in markup estimations, can be numerically computed using properties of implicit functions.

I consider both a two-sided single-homing model and a competitive bottleneck model. In

general oligopolistic setting. While Armstrong confines a demand function to Hotelling's framework, I adopt a more general discrete choice framework for consumers' single-homing decisions. Thus, in my models platforms are differentiated products with the presence of the other-side agents as an endogenous attribute.

My models, however, are not applicable to markets where platforms charge usage or per-transaction fees as, for example, in the credit card industry. Rochet and Tirole (2003) develop a model where platforms charge usage fees and Rochet and Tirole (2006) extend it to integrate usage and membership fees in a monopoly platform setting. Although a two-part tariff structure (a fixed membership fee plus a usage fee proportional to the size of the other-side members) is often seen in many industries, it is beyond the scope of my paper.[3]

Empirical research on the two-sided market is relatively scarce but steadily growing. Distinguished from existing empirical studies, my paper brings in two important features of the two-sided market together. The first feature is that agents of each side care about the presence of agents on the other side. This feature is the main factor driving the feedback loop but is suppressed in some studies by assuming that one of the two groups does not care about the presence of the other. For example, Argentesi and Filistrucchi (2007), in studying the Italian newspaper market, assume that readers are indifferent about advertising in newspapers. Although this assumption makes a model more tractable, it misses the essence of the two-sidedness.

The second feature is that platforms set two prices, one for each side. Free membership (or zero price) granted to one group of agents, observed in some of two-sided markets such as the radio industry and the online search engine industry, is part of the platforms' profit maximization behaviors. However, this zero price is often taken as an exogenous constraint in modeling platform behaviors. Examples include Rysman (2004) on the Yellow Pages and Jeziorski (2011) on the radio industry. As far as I know, Kaiser and Wright (2006) is the only structural empirical paper

[3] A well-known proposition in Armstrong (2006) shows that a continuum of equilibria exists when platforms compete in the two-part tariff. Weyl and White (2010) propose a new equilibrium concept to circumvent this problem.

that has both features together, but their model is only applicable to a duopoly in the symmetric equilibrium.

There are also empirical studies that test predictions from theoretical models using reduced-form regressions. For example, Jin and Rysman (2010) use data from baseball card conventions and test whether the conventions' pricing behaviors are consistent with the single-homing model in Armstrong (2006)*:* Chandra and Collard-Wexler (forthcoming) develop a two-sided market model in the Hotelling framework, derive predictions on post-merger price changes, and test them using data from the Canadian newspaper market.

The paper is organized as follows: Section 2 presents two models of the two-sided market, followed by an estimation procedure in section 3. Section 4 presents simulation results and section 5 presents empirical results. Section 6 concludes.

2 Models

2.1 Two-Sided Single-Homing Model

There are two groups of agents, groups A and B, and each group may like or dislike the presence of the other group on platforms. There are J platforms competing to attract agents from both sides. Assume for exogenous reasons that each agent chooses to join a single platform.

If platform j attracts s_j^A and s_j^B portions of the two groups, agents' utilities are

$$u_{ij}^A \quad = \quad {}_j^A + \; {}^A s_j^B \qquad {}^A p_j^A + \; {}_j^A + {}''^A_{ij} \tag{1}$$

$$u_{ij}^B \quad = \quad {}_j^B + \; {}^B s_j^A \qquad {}^B p_j^B + \; {}_j^B + {}''^B_{ij} \tag{2}$$

where ${}_j^A$ and ${}_j^B$ denote the mean utilities apart from prices and the size of the other group, p_j^A and p_j^B prices charged to each group, ${}_j^A$ and ${}_j^B$ qualities and/or demand shocks that the agents observe but researchers do not, and ${}''^A_{ij}$ and ${}''^B_{ij}$ idiosyncratic taste shocks. ^{A} and ^{B} measure the (dis)utility of interacting with agents of the other group and ^{A} and ^{B} the disutility of price. Consumers may choose the outside option of joining no platform and receive zero mean utility and an idiosyncratic shock.

Assuming $"_{ij}$

Given this observation, all I need for identification is instrumental variables that are not correlated with demand shocks but correlated with the other side's market shares. This even means that I do not need to use both sides to consistently estimate demand for one side.[4]

It is worth comparing multiplicity in the two-sided market model with multiplicity in the empirical game literature where multiple equilibria make model estimation more challenging. Consider a static incomplete information entry game with two firms. Firm 1's probability of entry is a function of firm 2's probability of entry, and vice versa, and these probability functions look similar to equations (5) and (6) with the type I extreme value distribution assumption on the idiosyncratic shock. The key difference is that researchers do not observe the entry probability and should compute it as a solution to the game. However, it is not guaranteed that they obtain the same equilibrium in all markets.

