Consumer Heterogeneity in Two-Sided Markets

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Introduction and framework
Optimal pricing and comparative statics
Special cases, applications and conclusion

AmEx and the Globe

American Express and Boston Globe

- Both two-sided markets but...
  - AmEx
    - Loyalists value acceptance more than marginals
    - Imperfect internalization because no discrimination
    - Higher card-holder price \implies more cross-subsidies
    - Classic 2sms logic (Rochet and Tirole 2003)
  - Globe
    - Loyalists hate advertising more
    - Ad prices too low?
    - Higher subscription price \implies less ads, higher prices
    - Ignored or assumed away by current analysis

- Today: full Rochet and Tirole (2006) accommodates both
  - Crucial difference is source of consumer heterogeneity
Outline

1. Two-sided markets and RT2006 model
2. Monopoly platform pricing
3. Socially optimal pricing
4. Comparative statics and identification
5. Special cases
6. Applications
7. Conclusion
Two-sided markets and the RT2006 model

- Definition of 2sms controversial
- For me: modeling approach (not market-type), useful when
  1. Cross-network effects
  2. Bilateral market power
  3. Market expansion
- Otherwise much easier approaches
- Simple, but general model by RT2006...assumptions:
  1. Valuations exogenous, no direct interactions
  2. (Direct) Network effects only across
  3. Affine valuations (not essential) and random sample
  4. Consumers equally valuable/harmful to other side
Model primitives

1. Demand
   - Two groups of consumers A and B, each unit mass
   - Consumers heterogeneous in two values
     - Fixed *membership* benefit/cost $B_i^I$ (Armstrong)
     - *Interaction* benefit/cost $b_i^I$ per partner (RT2003)
     $$U_i^I = B_i^I + b_i^I N_j^J - P^I (N_j^J)$$
   - Arbitrary correlations allowed (only smoothness)

2. Supply
   - Membership costs $C^I$ and interaction cost $c$
   - Only uniform pricing (no discrimination)

3. Equilibrium
   1. Firms choose price (schedules) anticipating...
   2. Induced equilibrium determines participation/demand
Participation rates and price schedules

- Potential multiplicity (for some price schedules)
- But unique equilibrium prices $P^I(N^I, N^J)$
  - So multiplicity inessential
  - Only possible multiple equilibria given prices
    - Evans and Schmalensee (2009)’s “failure to launch”
- Platform can always achieve desired $(\tilde{N}^A, \tilde{N}^B)$ uniquely
  - Set full insurance price schedule $P^I(N^J) \equiv P^I(\tilde{N}^I, N^J)$
  - Simple in many markets
  - Thus we can ignore coordination problem
    - Why not more common?
- So platform just chooses participation rates!
  - No more fixed point: dramatically simplifies analysis
Privately optimal pricing

\[ \pi(N^A, N^B) = \left( P^A \left[ N^A, N^B \right] - C^A \right) N^A + \left( P^B \left[ N^B, N^A \right] - C^B \right) N^B - cN^A N^B \]

(1)

For first-order condition directly take derivatives:

\[ P^l = C^l + cN^j - b^j N^j + \mu^l \]

- \( \overline{b}^l \) ≡ average interaction benefit of marginal consumers
- Also equivalent Lerner form
- Same as one-sided, but internalize marginal cross-value
- v. RT2006: primitives not just multiproduct monopoly
- One step to simplify to...
  - Armstrong \( P^l = C^l - b^j N^j + \mu^l \)
  - Or RT2003 \( p^A + p^B - c = m^A = m^B \)
- Also give sufficient conditions (first and near-necessary)

Weyl (2009)  Heterogeneity in 2sms
Pigouian pricing and the Spence distortion

Start with first-best, takes Pigou (1920) form

\[ P^I = C^I + cN^J - \bar{b}^J N^J \]

1. \( \bar{b}^I \equiv \text{avg. int. benefit of all participating consumers} \)
2. Thus two distortions
   1. Classic market power: prices too high
   2. If \( \overline{b}^I \neq \bar{b}^I \) don’t internalize right interaction benefits
      - Inability to price discriminate
      - Like Spence (1975)’s quality distortion, so *Spence distortion*
      - Even more important in two-sided markets
      - May go in either direction (credit cards vs. newspaper)
      - Depends crucially on source of consumer heterogeneity
      - So RT2003 \( \implies \) upwards, Armstrong \( \implies \) none

Weyl (2009) Heterogeneity in 2sms
• Optimum may require subsidies
• If these infeasible, Ramsey pricing is second best
• Ramsey pricing + externalities = Oum and Tretheway (1988)

\[ P^I = C^I + cN^J - \left( \alpha \tilde{b}^J + [1 - \alpha] \tilde{\tilde{b}}^J \right) N^J + \alpha \mu^I \]

\[ \alpha = \frac{K + \left( \tilde{b}^A + b^B - c \right) N^A N^B}{N^A \mu^A + N^B \mu^B + \left( \tilde{b}^A + \tilde{b}^B - b^A - b^B \right) N^A N^B} \]

• I also do RT2003 (rate of return on variable costs)
Of course, we need calibration for policy implications but...

