Network effects and two-sided platforms

Industrial Organization

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New business models for intermediaries

Traditional view of intermediaries such as retailers / distributors as vertical supply chain: intermediaries buy upstream from manufacturers, they possibly add some transformation value, and they re-sell downstream to consumers

Enriched with:

- Certification role
- Expertise on consumers' needs

New business models for intermediaries

Drastic change with the rise of online intermediaries

- e-intermediaries of physical goods without inventories, without physical plant
- intermediation of information goods, data processing
- new platform model: suppliers interact with consumers via the intermediary

Example: e-commerce retailers, price/information aggregators, media platforms, digital goods platforms, sharing economy

The economics of platforms, based on network effects.

Road map for today

Network effects: quick reminder of an old literature

Two-sided markets: a monopolistic platform

Competing two-sided platforms

Empirical investigations

Network effects

When the consumer's utility of consuming the good / service depends upon aggregate characteristics of market, e.g. total consumption, number of other active consumers ...

- Direct positive network effects in "communication" markets: larger communication opportunities are valuable
- E.g. phone, email, instant messaging, (programming) language
- Direct negative network effects: congestion problems
- Indirect network effects in systems: A and B complementary, more consumers buying A induces more demand on B, hence increases entry on B, hence higher value of buying A
- Examples: platforms "the old view" (computer, video game console, DVD player) + applications (software, games, DVD)

Canonical model of network

- Utility for consumer i, characterized by some taste parameters θ, of purchasing the network good / service at price p, depends on n size of (number of consumers in) the network:

$$U(\theta, n) - p$$

- Increasing in n: positive network effects
- Heterogeneity possibly among consumers: θ distributed uniformly on $[0, 1]$ and $U(.)$ increasing in θ.
- Yet, mostly static models: consumer does not know n when making purchase decision, hence role of expectations n^e

Canonical model of network

- Myopic expectations (more tractable) vs rational expectations (RE, more satisfactory)
- With RE, subtleties in timing:
- Uncontrolled expectations: (1) Consumers form expectations; (2) firms choose prices / quantities given expectations; RE equilibrium fixed point.
- Controlled expectations: (1) Firms choose prices / quantities; (2) consumers form expectations driven by firms' choices and make choices; RE equilibrium fixed point.

Demand for network and multiplicity

- Consumption when θ such that $U(\theta, n^e) \geq p$, hence inverse demand: $P(n, n^e) = U(1-n, n^e)$, the willingness to pay for the network for the marginal consumer given expectations
- $P(n, n) = U(1-n, n) = p$ may have multiple solutions in n: possible demand indeterminacy (e.g. if $U(\theta, n) = a + \theta n$)
- Multiplicity reflects fundamental coordination problem among consumers: a key feature of all static models of network externalities
- With $U(\theta, n) = \theta + vn$ and $v < \frac{1}{2}$, well-defined demand: use this from now on

Provision / size of network

- Social Welfare is: $\int_{1-n}^{1} U(\theta, n)d\theta - nc$
- FOC: $P(n,n) + \int_{1-n}^{1} \partial_n U(\theta, n)d\theta = c$; note that $\partial_n U > 0$
- Perfect competition: $P(n^*, n^*) = c$; leads to too small a network: externality not internalized
- Monopolist given expectations: $\max n(P(n, n^e) - c)$, FOC: $P(n,n) + nP_1(n,n) = c$ so that underprovision $n^m \leq n^*$
- Internalizing expectations: $\max n(P(n,n) - c)$, hence correction of $nP_2(n,n)$ and ambiguous effect on n^{mm}
- With $U(\theta, n) = \theta + vn$ and $v < \frac{1}{2}$:

$$n^o = \frac{1-c}{1-2v} > n^* = \frac{1-c}{1-v} > n^{mm} = \frac{1-c}{2(1-v)} > n^m = \frac{1-c}{2-v}$$

Provision / size of network

- Under k-oligopoly, crucial question: network i with size n_i gives rise to network utility $\theta + vn_i$ (incompatible networks) or $\theta + v\sum_j n_j$ (compatible networks)

- With compatible networks $N = \sum_j n_j$; market clearing implies $p_i = U(1 - N, N^e) = P(N, N^e)$ for all networks and Cournot-type competition given expectations: $n_i(P(n_i + n_{-i}, N^e) - c)$ leads to symmetric equilibrium: $P(N^c, N^c) + \frac{N^c}{k}P_1(N^c, N^c) = c$

- Underprovision compared to perfect competition, vanishes when $k \to \infty$

Provision / size of network

- With incompatible networks, i and j active in equilibrium iff: $U(1-n, n_i^e) - p_i = U(1-n, n_j^e) - p_j = 0$
- Cournot-type competition, i maximizes: $n_i(U(1-n, n_i^e) - c)$
- There exists a symmetric equilibrium with all firms active
- When network effects are large, however, there may exist asymmetric equilibria, some firms active, some others inactive
- With incompatible networks: success feeds success, competition for the market

Incompatible competing networks

How does (in)compatibility affect the nature of competition?