2.2 Competitive Bottleneck Model

In the competitive bottleneck model, while one group, group A, deals with a single platform (single-homes), the other group, group B, deals with multiple platforms (multi-homes). This is a situation where group B puts more weight on the network-benefits of being in contact with the widest population of group A consumers than it does on the costs of dealing with more than one platform. An example often used for this model is media advertising. Group A agents are readers who care about media content and may or may not like advertising. The other group agents are advertisers who want to reach as many readers as possible.

Following Armstrong (2006) I assume that a group B agent makes a decision to join one platform independently from its decision to join another as long as its net benefit is positive. In this sense there is no direct competition between platforms to attract group B agents and each platform acts as a monopolist towards them. 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 their

[4] However, multiple equilibria comes into play in counterfactual exercises.

share such that

$$u_{ij}^{A} = \quad _{j}^{A} + \quad ^{A}n_{j}^{B} \qquad ^{A}p_{j}^{A} + \quad _{j}^{A} + "_{ij}^{A}$$

where n_j^B denotes the number of group B agents on platform j: Thus, platform $j's$ market share function for group A is

$$s_{j}^{A} \quad p^{A}; n^{B}; \quad ^{A}j \quad = \frac{\exp \quad _{j}^{A} + \quad ^{A}n_{j}^{B} \qquad ^{A}p_{j}^{A} + \quad _{j}^{A}}{1 + \sum_{m=1}^{J} \exp \quad _{m}^{A} + \quad ^{A}n_{m}^{B} \qquad ^{A}p_{m}^{A} + \quad _{m}^{A}}$$

In the single-homing model I assume that agents care about which platform attracts more agents of the other side regardless of their numbers. For example, in choosing a night club men and women care about which night club attracts the most members of the opposite sex, not its absolute number. In the competitive bottleneck, on the other hand, I assume that single-homing agents, say group A agents, pay attention to the actual numbers of multi-homing agents on platforms. This means that in the example of media advertising, the audience cares about the absolute amount of advertising. This distinction is not relevant in (most theoretical) models where the group size is normalized to 1.

Let $_{i}^{B}$ denote a group B agent type which is i.i.d. from $G \quad ^{B}j$ and $!_j$ be a platform-speci...c quality perceived by group B agents. I assume that group B agents receive utility only from

ans which platfor3s.583(eyes)-53[hare ts.Ineatn

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p_j^B $_i^B$ veritths33s.33[nd(t)-338(a)-33s.330(platfos(1.)]TJ38.749-21.923TdGceiv)28norumbshioup and she will join this platform as long as $^{B}_{i}\,!\,_{j} n^{A}_{j} \quad p^{B}_{j}:$ Suppose platforms only know the distribution of $^{B}_{i}:$ Since each group B agent is ex ante identical, a given platform will charge the same price p^{B}_{j} and the number of group B agents joining platform j is determined by

$$N^{B}_{j} \quad \mathrm{p}^{B}; \mathrm{n}^{A}\mathrm{j} \quad = \quad 1 \quad G \quad p^{B}_{j}$$

for $j = 1, \ldots, J$ where s are endogenous variables and p are exogenous variables. In the competitive bottleneck model, let $F_1^A, F_1^B, F_2^A, F_2^B{}_2$

to compute the price elasticity. For a price change by platform j

$$\begin{pmatrix} \partial s_1^A/\partial p_j^A & \partial s_1^A/\partial p_j^B \\ \partial s_1^B/\partial p_j^A & \partial s_1^B/\partial p_j^B \\ \vdots & \vdots \\ \partial s_J^A/\partial p_j^A & \partial s_J^A/\partial p_j^B \\ \partial s_J^B/\partial p_j^A & \partial s_J^B/\partial p_j^B \end{pmatrix} = \begin{pmatrix} \partial F_1^A/\partial s_1^A & \partial F_1^A/\partial s_1^B & & \partial F_1^A/\partial s_J^A & \partial F_1^A/\partial s_J^B \\ \partial F_1^B/\partial s_1^A & \partial F_1^B/\partial s_1^B & & \partial F_1^B/\partial s_J^A & \partial F_1^B/\partial s_J^B \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ \partial F_J^A/\partial s_1^A & \partial F_J^A/\partial s_1^B & & \partial F_J^A/\partial s_J^A & \partial F_J^A/\partial s_J^B \\ \partial F_J^B/\partial s_1^A & \partial F_J^B/\partial s_1^B & & \partial F_J^B/\partial s_J^A & \partial F_J^B/\partial s_J^B \end{pmatrix}^{-1} \begin{pmatrix} \partial F_1^A/\partial p_j^A & \partial F_1^A/\partial p_j^B \\ \partial F_1^B/\partial p_j^A & \partial F_1^B/\partial p_j^B \\ \vdots & \vdots \\ \partial F_J^A/\partial p_j^A & \partial F_J^A/\partial p_j^B \\ \partial F_J^B/\partial p_j^A & \partial F_J^B/\partial p_j^B \end{pmatrix}; \tag{10}$$

