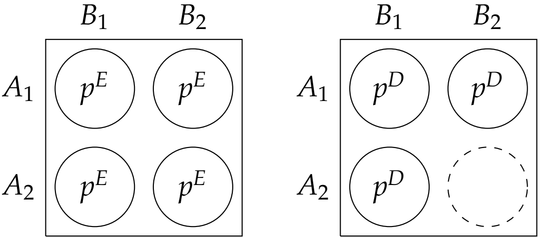
- Consumer would not **start** from $(1, 2)$ (or $(2, 1)$), but **could inspect it** depending on realizations A_1, B_1:

$$\pi = (1 - (1 - \alpha)^4)p^* + 2\alpha^2(1 - \alpha)(p^{**} - p^*)$$

Graphical representation of candidate prices



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High prob. trade

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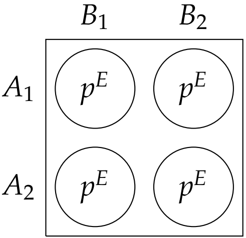

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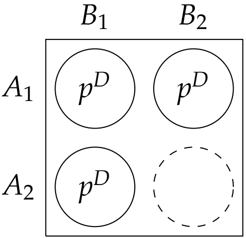

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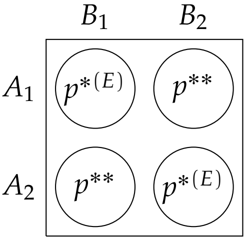

Differential prices
High prob. trade

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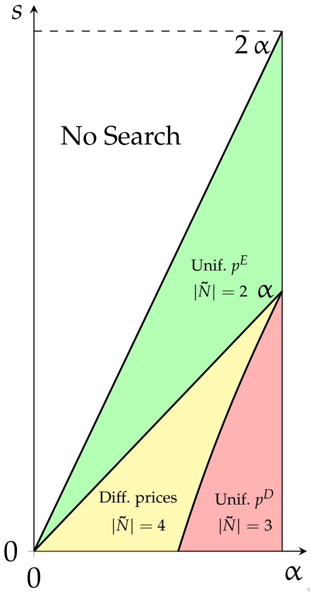
- All can be the best response for different values of α, s; supply restriction if α high, s low; $\widehat{\pi}$ dominated by uniform p^D

Equilibrium menu and prices, graphically



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- Implications for:
  - **Free samples**: positive experience increases wtp for novelty, allows higher prices
  - **Recommendation systems**: incentive not to recommend best match but sub-par match at low price and let consumers self-select towards more expensive products
  - **"Dynamic" price discrimination**: conditioning prices on search history based on correlation of products inspected in sequence

Conclusion

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- Menu restriction viable if monopolist cannot induce more profitable search path with prices only
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Predictability of search process allows monopolist to make buyers self-select based on taste, drives rent extraction

Thank you for your attention