Two-sided Markets, Pricing, and Network Effects

Theoretical and Empirical Study

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Outline

Introduction

- A central aspect of platform is the role of network effects:
  - **Network effect** refers to any situation in which the value of a product, service, or platform depends on the number of buyers, sellers, or users who leverage it
  - **Direct network effects** occur when the value of a product, service, or platform increases simply because the number of users increases, causing the network itself to grow
  - **Indirect network effects** occur when a platform or service depends on two or more user groups, such as producers and consumers, buyers and sellers, or users and developers

Introduction

- Indirect network leads to feedback loops between the two sides of the market, thus increasing efficiencies and also potential market power
- Pricing is one of the key tools that platforms can manage to success

Main Focus: **indirect network effects and pricing strategies in two-sided markets**

Introduction

- Two-sided market: at least two distinct sets of agents interact through an intermediary and in which the behavior of each set of agents directly impacts the utility, or the profit of the other agents
- **Two-sided market** vs **Two-sided strategies**
- Treating two-sidedness as a market concept

Now let's proceed to the benchmark model in Armstrong(2006)

Armstrong(2006): Monopoly Pricing

$$u_j^i = \alpha_j^i n^i + \xi_j^i$$

Basic Setting

1. Two groups of agents: j $= 1, 2$
2. Only one platform in the market: i $= 1$
3. No fixed benefits from using the platform: $\xi_j^i = 0$
4. One group cares about the number of agents in the other group but not itself
5. Interaction benefits are different across groups: $\alpha_j^i \neq \alpha_k^i$
6. The platform can charge a per-agent fee to each group of agents

Armstrong(2006): Monopoly Pricing

Utility of agents

$$u_1 = \alpha_1 n_2 - p_1 \qquad u_2 = \alpha_2 n_1 - p_2 \tag{1}$$

- α_1: Interaction benefit a group-1 agent gets from each group-2 agent
- α_2: Interaction benefit a group-2 agent gets from each group-1 agent
- n_1: number of group-1 agents on the platform
- n_2: number of group-2 agents on the platform
- p_1, p_2: prices charged by the platform to groups 1 and 2

Armstrong (2006): Monopoly Pricing

Demand Functions

$$n_1 = \phi_1(u_1) \qquad n_2 = \phi_2(u_2) \tag{2}$$

- n_1, n_2: numbers of agents from groups 1 and 2 who join the platform
- ϕ_1, ϕ_2: increasing demand functions mapping u_1, u_2 (utilities) to participation
- u_1, u_2: utilities offered to agents in groups 1 and 2

Armstrong (2006): Monopoly Pricing

Profit Function

$$\pi(u_1, u_2) \;=\; \phi_1(u_1)\Big[\alpha_1\,\phi_2(u_2) - u_1 - f_1\Big] \;+\; \phi_2(u_2)\Big[\alpha_2\,\phi_1(u_1) - u_2 - f_2\Big] \quad (3)$$

- $\pi(u_1, u_2)$: platform's profit in terms of utilities
- f_1, f_2: per-agent costs for groups 1 and 2
- α_1, α_2: cross-group interaction benefits
- ϕ_1, ϕ_2: same demand functions as in the previous slide

Armstrong (2006): Monopoly Pricing

Let the aggregate consumer surplus of group $i = 1, 2$ be $v_i(u_i)$, where $v_i(\cdot)$ satisfies the envelope condition $v_i'(u_i) \equiv \phi_i(u_i)$. Then welfare, as measured by the unweighted sum of profit and consumer surplus, is

$$w = \pi(u_1, u_2) \; + \; v_1(u_1) \; + \; v_2(u_2).$$

It is easily verified that the welfare-maximizing outcome has the utilities

$$u_1 = (\alpha_1 + \alpha_2)\, n_2 \; - \; f_1, \qquad u_2 = (\alpha_1 + \alpha_2)\, n_1 \; - \; f_2.$$

From expression (1), the socially optimal prices satisfy

$$p_1 = f_1 \; - \; \alpha_2\, n_2, \qquad p_2 = f_2 \; - \; \alpha_1\, n_1.$$

Armstrong (2006): Monopoly Pricing

From expression (2), the profit-maximizing prices satisfy:

$$p_1 \;=\; f_1 \;-\; \alpha_2\, n_2 \;+\; \frac{\phi_1(u_1)}{\phi_1'(u_1)}, \quad p_2 \;=\; f_2 \;-\; \alpha_1\, n_1 \;+\; \frac{\phi_2(u_2)}{\phi_2'(u_2)}.$$

Proposition 1

Proposition 1. Write

$$\eta_1(p_1 \mid n_2) \;=\; \frac{p_1\,\phi_1'(\alpha_1 n_2 - p_1)}{\phi_1(\alpha_1 n_2 - p_1)}, \quad \eta_2(p_2 \mid n_1) \;=\; \frac{p_2\,\phi_2'(\alpha_2 n_1 - p_2)}{\phi_2(\alpha_2 n_1 - p_2)}.$$

for a group's price elasticity of demand given the other group's participation level. Then the profit-maximizing pair of prices satisfy

$$\frac{p_1 \;-\; \left(f_1 - \alpha_2 n_2\right)}{p_1} \;=\; \frac{1}{\eta_1(p_1 \mid n_2)}, \quad \frac{p_2 \;-\; \left(f_2 - \alpha_1 n_1\right)}{p_2} \;=\; \frac{1}{\eta_2(p_2 \mid n_1)}.$$

Armstrong (2006): Main Conclusions of Monopoly Pricing

A monopolist platform, serving two distinct groups that benefit from interacting with one another, does not simply set each group's price to cover the marginal cost of serving that group. Instead, it balances the prices charged to each side to account for cross-group externalities and differences in demand elasticities. This leads to the following key insights:

- **Cross-Group Externalities:** Prices on one side depend on how that side's participation affects the other side's willingness to join.
- **Balancing Demand:** If one side's presence is highly valuable to the other side, the platform may lower or subsidize that side's fee to maximize overall profit.
- **Interdependence of Pricing:** Optimal monopoly prices for each group differ from the standard one-sided monopoly outcome, reflecting the platform's internalization of cross-group effects.

Armstrong(2006): Competition for the Market

Important Block

Key information goes here

- Method 1
- Method 2

Armstrong(2006): Competition on the Market

Important Block

Key information goes here

- Method 1
- Method 2

Results

- Result 1
- Result 2

[Your figure here]

Conclusion

- Main finding 1
- Main finding 2
- Future work