provided that the inverse matrix is non-singular.[7]

Suppose there are two platforms. For platform 1's price change in the two-sided single-homing model,

$$\begin{pmatrix} \partial F_1^A/\partial s_1^A & \partial F_1^A/\partial s_1^B & \partial F_1^A/\partial s_2^A & \partial F_1^A/\partial s_2^B \\ \partial F_1^B/\partial s_1^A & \partial F_1^B/\partial s_1^B & \partial F_1^B/\partial s_2^A & \partial F_1^B/\partial s_2^B \\ \partial F_2^A/\partial s_1^A & \partial F_2^A/\partial s_1^B & \partial F_2^A/\partial s_2^A & \partial F_2^A/\partial s_2^B \\ \partial F_2^B/\partial s_1^A & \partial F_2^B/\partial s_1^B & \partial F_2^B/\partial s_2^A & \partial F_2^B/\partial s_2^B \end{pmatrix}^{-1}$$

$= \Big($ 1 $\quad {}^A s_1^A \quad$ 1 $\quad s_1^A \quad$ 0 $\quad \partial F_J \quad {}^A s = \partial p^B$ B B J and

$$\begin{pmatrix} \partial F_1^A/\partial p_1^A & \partial F_1^A/\partial p_1^B \\ \partial F_1^B/\partial p_1^A & \partial F_1^B/\partial p_1^B \\ \partial F_2^A/\partial p_1^A & \partial F_2^A/\partial p_1^B \\ \partial F_2^B/\partial p_1^A & \partial F_2^B/\partial p_1^B \end{pmatrix} = \begin{pmatrix} {}^A s_1^A \; 1 \quad s_1^A & 0 \\ 0 & {}^B s_1^B \; 1 \quad s_1^B \\ {}^A s_1^A s_2^A & 0 \\ 0 & {}^B s_1^B s_2^B \end{pmatrix}$$

In the competitive bottleneck model,

$$\begin{pmatrix} \partial F_1^A/\partial s_1^A & \partial F_1^A/\partial s_1^B & \partial F_1^A/\partial s_2^A & \partial F_1^A/\partial s_2^B \\ \partial F_1^B/\partial s_1^A & \partial F_1^B/\partial s_1^B & \partial F_1^B/\partial s_2^A & \partial F_1^B/\partial s_2^B \\ \partial F_2^A/\partial s_1^A & \partial F_2^A/\partial s_1^B & \partial F_2^A/\partial s_2^A & \partial F_2^A/\partial s_2^B \\ \partial F_2^B/\partial s_1^A & \partial F_2^B/\partial s_1^B & \partial F_2^B/\partial s_2^A & \partial F_2^B/\partial s_2^B \end{pmatrix}^{-1}$$

$$= \begin{pmatrix} 1 \qquad {}^A M^B \end{pmatrix}$$

change on s_j^A and s_j^B. That is,

$$
\begin{aligned}
\frac{\partial s_j^A}{\partial p_j^A} &\approx \frac{\partial S_j^A(\cdot)}{\partial p_j^A} \\
\frac{\partial s_j^B}{\partial p_j^A} &\approx \sum_{k=1} \frac{\partial S_j^B(\cdot)}{\partial s_k^A}\frac{\partial S_k^A(\cdot)}{\partial p_j^A} \\
\frac{\partial s_j^A}{\partial p_j^B} &\approx \sum_{k=1} \frac{\partial S_j^A(\cdot)}{\partial s_k^B}\frac{\partial S_k^B(\cdot)}{\partial p_j^B}
\end{aligned}
\tag{11}
$$

where $S^A(\cdot)$ and $S^B(\cdot)$ are defined by equations (3) and (4).[8]

