Estimating Platform Market Power in Two-sided Markets with an Application to Magazine Advertising

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In Two-sided Markets

- Two groups of agents interact through a platform.
- Each group cares about the presence of agents on the other side, and thus the decisions of agents on one side affect the utility of agents on the other side.
- Platforms account for these cross-group externalities in making strategic decisions (e.g. setting prices).

Examples

- Payment systems
  - Merchants and consumers interact through credit cards.
- Video game systems
  - Game developers and game players interact through video consoles.
- Advertising in newspapers/magazines/websites
  - Advertisers and readers interact through media platforms.

What I do in this paper

- My paper brings two important features of the two-sided market into a structural model.
  - Agents on each side care about the presence of agents on the other side.
  - Platforms charge two prices, one for each group.
- I focus on cases where platforms charge fixed membership fees.
- I consider two versions of the two-sided market.
  - Two-sided single homing: agents on both sides join one platform each.
  - Competitive bottleneck: agents on one side join one platform but agents on the other side join multiple platforms.

- I show how to estimate agents' demand (preferences) for platforms using data on (two) membership prices, the number of agents on platforms, and other platform attributes.
    - The presence of agents from the other side is an important platform attribute and this variable is an endogenous variable.
- Given demand estimates, one can recover platforms' costs of serving agents and measure their markups (market power).
    - Price elasticity does not have a closed form because of the so-called feedback loop effect.
    - There are two demand equations, one for each group, and both should be used simultaneously to recover the costs.

Literature

- Numerous theory papers on two-sided markets.
  - The most cited ones are Rochet and Tirole (*JEEA* 2003; *RAND* 2006) and Armstrong (*RAND* 2006).
  - My paper is closely related to Armstrong (2006) .
- Relatively few empirical papers but the number is growing fast.
  - Rysman (*RESTUDS* 2004) on the Yellow Page market - zero price for consumers.
  - Argentesi and Filistrucchi (*JAE* 2007) on the Italian newspaper market - consumers do not care about advertising.

Model 1: Two-sided single-homing

- Two groups of agents, groups A and B. Each group cares about the presence of the other group on platforms.
- There are J platforms competing to attract agents from both sides.
- If platform j attracts s_j^A and s_j^B portions of the two groups, agents' utilities are

$$\begin{aligned} u_{ij}^A &= \mu_j^A + \alpha^A s_j^B - \lambda^A p_j^A + \xi_j^A + \varepsilon_{ij}^A \\ u_{ij}^B &= \mu_j^B + \alpha^B s_j^A - \lambda^B p_j^B + \xi_j^B + \varepsilon_{ij}^B \end{aligned}$$

- Consumers may choose the outside option of joining no platform and receive zero mean utilities and an idiosyncratic shock.

- Assuming ε_{ij} is distributed the type I extreme value, platform $j's$ market shares are

$$
\begin{aligned}
S_j^A\left(\mathbf{p}^A, \mathbf{s}^B, \boldsymbol{\xi}^A | \Omega\right) &= \frac{\exp\left(\mu_j^A + \alpha^A s_j^B - \lambda^A p_j^A + \xi_j^A\right)}{1 + \sum_{m=1}^{J} \exp\left(\mu_m^A + \alpha^A s_m^B - \lambda^A p_m^A + \xi_m^A\right)} \\
S_j^B\left(\mathbf{p}^A, \mathbf{s}^B, \boldsymbol{\xi}^A | \Omega\right) &= \frac{\exp\left(\mu_j^B + \alpha^B s_j^A - \lambda^B p_j^B + \xi_j^B\right)}{1 + \sum_{m=1}^{J} \exp\left(\mu_m^B + \alpha^B s_m^A - \lambda^B p_m^B + \xi_m^B\right)}
\end{aligned}
$$

Model 2: Competitive bottleneck

- In the competitive bottleneck model, while one group, say group A, deals with a single platform (single-homes), the other group, say group B, wishes to deal with multiple platforms (multi-homes).
- A good example is media advertising.
- For group A agents I use the same utility function used in the single-homing model except that I use the number of group B agents instead of the share.