- Preferences for network i at price p_i: $U_i(\theta) = \theta + v(n_i^e + \gamma n_j^e)$
- $v < 1/2$ and $\gamma \in [0, 1]$ measures compatibility
- Each network has an installed base of customers β_i so that $n_i^e = \beta_i + q_i^e$ where q_i^e denote new customers
- With $g_i = v(\beta_i + q_i^e + \gamma(\beta_j + q_j^e))$, net utility is $\theta - p_i + g_i$
- Again, for positive capacities, prices corrected by network benefits must be equalized: $1 - q_A - q_B - p_A + g_A = 1 - q_A - q_B - p_B + g_B = 0$
- Cournot model (uncontrolled expectations)

Incompatible competing networks

- Demand expansion effect: as γ increases, total equilibrium demand increases, as well as consumers' surplus.
- Quality differentiation effect: as γ increases, differentiation is reduced and the advantage of the most efficient (or largest installed base) network decreases
- More efficient and larger firms more likely to be reluctant to compatibility / standardization

Illustration: The LEGO story

Introduction to two-sided markets

A new literature about an heterogeneous set of markets:

- Dating agencies, clubs, card payment systems, e-marketplaces, search engines...

... that share some common characteristics:

- Platforms provide service to different classes of users
- The value of service exhibits cross-network externalities: utility for one class (side) depends on size / activity on the other class (side)
- Platforms have some market power and are able to price discriminate across classes (sides)

Introduction to two-sided markets

- Motivated by antitrust actions in credit card industry (US in 96-98, Europe in 02, Australia in 02)
- Fixation of interchange fees (across banks) and other contractual rules (no surcharge) appear anti-competitive in standard logic, maybe less so in two-sided logic
- Also motivated by development of platforms on the Internet and of corresponding new business models with dominant firms such as EBay, Google, Amazon
- Typical observation in these industries: lots of thought about the structure of prices to different groups of users, with some subsidized segments / loss-leaders

Introduction to two-sided markets

Plateforms	Source of revenues: profit making segment	Loss leader / break-even / subsidized segment
Operating systems: Windows, Palm,…	Users *Access fees: purchase of OS*	Application developers *Free or cheap access (devt kit, interfaces, forums)*
Video games consoles	Users / players: *Access fee: purchase of console*	Game developers *Cheap access (royalties): XBox, Sony* *Or expensive: Nintendo, Sega*
Credit cards: AmEx, VISA, Mastercard	Merchants *Transaction fees*	Cardholders: *Cheap access (subscription), bonuses from usage*
Online commercial websites : e-Bay, …	Vendors: *Registration fees and transaction fees*	Buyers *Transaction charges*
Conferences, academic journals	Audience *Entry fees, purchase of journal*	Speakers, authors, celebrities, … *Remuneration // subsmission fees*

Introduction to two-sided markets

Plateforms	Source of revenues: profit making segment	Loss leader / break-even / subsidized segment
Internet portals, Newspapers, non-pay TV	Advertisers *High access charges, depending on the audience / readership*	Readers, viewers, websurfers *Free or cheap access, no usage fees*
Commercial / shopping malls	Shops *Access charges*	Consumers, buyers, visitors *Free or subsidized access (free Parking, cheap gaz)*
Pure matchmaking markets: clubs, meetic	Men *Entry / access fees*	Women *Cheap of free access*
Word processors (Adobe), music transfer (MP3)	Producers of content *Encoding charges*	Users of content *Free viewing / listening*
Real estate agencies	Sellers *Transaction charges*	Buyers *Free visits, credit facilities*

Introduction to two-sided markets

- Borrows from literature on multi-service monopoly / oligopoly and 3rd degree price discrimination: pricing targeted to each side and structure of pricing matter
- Borrows from literature on network effects
- Main questions on the positive analysis: pricing strategies? compatibility / exclusivity strategies ? commitment strategies ?
- On the normative side: social efficiency properties / distortions, competition policy w.r.t. platforms

Linear monopolistic pricing on usage

- 2 sides of the market: continuum of sellers and buyers, $i = B, S$
- Net utility of one user i: $U_i = (b_i - a_i)N_{-i}$
- $\tilde{b}_i$ gross benefits associated with interaction - transaction, randomly distributed according to $F_i(b) = 1 - D_i(b)$
- a_i transaction fee charged by platform
- N_{-i} potential partners from the other side, corresponding to volume of / probability of transaction: one buyer- one seller pair is one transaction
- c cost for the platform of implementing a transaction