As an example, let $\,^A = \,^B = 1;$ $\,^A = \,^B = 2;$ $s_1^A = s_1^B = s_2^A = s_2^B = 0.3;$ $\omega_1 = \omega_2 = 1;$ and $p_1^B = p_2^B = 1.$ In the two-sided single-homing model

$$
\begin{pmatrix}
\partial s_1^A/\partial p_1^A & \partial s_1^A/\partial p_1^B \\
\partial s_1^B/\partial p_1^A & \partial s_1^B/\partial p_1^B \\
\partial s_2^A/\partial p_1^A & \partial s_2^A/\partial p_1^B \\
\partial s_2^B/\partial p_1^A & \partial s_2^B/\partial p_1^B
\end{pmatrix}
=
\begin{pmatrix}
0.45 & 0.11 \\
0.11 & 0.45 \\
0.21 & 0.08 \\
0.08 & 0.21
\end{pmatrix}
$$

while

$$
\begin{pmatrix}
\partial F_1^A/\partial p_1^A & \partial F_1^A/\partial p_1^B \\
\partial F_1^B/\partial p_1^A & \partial F_1^B/\partial p_1^B \\
\partial F_2^A/\partial p_1^A & \partial F_2^A/\partial p_1^B \\
\partial F_2^B/\partial p_1^A & \partial F_2^B/\partial p_1^B
\end{pmatrix}
=
\begin{pmatrix}
0.42 & 0 \\
0 & 0.42 \\
0.18 & 0 \\
0 & 0.18
\end{pmatrix}
$$

[8] In section 4 I numerically evaluate the accuracy of this approximation.

In the competitive bottleneck model

$$\begin{pmatrix} \partial s_1^A/\partial p_1^A & \partial s_1^A/\partial p_1^B \\ \partial s_1^B/\partial p_1^A & \partial s_1^B/\partial p_1^B \\ \partial s_2^A/\partial p_1^A & \partial s_2^A/\partial p_1^B \\ \partial s_2^B/\partial p_1^A & \partial s_2^B/\partial p_1^B \end{pmatrix} = \begin{pmatrix} 0.50 & 0.05 \\ 0.32 & 0.22 \\ 0.24 & 0.02 \\ 0.16 & 0.02 \end{pmatrix}$$

while

$$\begin{pmatrix} \partial F_1^A/\partial p_1^A & \partial F_1^A/\partial p_1^B \\ \partial F_1^B/\partial p_1^A & \partial F_1^B/\partial p_1^B \\ \partial F_2^A/\partial p_1^A & \partial F_2^A/\partial p_1^B \\ \partial F_2^B/\partial p_1^A & \partial F_2^B/\partial p_1^B \end{pmatrix} = \begin{pmatrix} 0.42 & 0 \\ 0 & 0.19 \\ 0.18 & 0 \\ 0 & 0 \end{pmatrix}$$

This example demonstrates that the cross-group price elasticity is non-zero in two-sided markets. When a platform changes its price on one side, it not only affects its market share on the

I use demand estimates and the profit maximization conditions to recover platforms' operating costs. Platform j maximizes its profit by setting membership prices for the two groups, p_j^A and $p_j^B.$ 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

$$\frac{\partial \pi_j}{\partial p_j^A} = s_j^A M^A + \left(p_j^A - c_j^A\right)\frac{\partial s_j^A}{\partial p_j^A} M^A + \left(p_j^B - c_j^B\right)\frac{\partial s_j^B}{\partial p_j^A} M^B = 0 \quad (12)$$

$$\frac{\partial \pi_j}{\partial p_j^B} = s_j^B M^B + \left(p_j^B - c_j^B\right)\frac{\partial s_j^B}{\partial p_j^B} M^B + \left(p_j^A - c_j^A\right)\frac{\partial s_j^A}{\partial p_j^B} M^A = 0 \quad (13)$$

where all the share derivatives are computed by (10). The two marginal costs should be searched simultaneously such that the two conditions are satisfied at the same time for each platform.[10]

Re-arranging equations (12) and (13) gives

$$p_j^A - c_j^A = -p_j^A \left(\frac{\partial s_j^A}{\partial p_j^A}\frac{p_j^A}{s_j^A}\right)^{-1} - \left(p_j^B - c_j^B\right)\left(\frac{\partial s_j^B}{\partial p_j^A}\frac{p_j^A}{s_j^B}\right)\left(\frac{\partial s_j^A}{\partial p_j^A}\frac{p_j^A}{s_j^A}\right)^{-1}\frac{n^B}{n_j^A} \quad (14)$$

$$p_j^B - c_j^B = -p_j^B \left(\frac{\partial s_j^B}{\partial p_j^B}\frac{p_j^B}{s_j^B}\right)^{-1} - \left(p_j^A - c_j^A\right)\left(\frac{\partial s_j^A}{\partial p_j^B}\frac{p_j^B}{s_j^A}\right)\left(\frac{\partial s_j^B}{\partial p_j^B}\frac{p_j^B}{s_j^B}\right)^{-1}\frac{n^A}{n_j^B} \quad (15)$$

These equations show that a platform's markup from one side is a function of (1) the own-price elasticity, (2) its markup from the other side, (3) the cross-group price elasticity divided by the own-price elasticity and (4) the relative group size.

