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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.
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.

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 $s^A_j$ and $s^B_j$ portions of the two groups, agents’ utilities are

$$u_{ij}^A = \mu^A_j + \alpha^A s^B_j - \lambda^A p^A_j + \zeta^A_j + \varepsilon^A_{ij}$$

$$u_{ij}^B = \mu^B_j + \alpha^B s^A_j - \lambda^B p^B_j + \zeta^B_j + \varepsilon^B_{ij}$$

- Consumers may choose the outside option of joining no platform and receive zero mean utilities and an idiosyncratic shock.
Assuming $\varepsilon_{ij}$ is distributed the type I extreme value, platform $j'$s market shares are

$$S^A_j \left(p^A, s^B, \xi^A | \Omega \right) = \frac{\exp \left( \mu^A_j + \alpha^A s^B_j - \lambda^A p^A_j + \xi^A_j \right)}{1 + \sum_{m=1}^J \exp \left( \mu^A_m + \alpha^A s^B_m - \lambda^A p^A_m + \xi^A_m \right)}$$

$$S^B_j \left(p^A, s^B, \xi^A | \Omega \right) = \frac{\exp \left( \mu^B_j + \alpha^B s^A_j - \lambda^B p^B_j + \xi^B_j \right)}{1 + \sum_{m=1}^J \exp \left( \mu^B_m + \alpha^B s^A_m - \lambda^B p^B_m + \xi^B_m \right)}$$
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 $p^B_j$, a type-$\alpha^B_i$ agent will join platform $j$ if

$$\alpha^B_i \omega_j n^A_j \geq p^B_j.$$

Suppose platforms only know the distribution of $\alpha^B_i$. Since each group B agent is ex ante identical, a platform will charge a single price $p^B_j$ and the number of group B agents joining platform $j$ is determined by

$$S^B_j (p^B, s^A | \Omega) = \left(1 - F \left( \frac{p^B_j}{\omega_j n^A_j | \theta} \right) \right)$$
Computing price elasticities

- Because of the cross-group externalities

\[
\frac{\partial S^A_j \left( p^A, s^B, \zeta^A | \Omega \right)}{\partial p^A_k} \neq \frac{\partial s^A_j}{\partial p^A_k}
\]

- 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,

\[
F^A_j (s, p) \equiv \frac{\exp \left( \mu^A_j + \alpha^A s^B_j M^B - \lambda^A p^A_j + \zeta^A_j \right)}{1 + \sum_{m=1}^{J} \exp \left( \mu^A_m + \alpha^A s^B_m M^B - \lambda^A p^A_m + \zeta^A_m \right)} - s^A_j = 0
\]

\[
F^B_j (s, p) \equiv \left( 1 - G \left( \frac{p^B_j}{\omega_j s^A_j M^A | \theta} \right) \right) - s^B_j = 0
\]

for \( j = 1, ..., J \). where \( s \) are endogenous variables and \( p \) are control variables.
With observed market shares treated as one of equilibria, I estimate the following system of equations

\[
\log \left( s^A_j \right) - \log \left( s^A_0 \right) = \mu^A_j + \alpha^A s^B_j - \lambda^A p^A_j + \xi^A_j \\
\log \left( s^B_j \right) - \log \left( s^B_0 \right) = \mu^B_j + \alpha^B s^A_j - \lambda^B p^B_j + \xi^B_j
\]

\( j = 1, \ldots, J \). The model parameters are \( \Omega = \left( \mu^A_j, \mu^B_j, \lambda^A, \lambda^B, \alpha^A, \alpha^B \right) \).

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 \( \left( \xi^A_j, \xi^B_j \right) \) for all \( js \) because of the feedback loop.
Estimation: Competitive Bottleneck Model

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

\[
\log (s_j^A) - \log (s_0^A) = \mu_j^A + \alpha^A n_j^B - \lambda^A p_j^A + \xi_j^A
\]

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

\[
\omega_{jt} = f \left( x_{jt} | \beta^B \right).
\]

where \( \omega_{jt} \) is computed by inverting

\[
n_j^B = \left( 1 - F \left( \frac{p_j^B}{\omega_{jt} n_j^A} | \theta \right) \right) M_B
\]
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