Linear monopolistic pricing on usage

- Platform sets its prices / fees / charges: observable
- 3rd degree price discrimination across sides (not within sides)
- Users simultaneously determine whether to use (i.e. implement transaction on) the platform or not
- Equilibrium: (prices (a_B, a_S), users decision to trade for any profile of prices)
- User i's *quasi*-demand: $\Pr\{U_i \geq 0\} = D_i(a_i)$
- Total number of transactions: $D_B(a_B)D_S(a_S)$, assuming net benefits (b_S, b_B) independent

Linear monopolistic pricing on usage

Monopoly's profit: $\pi = (a_B + a_S - c)D_B(a_B)D_S(a_S)$

- Platform total price $a = a_B + a_S$
- Partial elasticities: $\eta_i = -\frac{a_i D_i'}{D_i}$
- Total elasticity: $\eta = \eta_B + \eta_S$
- FOC:
$$a - c = -\frac{D_i}{D_i'} = \frac{a_i}{\eta_i} = \frac{a_B + a_S}{\eta_B + \eta_S} = \frac{a}{\eta}$$
- Platform total price follows Lerner formula: $\frac{a-c}{a} = \frac{1}{\eta}$
- Price structure is given by ratio of elasticities: $\frac{a_B}{a_S} = \frac{\eta_B}{\eta_S}$
- So that: $a_i = \frac{\eta_i c}{\eta - 1}$ (increases in η_i !)

Linear monopolistic pricing on usage

- Optimal price structure can be obtained by maximizing volume of usage (total demand) for a given level of total price:

$$V(a) = \max\{D_B(a_B)D_S(a_S),\ \text{such that } a_B + a_S = a\}$$

- Total elasticity = elasticity of volume of transaction

$$-a\frac{V'}{V} = -a\frac{D_i'}{D_i} = \frac{a\eta_i}{a_i} = \eta$$

Linear monopolistic pricing on usage

- Other writing for monopoly pricing: $\frac{a_i-(c-a_j)}{a_i} = \frac{1}{\eta_i}$
- Opportunity cost of transaction $(c - a_j)$: dN_i induces additional cost of service but increases the benefit for each $(-i)$-user
- Typical comparative statics (linkage, "seesaw" principle): factor conducive of high a_i (increasing the margin) tends to reduce a_{-i} as attracting (-i)-users becomes more profitable
- E.g. more captive buyers e.g. $\theta + D_B(a_B) \Rightarrow a_B$ increases $\Rightarrow$ opportunity cost on sellers' side decreases, hence a_S decreases
- Pricing may fall below marginal cost on one side (perhaps 0) and be high on other side: skewed pricing

Linear monopolistic pricing on usage

- Market is two-sided if realized volume of transactions depends on a_B holding $a = a_B + a_S$ constant
- Price structure, and not only aggregate price level a, matters
- If users negotiate with no frictions, only a matters, i.e. market is one-sided
- Analogy with VAT; e.g. bilateral electricity trading with injection/withdrawal charges to transmission system
- Two-sidedness if transaction costs: imperfect cost pass-through in negotiations (payment for downloads on a website)...
- ... or if constraints (imposed by platform) on the pricing of transactions between end-users (no-surcharge rule for cash / card)

Monopolistic pricing on membership

Polar view of platform service: there exists benefits / costs that are transaction insensitive, related to membership / access

- Usually transaction-insensitive users costs in accessing a platform (i.e. technological fixed cost for compatibility)
- Platform may charge interaction-independent fixed fees
- Indeed, some types of transaction are imperfectly monitored by platform (dating club, advertising) and fixed fees may be the only pricing instrument available
- And non-linear pricing can improve the capture of end-users' surplus
- Allocation of fixed fees between buyers and sellers matter: they determine participation in the platform

Monopolistic pricing on membership

- Net utility of one user i is modified as follows:

$$U_i = b_i N_{-i} + B_i - A_i$$

- $\tilde{B}_i$ gross benefits / costs associated with membership, random with distribution $F_i(B)$
- A_i membership fee charged by platform
- N_{-i} potential partners from the other side for interactions
- C_i cost of registering / accepting user i
- Transaction benefits (b_i) known, there are no transaction / usage fees nor usage cost

Monopolistic pricing on membership

- In general, coordination problems lead to multiplicity of demand configurations
- System to be solved:

$$\begin{aligned} N_B &= 1 - F_B(A_B - b_B N_S) \\ N_S &= 1 - F_S(A_S - b_S N_B) \end{aligned}$$

- Possibly multiple solution for a given pair of prices
- Regularity assumptions to rule out multiplicity...

