Two-sided markets: a progress report

Based on Rochet and Tirole (2006)

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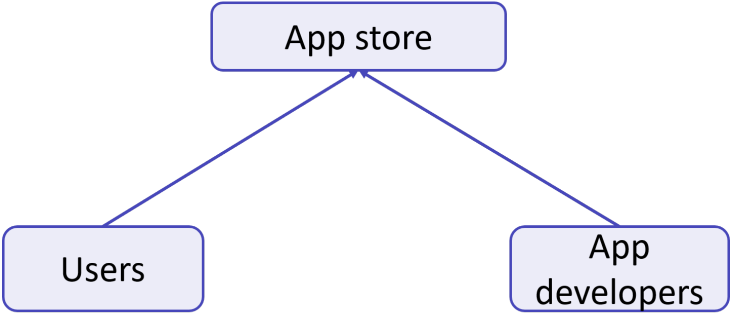
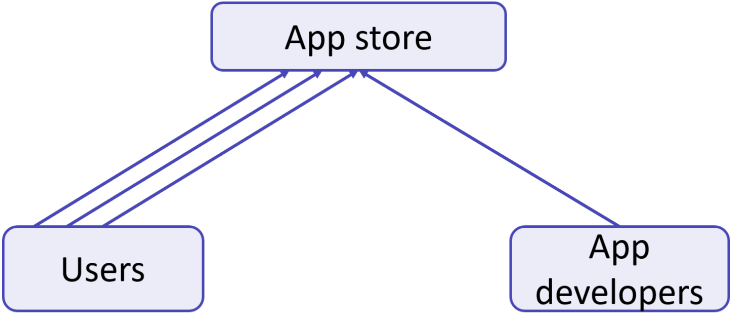
Outline

Outline

Basic concepts



Basic concepts



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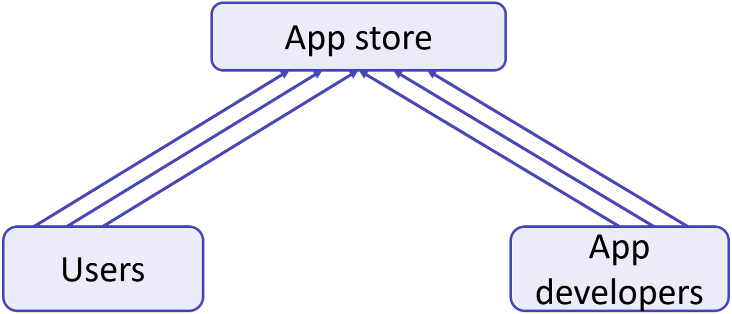
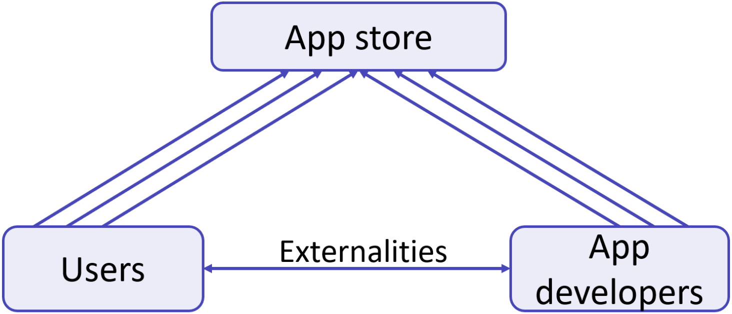


Basic concepts



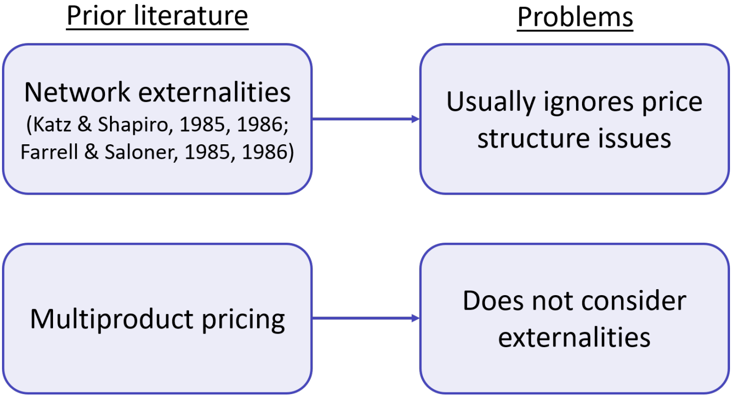
Motivation: They provide a road map to analyzing two-sided markets.