Note that Armstrong (2006) uses $C\left(n_j^A; n_j^B\right) = c_j n_j^A n_j^B$ in showing that the equilibrium n_j^B is determined regardless of the size of the platform's readership, $n_j^A.$ This means that advertisers do not gain or lose when the market for readers becomes more competitive. However, this cost

[10] This search process involves numerical computation of the share derivatives at each set of trial values.

function is not appropriate in an empirical setting because of an overidentification problem: the number of unknown variables should be the same as the number of equations to satisfy.

3 Estimation

In the two-sided single-homing model I take the log of equations (5) and (6), and estimate

$$\log s_j^A - \log\left(1 - \sum_{j=1}^{J} s_j^A\right) = \beta_j^A + \alpha^A s_j^B - \gamma^A p_j^A + \xi_j^A \quad (16)$$

$$\log s_j^B - \log\left(1 - \sum_{j=1}^{J} s_j^B\right) = \beta_j^B + \alpha^B s_j^A - \gamma^B p_j^B + \xi_j^B \quad (17)$$

$j = 1, ..., J.$ The model parameters are $\theta = (\alpha^A, \alpha^B, \beta^A, \beta^B, \gamma^A, \gamma^B)$. Let platform quality be $\delta_j^A = \beta_j^A + \alpha^A s_j^B - \gamma^A p_j^A + \xi_j^A$ and define δ_j^B similarly. In order to estimate these equations, the unique platform quality should exist for each side, given data on prices and market shares. One can use the same logic used in Berry (1994) to show this is true for both equations.

These demand equations can be consistently estimated by the GMM with instrumental variables for the price variable and the other group's share variable, s_j^B in equation (16) and s_j^A in equation (17). The latter is an additional endogenous variable that is correlated not only with the same side ξ_j but also with the other side ξ_j. The consistency does not require estimating both equations at the same time as long as each side has valid instruments for the endogenous variables. The efficiency, however, may improve by simultaneously estimating them.

Consumer heterogeneity can be added to the model by allowing $\alpha^A, \alpha^B, \gamma^A, \gamma^B$ to be where and $ are i.i.d. standard normal. The same logic used in BLP can be used to show the existence and uniqueness of ${}^A; {}^B$ and contraction mapping can be used to estimate them. The model parameters are now $e = {}_j^A; {}_j^B; l^A; l^B; m^A; m^B; {}^A; {}^B; {}^A; {}^B :$[11]

In the competitive bottleneck model the demand equation for group A agents is

$$\log s_j^A \quad \log\left(1 \quad \sum_{j=1}^{J} s_j^A\right) = {}_j^A + {}^A n_j^B \quad {}^A p_j^A + {}_j^A :$$

For group B /F46 10.9091 Tf 8.47.60 Td [($)]giv(w)]

In the one-sided logit model I define consumers' utility function as

$$u_{ijt} = \delta_{jt} - \alpha p_{jt} + \xi_{jt} + \varepsilon_{ijt}$$

where δ_{jt} is firm $j's$ mean quality, p_{jt} its price, ξ_{jt} firm-specific unobserved quality, and ε_{ijt} an idiosyncratic error term with the type I extreme value distribution. Firm $j's$ profit function is given as

$$\pi_{jt} = (p_{jt} - mc_{jt})\, s_{jt}$$

where mc_{jt} is firm $j's$ marginal cost in market t and s_{jt} its market share.

Assuming

$$\begin{aligned} \delta_{jt} &\sim U(0;2) \\ \xi_{jt} &\sim 0.1 \cdot N(0;1) \\ mc_{jt} &\sim U(0;1) \\ \alpha &= 2 \end{aligned}$$

and firms compete á la Bertrand, I generate the profit maximizing prices and market shares for 100 independent markets.