Monopolistic pricing on membership

- Or, other fruitful approach: platform offers utilities $u_i = b_i N_{-i} - A_i$ and prices given by $A_i = b_i N_{-i} - u_i$
- Quasi-demands: $N_i = 1 - F_i(-u_i) \equiv \phi_i(u_i)$, $\phi_i(.)$ increasing
- Platform's profits:

$$\pi = \phi_B(u_B)[b_B \phi_S(u_S) - u_B - C_B] + \phi_S(u_S)[b_S \phi_B(u_B) - u_S - C_S]$$

- Hence, FOC:

$$A_i = C_i + \frac{\phi_i(u_i)}{\phi_i'(u_i)} - b_{-i} N_{-i}$$

- Price = cost of providing service + factor related to elasticity of participation (market power) - external benefit to other group (marginal benefit extracted on other side)

Monopolistic pricing on membership

- Price elasticity of participation for group i: $\widehat{\eta}_i = \frac{A_i \phi_i'(b_i N_{-i} - A_i)}{\phi_i(b_i N_{-i} - A_i)}$
- Lerner formulas with opportunity cost:

$$\frac{A_i - (C_i - b_{-i} N_{-i})}{A_i} = \frac{1}{\widehat{\eta}_i}$$

- Price can be below marginal cost if group i if elasticity of participation of group i is large...
- ... or if the externality on the other group $-i$ is large
- Subsidy can be so large that price is negative (gifts for membership), or zero if negative prices not possible
- Highly skewed access pricing (e.g. Yellow pages,...) typical of two-sided situations

General monopolistic pricing

- General setting with b_i and B_i random

$$U_i = b_i N_{-i} + B_i - P_i$$

- Expenditure P_i paid by side i may depend upon the number of users on the other side N_{-i}: e.g. $A_i + a_i N_{-i}$
- This leads to quasi-demands: for a given N_{-i}, unique decreasing function of price P_i

$$\bar{D}_i(P_i, N_{-i}) = \Pr\{B_i + b_i N_{-i} \geq P_i\}$$

- A given pair (N_B, N_S) leads to a unique profit and welfare:
- Inverting, yields: $P_i(N_i, N_{-i})$; the unique set of prices consistent with participation (N_i, N_{-i})
- Platform may ensure that $\overline{N}_i$ participate on side i, irrespective of what side $-i$ does, by charging an "insulating tariff" based on observed participation of side $-i$: $P_i(\overline{N}_i, N_{-i})$: unique implementation

General monopolistic pricing

- Social planner chooses standard Pigouvian pricing, that maximizes:

$$V_B(N_B, N_S) + V_S(N_S, N_B) - C_B N_B - C_S N_S - cN_B N_S$$

  where: $V_i(N_i, N_{-i}) = \mathbf{E}[(B_i + b_i N_{-i})\mathbf{1}_{\{B_i + b_i N_{-i} \geq P_i(N_i, N_{-i})\}}]$

- The social marginal benefit from N_i is:

$$\frac{\partial V_i}{\partial N_i} + \frac{\partial V_{-i}}{\partial N_i} = P_i + \overline{b}_{-i} N_{-i}$$

$$\overline{b}_j = \mathbf{E}[b_j \mid B_j + b_j N_{-j} \geq P_j]$$

  is the value an additional user on side $-j$ brings to users on side j

- Social planner chooses: $P_i = C_i + cN_{-i} - \overline{b}_{-i} N_{-i}$

General monopolistic pricing

- Monopolist chooses marginal benefit = marginal cost; FOC:

$$P_i + \frac{\partial P_i}{\partial N_i} N_i + \frac{\partial P_{-i}}{\partial N_i} N_{-i} = C_i + cN_{-i}$$

- 2nd LHS term equals $\frac{P_i}{\eta_i}$, standard measure of market power
- 3rd LHS term specific to two-sided markets = revenue that can be extracted from side $-i$ by adding one extra i-user
- Define the average interaction benefit of marginal j-users:

$$\widetilde{b}_j = \frac{\int b_j f_j(P_j - b_j N_{-j}, b_j) db_j}{\int f_j(P_j - b_j N_{-j}, b_j) db_j} = \frac{\partial P_j}{\partial N_{-j}}$$

- Optimal pricing becomes:

$$P_i = [C_i + cN_{-i} - \widetilde{b}_{-i} N_{-i}] + [\frac{P_i}{\eta_i}]$$

General monopolistic pricing

- Monopoly distortion on P_i compared to social optimum = market power distortion + "Spence" distortion $(\bar{b}_{-i} - \widetilde{b}_{-i})N_{-i}$
- Comes from inability to price discriminate within one side
- As with standard "quality provision" problems, might over- or under-subsidization of i-users compared to optimum
- With only transaction benefit heterogeneity, the Spence distortion equals the per-interaction surplus on side $-i$
- With pure membership benefits, no Spence distortion !