Questions

- What is the definition of two-sided markets?
- What is the model that can explain the externalities between end-users?
- What is the optimal pricing for the platform?

Answers

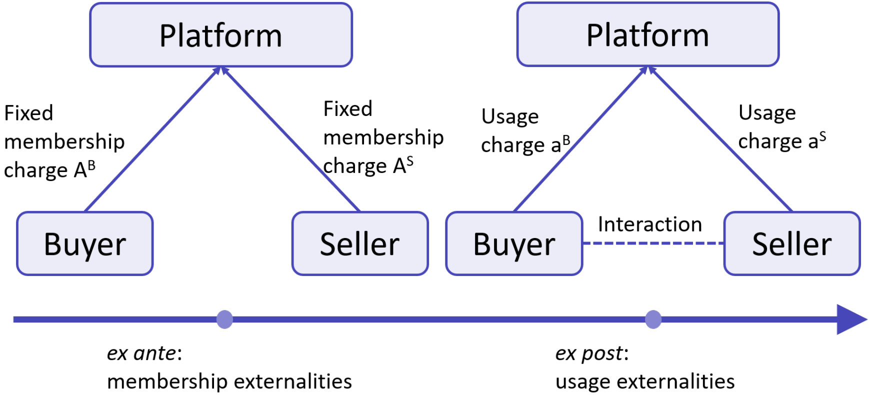
Prior literature



- The theory of two-sided markets focus on the fact that an end-user does not internalize the welfare impact of his use of the platform on other end-users.

Outline

Membership and usage externalities



Membership charges   Usage charges

Defining two-sidedness

Definition (Two-sided markets)

Consider a platform charging per-interaction charges p^B and p^S to the buyer and seller sides. The market for interactions between the two sides in one-sided if the volume V of transactions realized on the platform depends only on the aggregate price level

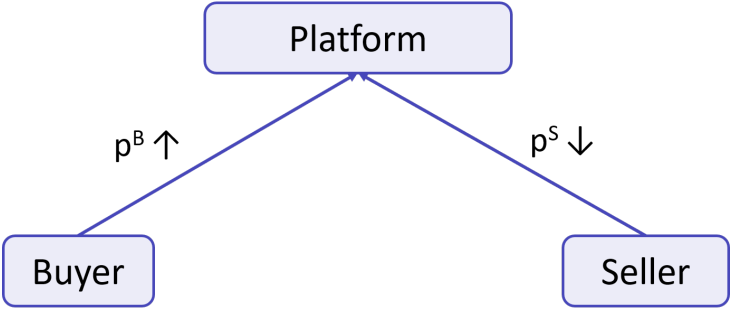
$$p = p^B + p^S$$

i.e., it is insensitive to reallocations of this total price a between the buyer and the seller.

If by contrast V varies with p^B while p is kept constant, the market is said to be two-sided.

another definition

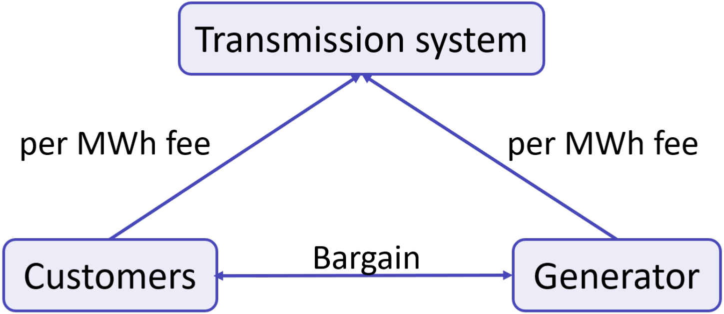
Defining two-sidedness



- $\bar{p} = p^B + p^S \Rightarrow$ When p^B (or p^S) changes holding a constant, V changes.