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

$$\frac{\partial \pi_j}{\partial p_j^B} = s_j^B M_B + \left( p_j^B - c_j^B \right) \frac{\partial s_j^B}{\partial p_j^B} M_B + \left( p_j^A - c_j^A \right) \frac{\partial s_j^A}{\partial p_j^B} M_A = 0$$
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.
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).
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.
### Table 5: Demand Estimation Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>OLS</th>
<th>System IV</th>
<th>GMM</th>
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<tbody>
<tr>
<td><strong>Readers</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-7.250*</td>
<td>-5.604*</td>
<td>-5.111*</td>
</tr>
<tr>
<td></td>
<td>(0.235)</td>
<td>(0.640)</td>
<td>(0.612)</td>
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<tr>
<td>Copy Price</td>
<td>-0.017</td>
<td>-0.135*</td>
<td>-0.155*</td>
</tr>
<tr>
<td></td>
<td>(0.012)</td>
<td>(0.033)</td>
<td>(0.032)</td>
</tr>
<tr>
<td>Ads Page</td>
<td>0.116*</td>
<td>0.208*</td>
<td>0.204*</td>
</tr>
<tr>
<td></td>
<td>(0.011)</td>
<td>(0.030)</td>
<td>(0.028)</td>
</tr>
<tr>
<td>Content Page</td>
<td>0.062*</td>
<td>0.069*</td>
<td>0.060*</td>
</tr>
<tr>
<td></td>
<td>(0.007)</td>
<td>(0.008)</td>
<td>(0.008)</td>
</tr>
<tr>
<td><strong>Advertisers</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>0.623</td>
<td>0.748*</td>
<td>0.919*</td>
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<tr>
<td></td>
<td>(0.167)</td>
<td>(0.239)</td>
<td>(0.230)</td>
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<tr>
<td>Content Page</td>
<td>-0.102*</td>
<td>-0.102*</td>
<td>-0.110*</td>
</tr>
<tr>
<td></td>
<td>(0.010)</td>
<td>(0.012)</td>
<td>(0.011)</td>
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</table>
### Table 7: Magazine Market Power

<table>
<thead>
<tr>
<th>Markets</th>
<th>One-Sided</th>
<th></th>
<th>Two-Sided</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Cost</td>
<td>Markup</td>
<td>% Markup</td>
<td>Cost</td>
</tr>
<tr>
<td></td>
<td>mc</td>
<td>(p – mc)</td>
<td>(p – mc)/p</td>
<td>mc</td>
</tr>
<tr>
<td>Readers</td>
<td>Median</td>
<td>0.40</td>
<td>0.51</td>
<td>0.62</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>0.29</td>
<td>0.79</td>
<td>0.78</td>
</tr>
<tr>
<td></td>
<td>20% QU*</td>
<td>0.13</td>
<td>0.50</td>
<td>0.48</td>
</tr>
<tr>
<td></td>
<td>80% QU</td>
<td>0.54</td>
<td>1.09</td>
<td>0.83</td>
</tr>
<tr>
<td>Advertisers</td>
<td>Median</td>
<td>2,761</td>
<td>13,733</td>
<td>0.73</td>
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<tr>
<td></td>
<td>Mean</td>
<td>1,031</td>
<td>21,446</td>
<td>0.84</td>
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<tr>
<td></td>
<td>20% QU</td>
<td>599</td>
<td>5,469</td>
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<td></td>
<td>80% QU</td>
<td>7,890</td>
<td>32,115</td>
<td>0.98</td>
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<tr>
<td>Readers</td>
<td>One-Sided</td>
<td>Two-Sided</td>
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<td></td>
</tr>
<tr>
<td>----------</td>
<td>-----------</td>
<td>-----------</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Single</td>
<td>Monopoly</td>
<td>Single</td>
<td>Monopoly</td>
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<tr>
<td>Magazine 1</td>
<td>1.42</td>
<td>1.45</td>
<td>1.43</td>
<td>1.38</td>
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<tr>
<td>Magazine 2</td>
<td>0.99</td>
<td>1.04</td>
<td>0.99</td>
<td>1.05</td>
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<tr>
<td>Magazine 3</td>
<td>1.00</td>
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<td>1.03</td>
<td>1.00</td>
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<td>0.73</td>
<td>0.70</td>
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<td>Magazine 5</td>
<td>1.42</td>
<td>1.47</td>
<td>1.42</td>
<td>1.48</td>
</tr>
<tr>
<td>Magazine 6</td>
<td>1.41</td>
<td>1.47</td>
<td>1.41</td>
<td>1.49</td>
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<td>Magazine 7</td>
<td>1.41</td>
<td>1.43</td>
<td>1.44</td>
<td>1.41</td>
</tr>
<tr>
<td>Magazine 8</td>
<td>1.00</td>
<td>1.03</td>
<td>1.05</td>
<td>0.98</td>
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<tr>
<td>Magazine 9</td>
<td>1.01</td>
<td>1.07</td>
<td>1.01</td>
<td>1.09</td>
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<td>Magazine 10</td>
<td>1.27</td>
<td>1.38</td>
<td>1.27</td>
<td>1.41</td>
</tr>
</tbody>
</table>
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.