General monopolistic pricing

- "Seesaw principle" : a factor conducive of a high price on one side tends to call for a low price on the other side ?
- Here really about strategic substitutability of participation rates: $\frac{\partial^2 \pi}{\partial N_B \partial N_S} < 0$?
- A value of B-user is proportional to the number of S-users she interacts with; thus more S-users make it more attractive to recruit B-users $\rightarrow$ complementarity !
- But increasing participation by S-users requires recruiting lower benefit users; this reduces $\widetilde{b}_S$, hence increases P_B and reduces participation on side B $\rightarrow$ substitutability !
- In general, sign indeterminate

Competing platforms

Previously, we analyzed monopolistic platform in a two-sided market environment. Now, we introduce imperfect competition between 2 platforms, $h = 1, 2$

One key issue:

- One end user may well participate in both platforms to enlarge the set of potential transaction partners: this is called "multi-homing"
- Natural if no membership costs and no access fees
- In many circumstances, though, exclusivity is technically imposed (clubs) or too costly to circumvent (compatibility issues in programming)

Single-homing and high differentiation

Two differentiated platforms charging registration fees but no transaction fees on single-homing users

- Platform h charges A_i^h and attracts N_i^h users on side i
- Platforms offer utilities: $u_i^h = b_i N_{-i}^h - A_i^h$
- Hotelling-type differentiation model: platform-membership benefits equal $v - t_i \mid x - x^h \mid$ with platforms at end points 0 and 1 and x uniformly distributed on $[0, 1]$
- $N_i^h = \frac{1}{2} + \frac{u_i^h - u_i^{-h}}{2t_i}$
- t_i measures the degree of differentiation on side i between the two platforms: corresponds to the mark-up over marginal cost from market power (classical Hotelling model)

Single-homing and high differentiation

- v is large so that market fully covered: $N_i^h = 1 - N_i^{-h}$
- Then, quasi-demands follow:

$$N_i^h = \frac{1}{2} + \frac{b_i(2N_{-i}^h - 1) - (A_i^h - A_i^{-h})}{2t_i}$$

- Keeping prices on side i fixed, an extra $(-i)$-user attracts a further $\frac{b_i}{t_i}$ agents of group i on the platform
- Focus on market-sharing equilibria (both platforms active), and for that assume "strong enough differentiation"
- Fully solved demand system:

$$n_i^h = \frac{1}{2} + \frac{b_i(A_{-i}^{-h} - A_{-i}^h) + t_{-i}(A_i^{-h} - A_i^h)}{2(t_B t_S - b_B b_S)}$$

- Complementary demands: n_i^h decreases in A_{-i}^h

Single-homing and high differentiation

- Unique equilibrium is symmetric, FOC:

$$A_i = C_i + t_i - \frac{b_{-i}}{t_{-i}}(b_i + A_{-i} - C_{-i})$$

- $C_i + t_i$ classical equilibrium price without network effects
- $\frac{b_{-i}}{t_{-i}}$ is the number of extra $(-i)$-agents attracted by one additional i-agent
- Attracting one extra $(-i)$-agent; yields extra revenue $A_{-i} - C_{-i}$ and increases group i's utility by b_i, which can be extracted from them
- Correcting terms : opportunity cost of raising A_i by enough to cause one i-agent to leave

Single-homing and high differentiation

With high differentiation, unique equilibrium is symmetric and $A_i = C_i + t_i - b_{-i}$; profits equal : $\frac{t_B + t_S - b_S - b_B}{2} > 0$

- One group targeted more aggressively if more competitive side (t_i smaller) or causes larger externality on other group (b_{-i} larger)
- Prices may be negative on one side (subsidization)
- Specificities due to linear Hotelling and fixed market
- Externalities reduce profits as platforms have incentives to compete harder for market share

Single-homing and high differentiation

- Alternative expression:

$$\frac{A_i - (C_i - 2b_{-i}N_{-i})}{A_i} = \frac{1}{\eta_i}$$

  with $\eta_i = \frac{A_i}{t_i}$ the demand elasticity on side i wrt own price given fixed and equal market shares on other side

- Duopoly puts twice emphasis on externalities as monopoly: one lost i-agent goes to competitor (does not disappear), hence more difficult to attract $(-i)$-agents

Single-homing and high differentiation

Suppose platforms can engage in price fixing so as to increase A_S by Δ

- They must decrease A_B by $b_S \frac{\Delta}{t_S}$: they compete more aggressively for buyers to earn extra Δ
- Overall, profits increase by $\frac{\Delta}{2}(1 - \frac{b_S}{t_S})$: smaller benefit of price fixing.