In the single-homing model, the utility functions are

$$\begin{aligned} u^A_{ijt} &= \delta^A_{jt} - \alpha^A p^A_{jt} + \gamma^A s^B_{jt} + \xi^A_{jt} + \varepsilon^A_{ijt} \\ u^A_{ijt} &= \delta^B_{jt} - \alpha^B p^B_{jt} + \gamma^B s^A_{jt} + \xi^B_{jt} + \varepsilon^B_{ijt} \end{aligned}$$

and the profit function for platform j is

$$\pi_{jt} = \left(p^A_{jt} - mc^A_{jt}\right) s^A_{jt} M_A + \left(p^B_{jt} - mc^B_{jt}\right) s^B_{jt} M_B$$

For the group A side, $i.e.;$ $\ _{jt}^{A};\ _{jt}^{A}; mc_{jt}^{A};\ ^{A}$; I use the same values as $\ _{jt};\ _{jt}; mc_{jt};$ in the logit model. For the B side, I independently draw $\ _{jt}^{B};\ _{jt}^{B}; mc_{jt}^{B}$ from the same distributions as those of $\ _{jt}^{A};\ _{jt}^{A}; mc_{jt}^{A}$ and set $\ ^{B} = 2$ and $M_A = M_B = 1.$ I set $\ ^{A};\ ^{B} = (1; 1)$ so that each set of group agents likes the presence of the other group agents on a platform. I sort $\ _{jt}^{A};\ _{jt}^{B}; mc_{jt}^{A}; mc_{jt}^{B}$ such that platform 1 has the lowest and platform 5 has the highest mean quality and marginal cost for both groups. In searching for prices and market shares that maximize the sum of pro…ts from the two sides, I use the marginal cost as a starting point.[12]

In the competitive bottleneck model I use the same values as $\ _{jt}^{A};\ _{jt}^{A}; mc_{jt}^{A};\ ^{A};\ ^{A}$ in the single-homing model for group A. The demand of group B agents is given as

$$s_j^B = \frac{n_j^B}{M_B} = @1 \quad G@\frac{p_j^B}{!_j \quad s_j^A M_A} j \quad A\,A$$

where $G\ \ ^{B}$ is the cdf of the log normal distribution with E log $\ ^{B} = 1$ and Var log $\ ^{B} = 1;$ and

$$!_{jt} = \ _{jt}^{B} + \ _{jt}^{B}.$$

I set $M_A = M_B = 10$ because it is more realistic to assume that the size of single-homing agents is much larger than the size of multi-homing agents.[13]

Table 1 shows the equilibrium prices and market shares averaged across 100 markets. Prices are lower and market shares are higher in the single-homing model than in the one-sided logit model. Platforms exploit the cross-group externalities by setting lower prices for both groups and attracting more agents from both sides. Not surprisingly, high quality platforms charge higher prices.

In the competitive bottleneck model, platforms charge much lower prices for group A agents than in the one-sided model, while charging much higher prices for group B agents. Some platforms even charge negative prices to group A. This is consistent with the common supposition

[12] I tried di¤erent starting points but obtained the same outcomes.

[13] Simulations show that when the two groups are of the equal size, some platforms are not attractive to any group B agents.

that platforms make profits from multi-homing agents who join platforms as long as the benefit is larger than the price they pay. To charge high prices for group B agents, platforms try to attract as many group A agents as possible with low prices. Despite high prices, more than 30 percent of group B agents join platforms. Notice that unlike the single-homing model, higher quality platforms charge lower prices to group A agents.

In table 2 I increase the size of group A in both models. In the single-homing model the size of group A is 10 times larger than that of group B, and in the competitive bottleneck model it is 20 times larger. The two models react to this change in the opposite ways. In the former model, platforms increase prices for group A while decreasing prices for group B. Because group B agents

I multiply the copy price by the number of issues and divide quarterly circulations by the number of issues in calculating market shares. For example, if the data show a monthly magazine sold 1.5 million copies in a quarter, my assumption implies that 500,000 consumers bought three issues of this magazine and paid its copy price three times in that quarter.

I make the same assumption for advertisers. If an advertiser chooses to advertise in a monthly magazine in a given quarter, he buys one advertising page in each issue and pays a per-page advertising price three times that quarter. This means that the number of advertisers is the number of advertising pages divided by the frequency. Putting the two sides together, 300 pages of advertising in a given quarter by a monthly magazine means 300 pages of advertising to consumers and 100 advertisers to a magazine.[14]

Magazines, on average, sell about 1.5 million copies, and have about 1,000 content pages and 250 advertising pages in each quarter. Large standard deviations imply that magazines are heterogeneous in terms of size and circulation. The average revenue from selling copies is about 1.5 million euros, while its advertising revenue is 7.5 million euros. It is hard to argue that the copy price covers the publishing cost. However, the low copy price is not unreasonable in the light of the two-sided market. The magazine may charge below marginal cost to sell as many copies as possible while charging a high price to advertisers to make pro…t.