1. Prices may be below socially optimal level
2. Market power may be especially bad, or beneficial
3. Ramsey pricing calls for balanced regulation
4. Price discrimination more beneficial...or may be harmful

Armstrong or RT2003 models impose answer
Complements v. substitutes

- Most basic comparative static: “seesaw” principle
  - RT2006 seem to think it is general
- Not clear what it means more broadly: what prices?
  - Equivalent to substitution of participation rates in RT2003
  - Natural way to generalize...but not true generally

Some definitions

1. \( \alpha \equiv \frac{b^A + b^B - c}{\pi} \) marginal interaction surplus ratio
2. \( \beta \equiv \frac{\mu_B}{\mu_B} \) interaction heterogeneity ratio

- Decompose \( \mu = \mu^A + \mu^B \) and aggregate \( \mu = N^A \mu^A + N^B \mu^B \)

- Substitutes if \( \mu_B \leq 0 \) or \( \beta > \alpha \)
- If \( \mu_B > 0 \), complements if \( \alpha > \beta \), independent if \( \alpha = \beta \)

- Change in cross-subsidy versus scaling
- Again source of heterogeneity, link to normative properties
  - RT2003 \( \Rightarrow \) substitutes, Armstrong \( \Rightarrow \) complements

Weyl (2009) Heterogeneity in 2sms
Equilibrium externalities

- For me: 2sms = externalities \textit{in absence of transfers}
  - But other say “holding fixed price” \textit{indirect} externalities
  - But what price? Model says only $P^I(N^J \star)$ “matters”

- Perhaps more sensible: does $I$ want $C^J$ to rise or fall?
- Sign is same as $\tilde{b}^I - \bar{b}^I + \rho^I \chi^\times$
  - $\rho^I \equiv \frac{dP^I}{dC^I}\bigg|_{N^J \text{ fixed}}$ \textit{pass-through rate}
  - $\chi^\times$ is cross participation effect

- Crucial: infra-marginal v. marginal
  - But pass-through related to this as $V = \rho \mu D$ (other talk)
  - For example: RT2003 sign determined by $\rho''$
  - Third derivative of log-demand important

- Even possible that $C^I \uparrow$ good for $I$
  - Again, when infra-marginal dominates marginal (by a lot)
Lots of ambiguity left

- Much resolved by intuition, casual empiricasm
- But rigorous empirics may help resolve some as well
- So what does data give us? Identification problem
  - I take a different approach vs. parametric or non-parametric
    - Parametric puts restrictions
    - Non-parametric assumes infinite data
  - Instead: observe some derivatives, what do they say?
    - $N^I$ variations give $\mu^I, \bar{b}^I$
    - Signed $C^I$ variations give substitutes v. complements
    - Measured $C^I$ shocks given $\rho^I, \chi^x$
    - Tests as well, demand side can replace cost shock
  - In fact, methods give arbitrary comparative statics
    - In paper example of multiplicative demand shock
Another way to resolve ambiguity is more structure
Also make more concrete
Natural direction: only one dimension of heterogeneity

- Armstrong and RT2003 examples
- But Armstrong heterogeneity rarely plausible
- RT2003 restricts membership costs/benefits implausibly
  - Easily solved: only source of heterogeneity matters
  - *Generalized* RT2003 model potentially well-suited
  - Analyzed in paper; quite similar to RT2003

- But still many markets seem mismatched to these
- So here: two new models, perhaps more realistic

- First is *Hybrid*: one side RT2003, one Armstrong
- May fit some better (advertising, software platforms)
- But better is one I’ll discuss in more detail
Scale-Income model

- Idea: homogeneous ratio $\frac{b_i^l}{B_i^l} \equiv \beta^l$
- Either dimension may be negative
- Examples:
  1. Newspapers: reader wealth, advertiser size
  2. Software platforms: constant profit ratio, project size
- For concreteness: newspapers
- Now $\bar{b}^l = \frac{P_i^l}{N^l + \frac{1}{\beta^l}} \equiv P_i^l \nu^l$
- $\nu^j \mu^j \rho^j$ is Spence distortion
  - Sign determined by $\nu^l = \text{sign of } \frac{b_i^l}{P_i^l}$
  - Serve large or small scale readers?
  - Tabloids v. serious papers
    - Different predictions on effects of competition, discrimination
- Predicts complementary participation for serious papers
- Empirical data now very useful
Identifying market power, predation and costs

- Identifying market power, predation are old open questions
- Two approaches, paper speaks to both
  1. Casual/applied
     - Use price cost margins, but 2sms complicate...
     - No reason to dismiss market power or predation
     - Just add in $b^J/N^J$
     - Not much harder to measure than other costs
  2. Structural (Bresnahan 1989)
     - Costs, other things may be hard to estimate directly
     - If so, can use data to back out: measure demand directly
     - Add: multiproduct, too many costs
- Under competition (guess) just adjust
  - Right marginal consumers, instruments to hold things fixed
- Not much more complicated than standard market
Mergers

Alternative merger analysis for 2sms is holy grail

- But requires work-horse model of competition
  - Working on this with Alex White (TSE)
  - But in mean time, my paper mostly monopoly

- Nonetheless three small contributions to merger analysis
  1. Quantity approach simplifies analysis, makes more possible
     - In appendix I show merger with non-two-sided firm easy
     - Companion does complements case in detail
     - General Armstrong single-homing competition
  2. Helps deal with multiplicity
     - Full insurance natural refinement of price schedules
  3. Source of consumer heterogeneity important (caution!)
     - RT2003 merger help welfare, lower overall prices
     - Under weak conditions Armstrong merger harmful both sides

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Directions for future research

- Paper aspires to make two contributions
  1. Simplify analysis
  2. Importance of source of consumer heterogeneity

- Empirical applications: which models fit, test predictions

- Direct important extensions
  1. Direct interactions
  2. Crowding within a side
  3. Heterogeneous quality
  4. Price discrim., $N$-sided markets, regulatory design, etc.

- Two big, open theoretical questions
  1. Revenue maximizing matching (market design meets 2sms)
  2. Price schedules and coordination problems