If constraint on non-negative prices

- If t_B decreases, platforms tend to lower A_B
- But if $A_B = 0$, then $A_S = C_S + t_S - \frac{b_B(b_S - C_B)}{t_B}$ decreases
- More intense competition on buyers, platforms reduce sellers prices (to attract sellers so as to attract more buyers...)!

Single-homing and high differentiation

- With registration and transaction fees: with high differentiation, exists a continuum of symmetric equilibria indexed by $(a_B, a_S) \in [0, 2b_B] \times [0, 2b_S]$, with $A_i = C_i + t_i - b_{-i} + \frac{a_{-i} - a_i}{2}$ and profits $\pi = \frac{t_B + t_S - b_B - b_S}{2} + \frac{a_B + a_S}{4}$
- π increase in transaction fees as they reduce (overturn?) externality effects that make market so competitive
- Continuum comes from existence of a continuum of best responses, because rich set of strategic instruments
- Exist also other equilibria (see next)

Single-homing and low / no differentiation

With no differentiation, network effects become critical and serious coordination problem: given prices, several allocation $\{n_i^k\}_{i,k}$. Routes to select:

- Optimistic beliefs in favor of an "incumbent platform"
- Or pessimistic beliefs (in the worst scenario...)
- Monotonicity: starting from a given equilibrium, an increase in (A_B^k, A_S^k) cannot increase the demand for platform k
- Inertia: starting from a given equilibrium with users allocation $\{n_i^k\}_{i,k}$, maintain the same users allocation after a deviation in (A_B^k, A_S^k) if this allocation is still rational
- Pareto selection: maximizes users' welfare

There exist market sharing (symmetric) equilibria, with zero profits, i.e. Bertrand (under monotonicity or inertia)

Single-homing and low / no differentiation

Moreover, the market may "tip": monopolization equilibria

- Divide and conquer strategies under inertia
- Starting from equilibrium with $n_i^1 = 1$ and $n_i^2 = 0$, platform 2 must subsidize one group, say i: $-A_i^2 > b_i - A_i^1$ (to change allocation despite inertia)
- Then group $-i$ expects $N_i^{2,e} = 1$ and platform 2 can charge A_{-i}^2 such that $b_{-i} - A_{-i}^2 \geq -A_{-i}^1$ and $b_{-i} - A_{-i}^2 \geq 0$
- Platform 2 loses on group i (divide) and gains on group $-i$ (conquer) with profits: $\sup_i [A_i^1 - b_i + b_{-i} + \inf\{A_{-i}^1, 0\}]$
- Platform 1 sustains monopoly by subsidizing (negative price) the group that causes the larger externality and extracting this high externality benefit on the other group: if $b_S > b_B$, $A_S^1 = b_S$ and $A_B = \inf\{-b_B, b_B - b_S\} < 0$

Single-homing and low / no differentiation

- Introducing transaction fees, all equilibria involve monopolization, with zero profit for the monopolistic platform!
- Drastic consequences: more pricing instruments allows more profitable deviation from the non-active firm (subsidize one side with membership subsidies and recoup with transaction fees), therefore it constrains the monopoly
- Cf contestability
- In equilibrium, the monopoly cancels externalities through transaction fees ($a_i^1 = b_i$), subsidizes through membership fees the group causing the larger externality, and extracts this large externality by membership fees on the other group: the group that benefits from the larger externality therefore fully subsidizes the group causing this larger externality

Multi-homing without differentiation

- Suppose that users can access / become members / trade on both platforms. What does it change ?
- What about previous types of equilibria (market-segmentation, monopoly-like) in which users single-home in equilibrium: key is that more deviations are now possible !
- Existence of new forms of equilibria with users on one side multi-homing: competitive bottleneck
- In all cases, careful specification of users allocation: N_i^k single-homing users of group i at platform k, N_i^M multi-homing users of group i

Multi-homing without differentiation

- Given prices (under inertia), platform uses more intricate divide-and-conquer strategy to become active
- Starting from $N_i^1 = 1$ and $N_i^2 = 0$, platform 2 may simply charge $A_i^2 = 0^-$: i-users will register with it as a "second home": dividing is costless
- Conquering is more complicated:
  - attracting $(-i)$-users as multi-homers: interactions can take place on both platforms, hence competition to process transaction; not much pressure on access fees, but competitive pressure on transaction fees
  - attracting at least one group as single-homers; this is more demanding in terms of membership fees, but transaction fees can be used to extract surplus

Multi-homing without differentiation

- Relying on such analysis of possible deviations: there still exists monopoly-like equilibria (of course, zero profit)
- They rely on zero transaction fees in equilibrium (make conquer costly for rival), while when multi-homing is not possible, the pricing aims at making divide more costly
- But generically, there does not exist equilibria with each platform getting a positive market share on both side, and users single-homing
- Intuition: segmented users allocation is unstable + monotonicity $\Rightarrow$ one platform can always get the whole market
- Any market-sharing equilibrium (both firms active) necessarily involves one group multi-homing !