- I follow Armstrong (2006) to model group B agents' membership decision. I assume that she makes a decision to join one platform independently from her decision to join another. She joins a platform as long as its net benefit is positive.
- Given the fixed membership fee, say p_j^B, a type-α_i^B agent will join platform j if

$$\alpha_i^B \omega_j n_j^A \geq p_j^B.$$

- Suppose platforms only know the distribution of α_i^B. Since each group B agent is ex ante identical, a platform will charge a single price p_j^B and the number of group B agents joining platform j is determined by

$$S_j^B\left(\mathbf{p}^B, \mathbf{s}^A|\Omega\right) = \left(1 - F\left(\frac{p_j^B}{\omega_j n_j^A}|\theta\right)\right)$$

Computing price elasticities

- Because of the cross-group externalities

$$\frac{\partial S_j^A\left(\mathbf{p}^A, \mathbf{s}^B, \boldsymbol{\xi}^A | \Omega\right)}{\partial p_k^A} \neq \frac{\partial s_j^A}{\partial p_k^A}$$

- This makes elasticity computation an implicit function problem. Treating share equations as an implicit function, the elasticity can be computed using the Implicit Function Theorem.
- For example, in the competitive bottleneck model,

$$\begin{aligned}
F_j^A(\mathbf{s}, \mathbf{p}) &\equiv \frac{\exp\left(\mu_j^A + \alpha^A s_j^B M^B - \lambda^A p_j^A + \xi_j^A\right)}{1 + \sum_{m=1}^J \exp\left(\mu_m^A + \alpha^A s_m^B M^B - \lambda^A p_m^A + \xi_m^A\right)} - s_j^A = 0 \\
F_j^B(\mathbf{s}, \mathbf{p}) &\equiv \left(1 - G\left(\frac{p_j^B}{\omega_j s_j^A M^A} | \theta\right)\right) - s_j^B = 0
\end{aligned}$$

for $j = 1, ..., J$. where $\mathbf{s}$ are endogenous variables and $\mathbf{p}$ are control variables.

Estimation: Two-sided Single-home Model

- With observed market shares treated as one of equilibria, I estimate the following system of equations

$$\begin{aligned}\log\left(s_j^A\right) - \log\left(s_0^A\right) &= \mu_j^A + \alpha^A s_j^B - \lambda^A p_j^A + \xi_j^A \\ \log\left(s_j^B\right) - \log\left(s_0^B\right) &= \mu_j^B + \alpha^B s_j^A - \lambda^B p_j^B + \xi_j^B\end{aligned}$$

  $j = 1, ..., J$.The model parameters are $\Omega = \left(\mu_j^A, \mu_j^B, \lambda^A, \lambda^B, \alpha^A, \alpha^B\right)$.
- The demand-side model can be consistently estimated by the GMM with IVs.
  - In addition to the price variable, the other group's share variable is also an endogenous variable.
  - This variables is correlated with $\left(\xi_j^A, \xi_j^B\right)$ for all *js* because of the feedback loop.

Estimation: Competitive Bottleneck Model

- For group A agents we have the following equation to estimate

$$\log\left(s_j^A\right) - \log\left(s_0^A\right) = \mu_j^A + \alpha^A n_j^B - \lambda^A p_j^A + \xi_j^A$$

- For group B agents ω_j is recovered by inverting the second share equation with a given value of θ and data on $\left(n_j^B, n_j^A, p_j^B, M_B\right)$. Assuming that ω_j is a function of platforms' non-price characteristics, we have another equation to estimate

$$\omega_{jt} = f\left(\mathbf{x}_{jt} | \beta^B\right).$$

where ω_{jt} is computed by inverting

$$n_{jt}^B = \left(1 - F\left(\frac{p_{jt}^B}{\omega_{jt} n_{jt}^A} | \theta\right)\right) M_B$$

Recovering marginal costs and markup

- Demand estimates are used to recover platforms' costs using the profit maximization condition. Assuming the constant marginal cost, platform j's profit is

$$\pi_j = \left(p_j^A - c_j^A\right) s_j^A M_A + \left(p_j^B - c_j^B\right) s_j^B M_B$$

where M_A and M_B denote the total number of agents for each group respectively.

- The profit maximizing first order conditions are

$$\begin{aligned} \frac{\partial \pi_j}{\partial p_j^A} &= s_j^A M_A + \left(p_j^A - c_j^A\right) \frac{\partial s_j^A}{\partial p_j^A} M_A + \left(p_j^B - c_j^B\right) \frac{\partial s_j^B}{\partial p_j^A} M_B = 0 \\ \frac{\partial \pi_j}{\partial p_j^B} &= s_j^B M_B + \left(p_j^B - c_j^B\right) \frac{\partial s_j^B}{\partial p_j^B} M_B + \left(p_j^A - c_j^A\right) \frac{\partial s_j^A}{\partial p_j^B} M_A = 0 \end{aligned}$$

- The two marginal costs should be searched simultaneously. This search process involves numerical computation of the own- and cross-price elasticities as derivatives of the implicit function for each set of trial values.
- Platform's markup from one group is a function of its markup from the other group.