During the sample period seven publishers published 19 magazines in total, seven of which remained in the market for the entire sample period. Table 4 shows that the number of magazines increased from 10 to 17 by 2005 and dropped to 15 in 2006 and stayed at that level until the end of the sample period. However, the market became much more concentrated in the late 2000s. In 1992 six publishers published ten magazines, adding …ve more magazines by 2000. Then, Gong Verlag GmbH & Co. KG (GVG), which had been publishing a weekly magazine DieZwei and a biweekly magazine TVdirekt, sold its magazines to WAZ Verlagsgruppe (WAZ). In 2002 Michael Hahn Ver-

[14] An alternative approach is to assume that consumers and advertisers make decisions for each issue. Under this assumption I should make slight modi…cations in calculating market shares as well as the number of content and advertising pages consumers “consume". However, it does not signi…cantly change empirical results.

lag (MHV) entered the market with a monthly magazine nurTV and soon exited the market in 2005, selling its magazine to WAZ. In 2004 Hubert Burda Media (HBM) took over Verlagsgruppe Milchstrasse's (VM) two magazines. Thus, from 2006 only four publishers, Axel Springer Verlagsgruppe (ASV), Bauer Media KG (BMK), HBM and WAZ, remained in the market.[15] These publishers publish a mixture of different frequency magazines. For example, WAZ publishes two weekly magazines, one bi-weekly magazine and one monthly.

These publishers also publish magazines in other magazine segments such as women, business and politics, adult, automotive, etc. An exception is WAZ, which only publishes women's magazines and pet magazines other than TV magazines. I exploit this multi-segment feature in constructing instrumental variables. For example, the prices of magazines in different segments that are published by the same publisher can be used as IVs for the price variable, because they are likely to be correlated through common publisher cost factors but demand shocks are unlikely to be correlated across segments.

5.2 Demand Estimation: Competitive Bottleneck

I assume that consumers choose at most one TV magazine title per quarter and consumer $i's$ indirect utility of purchasing magazine j in period t is

$$u^A_{ijt} = x_{jt}\beta - \alpha p^A_{jt} + \xi_{jt} + \varepsilon_{ijt}$$

where x_{jt} is a vector of observed magazine attributes, p^A_{jt} magazine copy price, ξ_{jt} unobservable attribute and demand shock and ε_{ijt} an idiosyncratic taste shock with type I extreme value distribution. x includes the magazine fixed effect, the time effect, the number of content pages and the number of advertising pages. Both the copy price and the advertising pages are endogenous variables that are correlated with the unobservable attribute.

[15] Two magazines published by Hubert Burda Media are excluded from the sample from 2006 because their attribute data are missing. This explains a drop in the number of magazines from 17 to 15 in 2006 in table 4.

An advertiser, whose type is $\ ^B_i;$ buys an advertising page if its net pro…t is positive. The advertising pro…t is de…ned as

$$\ ^B_{ijt} = \ ^B_i \,!_{jt} n^A_{jt} \quad p^B_{jt}$$

where p^B_{jt} is price magazine j charges to an advertiser, n^A_{jt} the number of readers for magazine j, and $!_{jt}$ a per-reader pro…tability of one page advertising. I assume that its advertising decision regarding one magazine is independent of its decision regarding another.[16] Thus, there is no direct competition between magazines to attract advertisers and each magazine acts as a monopolist towards advertisers. However, there is still an indirect competition between magazines as long as readers care about (like or dislike) advertising. Given the distribution of advertiser type, $F(\ \ j\ \ )$, the number of advertising pages in magazine $j;\ n^B_j;$ is determined by

$$n^B_{jt} = \quad 1 \quad F \quad \frac{p^B_{jt}}{!_{jt} n^A_{jt}} j \quad !\ ! \quad M_B$$

where M_B the number of advertisers in the market and $F(\ )$ is assumed to be the lognormal distribution with the mean parameter 0 and the variance parameter 1.4. Notice that the distribution parameters are not estimable and should be …xed as part of normalization.[17] Thus, estimating advertisers' demand is equivalent to imputing the mean bene…t (pro…tability) that advertisers receive from advertising in magazines, $i{:}e{:};\ \ !;$ and projecting it on characteristics space. I discuss how this normalization a¤ects demand estimates below.