Multi-homing with differentiation

- With high differentiation, multi-homing very costly, hence, no users multi-home in any equilibrium (single homing analysis valid without a priori restriction)
- Suppose platforms are differentiated for buyers, but not for sellers: $t_S = 0 << t_B$
- Focus on pure access pricing ($a_i^k = 0$)
- Buyers single-home (differentiation) and split (heterogeneity) $\Rightarrow$ incentives for sellers to multi-home to transact with more buyers, provided access fees not prohibitive
- Platforms have monopoly over access to "their" buyers, hence market power on sellers; intense competition to attract buyers leads buyers to capture most of platforms' rent

Multi-homing with differentiation

All equilibria involve zero sellers' surplus (under inertia)

- If sellers multi-home: $b_S - A_S^1 - A_S^2 \geq b_S N_B^k - A_S^k$
- If both equalities for $k = 1, 2$, summing one gets: $b_S - A_S^1 - A_S^2 = 0$ i.e. zero sellers' surplus !
- Hence not possible, so for one platform k, $A_S^k < (1 - N_B^{-k}) b_S$ and this platform can increase A_S^k!
- If they single-home at platform (e.g.) 1 with positive surplus: $b_S N_B^1 - A_S^1 > 0$, and $b_S N_B^1 - A_S^1 \geq b_S - A_S^1 - A_S^2$
- So A_S^1 can be increased locally !
- Hence contradiction.

Multi-homing with differentiation

This can be extended in a more general setting

- Fix the utility offered to buyers u_B and the equilibrium number of attracted buyers N_B
- A platform maximizes its profits in (A_B, N_S) under the constraint that $A_B = b_B N_S - u_B$
- The profits are:

$$N_B A_B + N_S A_S - C(N_B, N_S)$$

- So, using the constraint, as if maximizing:

$$N_B N_S b_B + N_S A_S - C(N_B, N_S)$$

  i.e. the platform's profit + B's surplus
- S's surplus omitted: too few sellers N_S^k (their surplus is squeezed out)

Multi-homing with differentiation

- Looking for symmetric equilibrium with zero sellers' surplus, i.e. $A_S = b_S/2$
- Small undercut in A_B^k leads to decrease N_B^{-k}; sellers surplus at $-k$ becomes negative, hence all sellers go to platform k exclusively (monotonicity), i.e. tipping, which leads to jump increase in N_B^k: profitable if $A_B^k > C_B$!
- Therefore, in symmetric equilibria $A_B \leq C_B$
- If b_S large and c low, range of symmetric competitive bottleneck equilibria, $\max\{0; C_B + t_B - b_S\} \leq A_B \leq C_B$ and $A_S = b_S/2$
- Platform give away service to buyers who still single-home, while sellers pay high price and multi-home

Multi-homing with differentiation

- In this competitive bottleneck situation, platform 1 has incentives to offer exclusive services (forbidding multi-homing)
- Suppose it offers exclusive price $A_S^1 = \frac{b_S}{2} - \epsilon$ and increase A_B by b_B
- Sellers sign exclusive contracts with platform 1
- Half of buyers stick with platform 1 (increase in price balanced by no more sellers at platform 2)
- Hence same users at platform 1, at higher profit !
- Platform 2 is partially foreclosed: keeps buyers due to differentiation
- In a model without differentiation on buyers' side, complete foreclosure: i.e. monopoly like equilibria

Empirical investigation – Newspapers as platforms

Newspapers are prototypical examples of two-sided markets: they cater to two different types of users, namely readers and advertisers

Industry in distress looking for new business models (freemium, paywall) especially because of the diffusion of the Internet and connected mobile devices

Industry under the scrutiny of public authorities (state aids, specific VAT regime, antitrust and mergers) because they are thought to enhance ideological diversity, to promote truth and contributed to the political process

Empirical analysis of seesaw principle

Newspapers actually rely on three sources of revenues that are interrelated:

- Readers
- Classified ads
- Commercial ads

Seamans-Zhu (Mangt Sc 2014) use the entry of Craiglist as a negative shock on the classified ads side to study the relationships between the different prices

Empirical analysis of seesaw principle

Nice empirical setting:

- Craiglist only provides classified ads, but no editorial content nor commercial ads, so it is a negative shock on only one side of local newspapers which rely on classified ads revenue
- Circulation of local newspapers has limited geographical reach, effectively segmenting the US into non-overlapping geographical markets
- Entry of Craiglist in different areas was almost random wrt newspapers market
- Entry of Craiglist occurred in different areas at different points in time