Example of an one-sided market

Bilateral electricity trading



- When bargaining for a bilateral energy trade, they should take into account only the total fee paid to the transmission system.

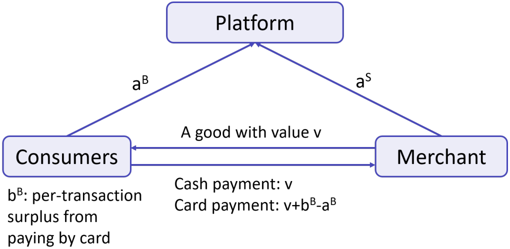
Factors of nonneutrality under usage pricing

- Transaction costs: Seller (Buyer) cannot pass the increase in his cost of interacting with the buyer (seller) to the buyer (seller).
  (Example: In telecom interactions, there is no monetary transaction between the caller and the receiver.)
- Prohibition or constraint put by the platform on the pricing of transactions between end-users
  (Example: No-surcharge rule imposed by a payment system)

Failure of the Coase theorem

Membership externalities

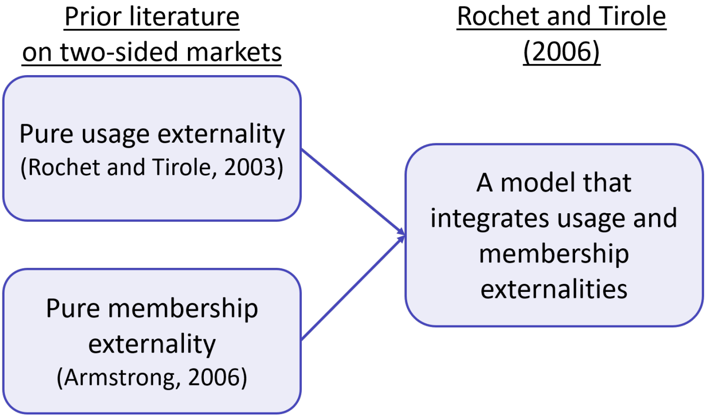
- Existence of transaction-insensitive end-user costs
(Example: A software developer incurring a fixed payment for the development kit and attendance at trade shows)
- Nonneturallity of fixed fee: The platform's profit, the volume of trade, and social welfare all depend on both fixed fees A^B and A^S.
(Example: Extreme example (Wright, 2003))



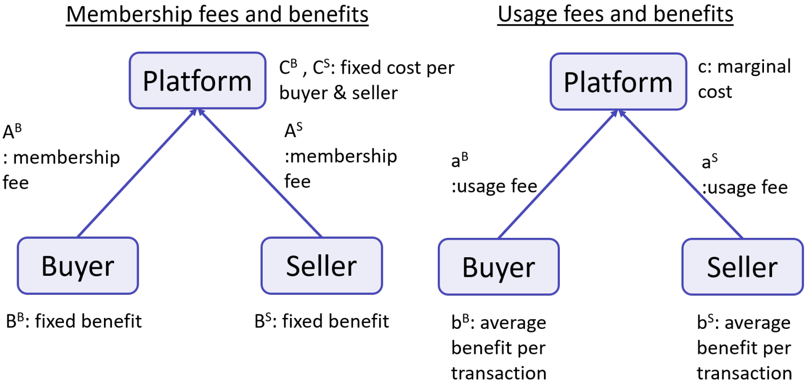
  - Consumers will not hold a card if there is a yearly fee.

Outline

Motivation


Prior literature on two-sided markets
Rochet and Tirole (2006)
Pure usage externality (Rochet and Tirole, 2003)
Pure membership externality (Armstrong, 2006)
A model that integrates usage and membership externalities

Assumption



- A monopoly platform
- No payment between end-users
- Volume of transactions $= N^B N^S$ where N^i is the number of members on side i

Model

- Net utility of an agent on side i

$$U^i = (b^i - a^i)N^j + B^i - A^i \tag{1}$$

where N^j denotes the number of members on the other side.

