Ranking Competition on Online Retailers Platforms

Evidence from Tmall and/or JD

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Motivation

- Levin(2014) proposes a model to structure price competition under search engine of online retailers
  - Price is only one dimension of sellers competition
  - No dynamic trends were described

Theme

- Structure price competition
  - Dynamic model
  - Rank competition by price and quality(proxied by sales)

Overview I

- Background:
  - There are two main steps of consumer online search. On the first step, consumers search for relevant products and choose their favorite model. On the second step, consumers search for goods with lower prices and higher qualities. We focus on the second step in this paper.
  - There are two main steps to make goods chosen by consumers. On the first step, goods are ranked by platform and displayed with order. On the second step, consumers search for the goods displayed. Goods with higher ranks are more possible to be chosen.

Overview II

- There are several different approaches to rank goods, including Best Match(sorted by relevance), sort by monthly sales, sort by price, sort by time, etc. There are no perfect rank design, but we can find a better way to avoid problems as much as we can.

Overview III

- Model:
  - Consumer choice is a traditional discrete choice model. Consumer decides goods with the highest utility each period.
  - Goods go into consumers' consideration set by two steps: goods are ranked by platform; then goods are searched by consumer; higher rank with higher possibility.
  - Sellers maximize their net present value of their profits given consumer choices.
  - Solve the Nash equilibrium of consumer search and seller pricing.
  - Calculate consumer welfare given the equilibrium solutions.

Overview IV

- Data:
  - Available data:
    - Time Period: daily data from May 2016 - Present
    - Variables: price, monthly sales, comment number, name of goods, URL of product page, name of shop, name of shop page, rank method, scrape time, category information, page number, rank order, etc.
    - Observations: more than 0.5 billion
  - Required additional data:
    - Daily sales data for each goods
    - Click data and purchase history of consumers

Literatures Review

- Levin(2014): structuring consumer search and platform design for online retailers
- Fan(2013): cross-period return to reputation and how sellers manage their reputation
- Ellison(2009): obfuscation creates search costs and prevent consumer search
- Jolivet(2015): the influence of reputation to price with unobserved factors
- Cai(2014): the influence of a centralized feedback
- Stahl(1989): the strategy of pricing with sequential consumer search

Dimensions of Consumer Online Search

- Step 1: search relevant products
  - **User query** or **keyword search**
  - Advertising (i.e. home page, social media, video platforms)
  - Recommendation (i.e. home page, item page)
- Step 2: search products with attractive **prices** and **qualities** (which we will focus in this paper)

Processes of Goods Chosen by Consumer Search

- All available set $\rightarrow$ Rank by order
- Rank by order $\rightarrow$ Consideration Set

Different Approaches of Ranking for Search Results

- Best Match (default)
- Sort by monthly sales
- Sort by prices
- Sort by date

Notation

- Consumer: i
- Seller/Goods: j
- Time: t
- All available set: **J**
- Consideration set: J_i

Economic Environment I

- The extent of market: goods with vertical differentiation
- Economic actors:
  - Consumer
  - Seller
  - Platform (as "Government")

Economic Environment II

- Institution: search engine
- ?? Information available:
  - Public: price, rank
  - Consumer: perference
  - Seller: own quality, own sales
  - Platform: seller sales, rank design

Primitives

- Technology: seller marginal cost is affected by quality and other control variables

$$c_j(s_j, w_j)$$

- Preferences: consumer perfer lower price and higher quality

$$u_{ijt} = V_{ijt}(p_{jt}, s_j) + \varepsilon$$

$$\frac{\delta v_{ijt}}{\delta p_{jt}} < 0$$

$$\frac{\delta v_{ijt}}{\delta s_j} > 0$$

Exogenous Variables

- Contraints on agents' behavior
  - Consumer: parameters of utility function
  - Seller: quality s_j, other control variables w_j
- Outside variables
  - Rank design

Decision Variables

- Consumer: choose goods j at time t for utility maximization
- Seller: choose price p_{jt} at time t for profit maximization

Equilibrium Solution Concept: Nash equilibrium

- Profit maximization:

$$\max_{p_{jt}} \Pi_j = \max_{p_j t} \sum_{t=0}^{\infty} \delta^t \pi_{jt}$$

- Utility maximization (assume no borrowing and lending):

$$\max_j u_{it} = \max_j \{u_{ijt}, 0\}$$

Consideration Set I

- Sample weight:

$$w_{jt} = w_j(p_{jt}, s_j)$$

replaced by

$$w_{jt} = w_j(p_{jt}, q_{jt})$$

Consideration Set II

- Probability of chosen into consideration set(by Wallenius' non-central hypergeometric distribution):

$$Pr(j \in J_{it} | \mathbf{J}_t) =$$

Random Utility Model

- Assume type I extreme error

$$Pr(j \in L_t | j \in J_{it}) = \frac{e^{V_i t}}{\sum_i e^{V_i t}}$$

$$=$$

Probability of Chosen

$$D_{jt}(p_{jt}, s_j) = \sum_{J_t} Pr(j \in L_{it} | j \in J_{it}) Pr(j \in J_{it} | \mathbf{J}_t)$$

$$= \sum_{J_t} \frac{e^{V_i t}}{\sum_i e^{V_i t}} Pr(j \in J_{it} | \mathbf{J}_t)$$

Available Data

- Time Period: daily data from May 2016 - Present
- Variables: price, monthly sales, comment number, name of goods, URL of product page, name of shop, name of shop page, rank method, scrape time, category information, page number, rank order, etc.
- Observations: more than 0.5 billion

Additional Required Data

- Daily sales data for each goods
- Click data and purchase history of consumers

Methods

- Change $w_j(p_j)$, find a solution that maximize consumer welfare.

Next Step

- Relax the assumption that qualities of goods are given / Allow entry and exit of sellers

Further Work

- Competition for heterogeneous goods on one search results
- Competition/Obfuscation for user query
- .....

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