Empirical application

- Advertising in magazines. Magazines serve readers on one side and advertisers on the other side.
- Panel data (1992 to 2010) on TV magazines in Germany.
- Quarterly information on copy prices, advertising rates, advertising pages, content pages, and circulation are collected from a non-profit public institution equivalent to the US Audit Bureau of Circulation.
- Finding IVs from different magazine segments (Kaiser and Song, IJIO 2009).

Data

- There are about 10 to 15 magazines in each quarter published by 5 to 7 publishers.
- Each copy is sold at around 1 Euro, while one page of advertising is sold at around 30,000 Euros.
- The average magazine sells about 1.5 million copies in each quarter, has about 1,000 content pages and about 250 advertising pages.
- The average magazine's revenue from selling copies is about 1.5 million Euros, while its advertising revenue is 7 million Euros.
- It is hard to argue that the copy price covers the publishing cost. 1 Euro for an over 100 page magazine seems unreasonably low. However, the low copy price is not unreasonable in the two sided market.

Estimation results

Table 5: Demand Estimation Results

Variable		OLS	System IV	GMM
Readers	Constant	-7.250*	-5.604*	-5.111*
		(0.235)	(0.640)	(0.612)
	Copy Price	-0.017	-0.135*	-0.155*
		(0.012)	(0.033)	(0.032)
	Ads Page	0.116*	0.208*	0.204*
		(0.011)	(0.030)	(0.028)
	Content Page	0.062*	0.069*	0.060*
		(0.007)	(0.008)	(0.008)
Advertisers	Constant	0.623	0.748*	0.919*
		(0.167)	(0.239)	(0.230)
	Content Page	-0.102*	-0.102*	-0.110*
		(0.010)	(0.012)	(0.011)

Magazine (Platform) markup

Table 7: Magazine Market Power

Markets		One-Sided			Two-Sided		
		Cost	Markup	% Markup	Cost	Markup	% Markup
		mc	$(p-mc)$	$(p-mc)/p$	mc	$(p-mc)$	$(p-mc)/p$
Readers	Median	0.40	0.51	0.62	3.39	-2.39	-2.26
	Mean	0.29	0.79	0.78	4.23	-3.15	-2.58
	20% QU*	0.13	0.50	0.48	1.56	-5.48	-4.52
	80% QU	0.54	1.09	0.83	6.83	-0.74	-0.88
Advertisers	Median	2,761	13,733	0.73	3,061	13,580	0.72
	Mean	1,031	21,446	0.84	1,329	21,148	0.83
	20% QU	599	5,469	0.63	950	5,283	0.61
	80% QU	7,890	32,115	0.98	7,999	31,582	0.96

Merger Analysis

Table 8: Price Changes from the Single Magazine Onwership to the Monopoly

	One-Sided		Two-Sided	
	Single	Monopoly	Single	Monopoly
Readers				
Magazine 1	1.42	1.45	1.43	1.38
Magazine 2	0.99	1.04	0.99	1.05
Magazine 3	1.00	1.03	1.03	1.00
Magazine 4	0.70	0.72	0.73	0.70
Magazine 5	1.42	1.47	1.42	1.48
Magazine 6	1.41	1.47	1.41	1.49
Magazine 7	1.41	1.43	1.44	1.41
Magazine 8	1.00	1.03	1.05	0.98
Magazine 9	1.01	1.07	1.01	1.09
Magazine 10	1.27	1.38	1.27	1.41

Summary

- My structural model has two key features of the two-sided market.
  - Both groups care about the presence of the other group, so the cross-group externalities are present on both sides.
  - Platforms set different prices for each group to maximize joint profits from both sides.
- The empirical results show that most magazines set copy prices below marginal costs to increase the reader basis and make profits from selling advertising space.
- When the advertising side is ignored, the same demand estimates imply high markups on the reader side.
- Counterfactual exercises show that platform mergers do not necessarily increase copy prices and, as a result, readers may not necessarily be worse off in more concentrated markets.