- Number of members on side i

$$N^i = \Pr(U^i \geq 0) \tag{2}$$

- Per-interaction price

$$p^i \equiv a^i + \frac{A^i - C^i}{N^j} \tag{3}$$

- Demand functions

$$N^i = \Pr\left(b^i + \frac{B^i - C^i}{N^j} \geq p^i\right) \equiv D^i(p^i, N^j), \quad i \in \{B, S\} \tag{4}$$

Solving the model

- Solving (4),

$$\begin{cases} N^B = n^B(p^B, p^S) \\ N^S = n^S(p^B, p^S) \end{cases}$$

- Platform's profit

$$\begin{aligned} \pi &= (A^B - C^B)N^B + (A^S - C^S)N^S + (a^B + a^S - c)N^B N^S \\ &= (p^B + p^S - c)n^B(p^B, p^S)n^S(p^B, p^S) \end{aligned}$$

- For a given total price ($p^B + p^S = p$), the platform maximizes the volume of usage.

$$V(p) = \max\{n^B(p^B, p^S)n^S(p^B, p^S) \text{ under the constraint } p^B + p^S = p\}$$

Optimal pricing

- $V(p) = \max\{n^B(p^B, p^S)n^S(p^B, p^S) \text{ s.t. } p^B + p^S = p\}$
- The price level is determined by a standard Lerner formula,

$$\frac{p-c}{p} = \frac{1}{\eta} \tag{5}$$

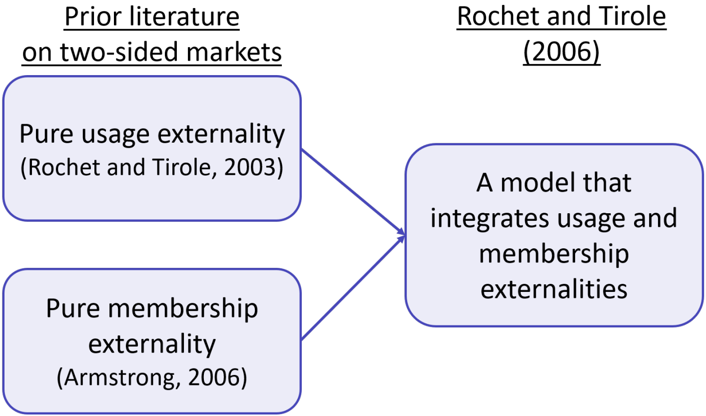
  where η is the elasticity of volume with respect to total price: $\eta \equiv -pV'(p)/V(p)$.
- The optimal price structure is obtained when derivatives of volume with respect to both prices are equal,

$$-\frac{1}{p-c} = \frac{\frac{\partial n^B}{\partial p^B}}{n^B} + \frac{\frac{\partial n^S}{\partial p^B}}{n^S} = \frac{\frac{\partial n^S}{\partial p^S}}{n^S} + \frac{\frac{\partial n^B}{\partial p^S}}{n^B}$$

- Using the total derivatives of (4) (demand functions),

$$-\frac{\left(1 - \frac{\partial D^B}{\partial N^S} \cdot \frac{\partial D^S}{\partial N^B}\right)}{p-c} = \frac{\frac{\partial D^B}{\partial p^B}}{D^B} + \frac{\frac{\partial D^B}{\partial p^B}\frac{\partial D^S}{\partial N^B}}{D^S} = \frac{\frac{\partial D^S}{\partial p^S}}{D^S} + \frac{\frac{\partial D^S}{\partial p^S}\frac{\partial D^B}{\partial N^S}}{D^B} \tag{6}$$

Motivation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No fixed costs and benefits (RT 2003)

- Simpler model with no fixed costs and benefits ($B^i = C^i = 0$)
- Then (4) becomes

$$N^i = \Pr\left(b^i + \frac{B^i - C^i}{N^j} \geq p^i\right) = \Pr(b^i \geq p^i) \equiv D^i(p^i) \qquad (4')$$