Diff-in-diff approach that compares the affected newspapers before and after Craiglist's entry to the control newspapers

Empirical analysis of seesaw principle

$$
\begin{aligned}
p_{it} \quad = \quad & \beta_0 + \beta_1.CraiglistEntry_{it} \\
& + \beta_2.CraiglistEntry_{it} * Classified_{it} \\
& + \beta_3.Classified_{it} + X_{it}.\beta + \gamma_i + \eta_t + \epsilon_{it}
\end{aligned}
$$

- i indexes newspapers and t years
- $CraiglistEntry_{it}$: dummy variable if Craiglist is active in area where newspaper i operates in year t
- $Classified_{it}$: dummy variable for newspapers with substantive revenue from classified ads in year t
- Estimated on a panel data set between 2000 and 2007 for several hundreds newspapers over 100 geographical areas

Empirical analysis of seesaw principle

Results:

- The entry of Craiglist causes...
- ... a decrease in classified-ad price (direct effect)
- ... an increase in subscription price (first indirect effect)
- ... and a decrease in commercial ad price (second indirect effect)

The effect of Craiglist's entry on the classified ad side propagates first to the readers side and then to the commercial-ad side

Estimation of cross-side externalities

Kaiser - Wright (IJIO 2006): discrete choice model of competition in the magazines market

- Use two-sided duopolistic model with Hotelling-type differentiation and single-homing on all sides
- Magazine i: content pages N_i^c, advertising pages N_i^a, circulation N_i^r, price per copy to readers p_i and ad-rate a_i
- Readers' utility from reading magazine i:

$$u_i = \theta_i^r + \gamma N_i^a + \phi N_i^c - \beta p_i - t_i(x) + \epsilon_i^r$$

  θ_i^r common fixed effect across readers, $t_i(x)$ index capturing preference of reader located at x for magazine i

- Similarly for advertisers' profit placing an ad in magazine i

$$\pi_i = \theta_i^a + \rho N_i^r - \eta a_i - t_i(y) + \epsilon_i^a$$

Estimation of cross-side externalities

Assuming a duopoly with full market coverage, the readership market share and advertising market share are:

$$\begin{aligned}
n_1^r &= \frac{1}{2} + \theta_1^r - \theta_2^r + \gamma(N_1^a - N_2^a) + \phi(N_1^c - N_2^c) \\
&\quad -\beta(p_1 - p_2) + \epsilon_1^r - \epsilon_2^r \\
n_2^r &= 1 - n_1^r \\
n_1^a &= \frac{1}{2} + \theta_1^a - \theta_2^a + \rho(N_1^r - N_2^r) - \eta(a_1 - a_2) + \epsilon_1^a - \epsilon_2^a \\
n_2^a &= 1 - n_1^a
\end{aligned}$$

Assume Readers and advertisers make their choice after observing prices and assume REE (with small enough externalities)

Estimation of cross-side externalities

- Magazine i profit given by:

$$(p_i - f_i)N_i^r + (a_i - c_i)N_i^a - d_i(N_i^c)^2 - F_i$$

- Each magazine sets both prices (per copy and ad rate) and the number of content pages to maximize profits given the rival's choice
- Equilibrium conditions given price - cost margins on each side:

$$\begin{aligned} p_i - f_i &= \frac{n_i^r}{\beta} - \frac{2\rho N_i^a}{\eta} \\ a_i - c_i &= \frac{n_i^a}{\eta} - \frac{2\gamma N_i^r}{\beta} \\ N_i^c &= \frac{\phi N_i^r}{2 d_i \beta} \end{aligned}$$

Estimation of cross-side externalities

- Estimate the demand equations to recover the estimated parameters $(\gamma, \phi, \beta, \eta, \rho)$
- Use these estimates to solve equilibrium for the equilibrium cost - margins
- GMM estimation to jointly estimate the two demand equations in first differences (get rid of common fixed effect)
- All RHS variables are possibly endogenous and therefore instrumented (typically with the editor's average similar variables over other magazines / other advertisers' contracts)

Data: unbalanced panel data of 9 duopolistic magazine markets in Germany, 1972-2003: cover prices, ad rates, number of ads pages, number of content pages, circulation

Estimation of cross-side externalities

Results:

- Magazines with more content and more ads attract a greater share of readers
- Readers are willing to pay more for one additional ads page than for one additional content page (no control for quality)!
- Advertising demand depends on both the number of readers (positively) and ad rate (negatively)
- Advertisers value more extra 1% of readers than readers do for an extra 1% of ads
- Structure of price - cost margins shows skewed pricing, high margin on the ads side and negative margin on the readers' side

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