- Now the optimal pricing formula (6) becomes

$$-\frac{-1}{p-c} = \frac{\frac{\partial D^B}{\partial p^B}}{D^B} = \frac{\frac{\partial D^S}{\partial p^S}}{D^S}$$

or letting $\sigma^i \equiv -[\partial D^i/\partial p^i]/D^i$ denote the semielasticities

$$p - c = \frac{1}{\sigma^B} = \frac{1}{\sigma^S}$$

- This formula can be written as a standard Lerner formula

$$\frac{p^i - (c - p^j)}{p^i} = \frac{1}{\eta^i} \qquad (7)$$

where $\eta^i \equiv p^i \sigma^i$ is the elasticity of demand on side i.

- $c - p^j$: opportunity cost of losing a transaction on side i

Homogeneous per-transaction benefits (Armstrong 2006)

- Assumptions
  1. Identical benefit per interaction (b^i)
  2. Platform cannot observe transactions ($a^S = a^B = 0$)
  3. No transaction costs ($c = 0$)
- Pure membership pricing

$$p^i = \frac{A^i - C^i}{N^j}$$

- Number of members on side i

$$N^i = D^i(p^i, N^j) \equiv \phi^i(U^i)$$

where $U^i = (b^i - p^i)N^j + B^i - C^i$.

- Using formula (6) and after many steps of algebras,

$$\frac{p^i - (-b^j)}{p^i} = \frac{1}{\eta^i} \tag{8}$$

Canonical model

Proposition

Consider the canonical model with utilities and profit,

$$U^i = (b^i - a^i)N^j + B^i - A^i$$

$$\pi = \sum_{i=B,S} (A^i - C^i)N^i + (a^B + a^S - c)N^B N^S$$

and let

$$p^i \equiv a^i + \frac{A^i - C^i}{N^j}$$

- *The monopoly price per interaction, $p = p^B + p^S$, is given by the Lerner formula $(p - c)/p = 1/\eta$, and the price structure is given by*

$$-\frac{\left(1 - \frac{\partial D^B}{\partial N^S} \cdot \frac{\partial D^S}{\partial N^B}\right)}{p - c} = \frac{\frac{\partial D^B}{\partial p^B}}{D^B} + \frac{\frac{\partial D^B}{\partial p^B}\frac{\partial D^S}{\partial N^B}}{D^S} = \frac{\frac{\partial D^S}{\partial p^S}}{D^S} + \frac{\frac{\partial D^S}{\partial p^S}\frac{\partial D^B}{\partial N^S}}{D^B}$$

Canonical model

Proposition (continued)

- *When there are no fixed costs and benefits, the price structure is given by*

$$\frac{p^i - (c - p^j)}{p^i} = \frac{1}{\eta^i}$$

- *Pure membership pricing arises when end-users on each side differ only in their fixed membership benefit B^i. The price structure is then given by*

$$\frac{p^i - (-b^j)}{p^i} = \frac{1}{\eta^i}$$

▸ Cross-group externalities

Implication 1: Lerner formula

- Pricing in two-sided markets obeys the standard Lerner principles with a proper reinterpretation of marginal cost.
  1. Usage pricing: One more transaction $\rightarrow$ Another p^j on the other side $\rightarrow$ Net cost of a transaction: $(c - p^j)$

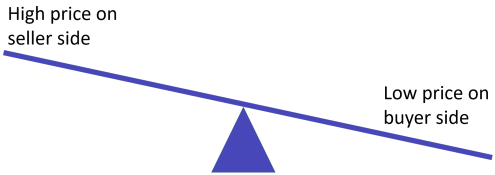
$$\frac{p^i - (c - p^j)}{p^i} = \frac{1}{\eta^i}$$

  2. Membership pricing: One more consumer on side i $\rightarrow$ Surplus b^j increases on side j $\rightarrow$ Platform can raise its price on side j by b^j

$$\frac{p^i - (-b^j)}{p^i} = \frac{1}{\eta^i}$$

Implication 2: Linkage between two sides

- Seesaw principle: A factor that is conducive to a high price on one side tends lower the price on the other side as attracting members on that other side becomes more profitable.



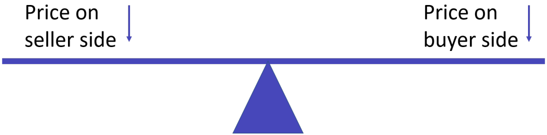
- Examples: Free newspapers, Adobe Acrobat reader

Implication 3: Platform competition and multihoming

Example of many buyers multihoming

- Elasticity of buyers' demand increases:They can switch usage to a competing platform.
- Elasticity of sellers' demand increases: Buyers' multi-homing allowing platforms to "steer" sellers.

⇒ Platform competition creates downward pressure on prices on both side of the market.



Extensions

Outline

Summary

1. Definition of a two-sided market: A market is two-sided if the platform can affect the volume of transactions by charging more to one side of the market and reducing the price paid by the other side by an equal amount.
2. Factors making a market two-sided
   1. transaction costs among end-users
   2. platform-imposed constraints on pricing between end-users
   3. membership fixed costs
3. A model of two-sided markets encompassing usage and membership externalities
4. Pricing principle: Lerner pricing formula must be reinterpreted by replacing cost by opportunity cost.

Questions and answers

- Q: What is the definition of two-sided markets?

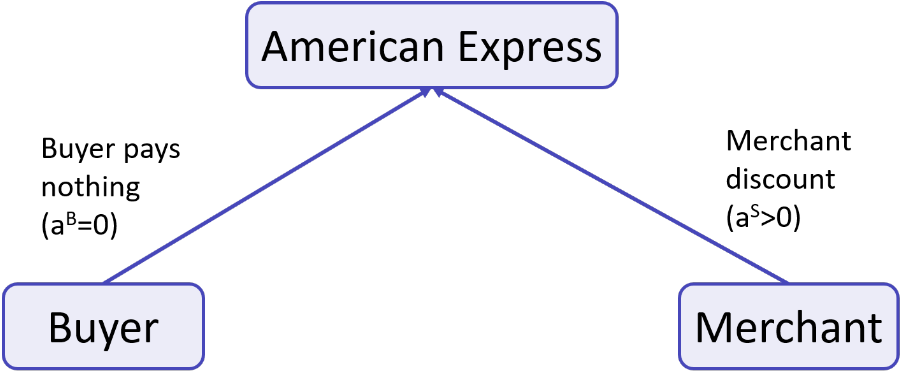
  A: A market is two-sided if the platform can affect the volume of transactions by charging more to one side of the market and reducing the price paid by the other side by an equal amount.
- Q: What is the model that can explain the externalities between end-users?

  A: A model of two-sided markets encompassing usage and membership externalities
- Q: What is the optimal pricing for the platform?

  A: Lerner pricing formula must be reinterpreted by replacing cost by opportunity cost.

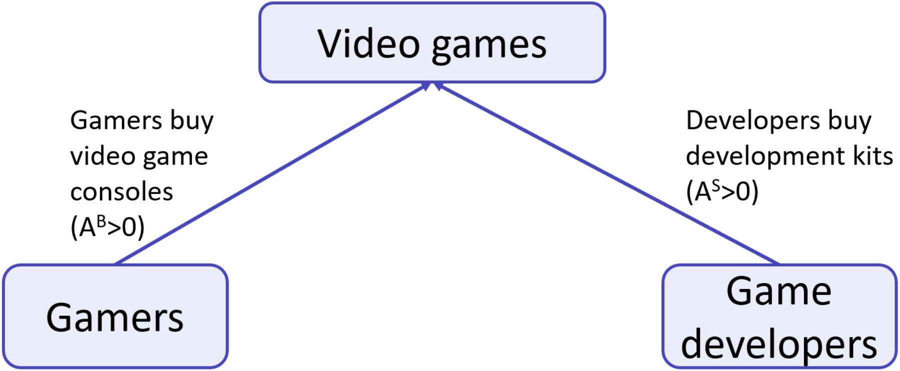
Outline

Usage charges



- If I strictly benefit from using my card than cash, then the merchant exerts a usage externality on me by accepting the card.

Membership charges



- To the extent that an end-user on side i derives a strictly positive net surplus from interacting with additional end-users on side $j \neq i$, membership decisions generate membership externalities.

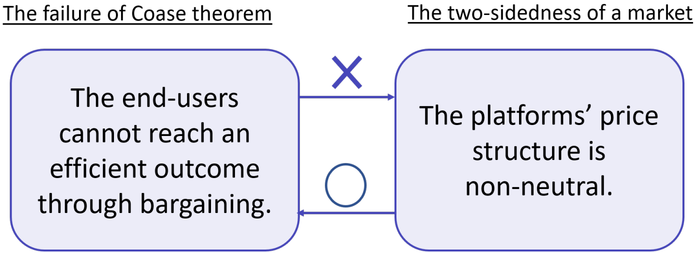
The Coase theorem

Theorem (The Coase theorem)

If property rights are clearly established and tradeable, and if there are no transaction costs nor asymmetric information, the outcome of the negotiation between two parties will be Pareto efficient.

Question: Does the failure of the Coase theorem imply that the market is two-sided?

Failure of the Coase theorem and two-sidedness



- Counterexample for $\Rightarrow$: Asymmetric information bargaining/price setting – the Coase theorem fails to apply, yet the price structure is neutral.

Interpretation of cross-group externalities

- Does U^i increases with N^j?
  1. The utility of cardholders increases with the number of merchants who accept the card ($\partial U^i / \partial N^j > 0$).
  2. Getting more merchants on board requires lowering the merchant discounts. $\rightarrow$ Cardholders pay more for their card. $\rightarrow \partial U^i / \partial N^j < 0$
- So the total derivative dU^i / dN^j can be positive or negative.
- We focus on an increase in membership keeping prices charged by the platform to end-users constant (adopting the "partial derivative definition.")

Another definition of two-sidedness

- A market is two-sided iff the solution to the maximization of volume s.t. total price constraint ($p^S + p^B \geq p$) is unique.
- With two-part tariffs, a market is two-sided in two cases:
  1. Either the split of marginal prices satisfying $a^B + a^S = a$ is non-neutral.
  2. or the split of marginal prices is neutral but the structure of fixed fees matters. In this case, membership on each side depends only on fixed charges and total marginal price a,

$$N^S = N^S(A^S, \beta^S(a)N^B) \text{ and } N^B = N^B(A^B, \beta^B(a)N^S).$$

where $\beta^i(a)$ is the per-interaction expected net surplus of a member on side i.

Fixing a, this yields two functions,

$$N^i = \hat{n}^i(A^i, A^j), \quad i, j = B, S.$$

Then the market is two-sided if the program

$$\max_{\{A^i, A^j\}} \sum_i (A^i - C^i)\hat{n}^i(A^i, A^j) + (a - c)\hat{n}^B(A^B, A^S)\hat{n}^S(A^B, A^S)$$

admits a unique solution.

Extension: payment between end-users

Proposition (Payment between end-users)

Suppose that trade between end-users is the outcome of bargaining, and that on each side i, the ex post transaction benefits (or costs) b^i are drawn from distribution $F^i(b^i)$ independently of the end-user's fixed membership benefit B^i.

Then, the platform's optimization problem decomposes.

1. *The transaction charge a is set so as to maximize the average social surplus from potential interactions:*

$$v(a) = E[(b^B + b^S - c)x(b, a)]$$

Under symmetric information bargaining between end-users, the platform passes through the per-transaction cost:

$$a^* = c$$

Extension:payment between end-users

Proposition (Payment between end-users (continued))

1. *(continued) Under asymmetric information bargaining, in a wide range of cases, the platform optimally subsidizes transactions:*

$$a^* < c$$

2. *The platform set the price level and structure as in the pure-membership version of the canonical model of Proposition 1, so as to maximize*

$$\pi = [p^B + p^S + v(a^*)]n^B n^S$$

and utilities from membership are

$$U^i(B^i) = \max\{\beta^i(a^*)N^j + B^i - A^i, 0\}$$

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Q & A

Thank you.