Būse the generalized methoone pageth372(gen;r5b[(M)]Ti]TJ/F63tls2wwgb[(M/F63tls2wwgb3tls2ww where w includes the magazine fixed effect, the time effect and the number of content pages. Moment conditions are that the demand residuals in the two equations, $_{jt}, e_{jt}$, are not correlated with the number of content pages, the time effects, and the mean magazine quality for readers and advertisers, i.e. the magazine fixed effects. In addition, I use the same and rival publishers' average copy price and advertising pages in other magazine segments such as women's magazines, automotive magazines, etc. as instrumental variables. An identifying assumption is that copy prices and advertising pages are correlated across magazine segments because of common cost shocks but demand shocks are not correlated across magazine segments.

Table 5 shows estimation results, and in the appendix I estimate the model using alternative specifications for the advertiser profit function. The number of potential readers is set to 40 million and the number of potential advertisers is set to 200. Both numbers are set to exceed per-period maximum copy sales and advertising pages respectively. Notice that advertising pages reported in table 4 are the aggregated number for each quarter and a frequency-adjusted advertising page is no larger than 150 pages. The magazine fixed effects and the time effects are included in all estimations but not reported.

The first column shows OLS results for equations (18) and (19) respectively. In equation (18) the price coefficient is negative but statistically insignificant. Both the advertising page and the content page coefficients are positive and significant at the 5 percent level. In equation (19) the content page coefficient is negative and significant. The R-square is 0.96 for the former equation and 0.91 for the latter.

The second column shows the system IV results. I use $(Z'Z)^{-1}$ as a weighting matrix where

Z

residual. When there are two endogenous variables, it is hard to predict the sign of inconsistency in the OLS estimates because it is driven by how strongly the two endogenous variables are correlated with the error term. I test if the instruments used for the …rst equation are weak IVs with the …rst stage F-test. The F-statistics are 24.43 for the price variable and 24.84 for the advertising page variable.

The last column shows the GMM results, using the inverse of the variance of the moment conditions as the weighting matrix. The weighting matrix is optimal such that standard errors are smallest under the current moment conditions. The price coe¢ cient goes down little further to -0.155 but the advertising page coe¢ cient hardly changes. The content page coe¢ cient does not change across the columns. I test the overidentifying restrictions and accept them with the test statistics close to zero.

The magazine …xed e¤ects show that popular magazines do not necessarily have higher per-reader pro…tability for advertisers. A correlation between a quality ranking for readers and a quality ranking for advertisers is -0.45 using the system IV estimates and -0.29 using the GMM estimates. For example, the "lowest pro…table" magazine for advertisers, i.e., BMK's tvpur, in both estimations is estimated to be the fourth or …fth highest quality for readers. This suggests that magazine quality not captured by the size of reader basis is also important in explaining advertising price di¤erences across magazines.

Di¤erent parameter values of the advertiser distribution (i.e., F ( )) mainly a¤ects the constant term of the advertising demand equation. When the variance parameter varies from 0.5 to 3 with the mean parameter …xed, the constant term decreases from 1.702 to -0.628, but the other estimates hardly change. For example, the content page coe¢ cient changes from -0.103 to -0.115. Di¤erent market sizes have similar e¤ects. As the number of potential advertisers increases from 150 to 500, the constant term decreases from 1.126 to 0.175 while the other estimates hardly

5.3 Elasticity and Market Power

Table 6 summarizes price elasticities calculated from the demand estimates. The left panel shows the own-price elasticities in the one-sided model ($\frac{\partial S}{\partial p}\frac{p}{s}$ and $\frac{\partial S}{\partial p}\frac{p}{s}$) which do not account for the feedback loop following a price change. The right panel shows the price elasticities in the two-sided model including the own-price elasticities for readers ($\frac{\partial s}{\partial p}\frac{p}{s}$) and advertisers ($\frac{\partial s}{\partial p}\frac{p}{s}$) and the cross-group price elasticities ($\frac{\partial s}{\partial p}\frac{p}{s}$ and $\frac{\partial s}{\partial p}\frac{p}{s}$)*:* The latter measures a percent change in the number of readers (advertisers) with respect to one percent change in the advertising (copy) price. Compared to the one-sided model, the own-price elasticities go up (in the absolute term) by about 4 percent.

The cross-group elasticities show that advertisers are much more sensitive to a price change

$\partial s_j^A/\partial p_j^B$ and $\partial s_j^B/\partial p_k^B, j \neq k$ become zero. As mentioned above, although pricing for advertisers is modeled as monopolistic, the cross-group interaction makes advertisers' cross-price elasticity (among platforms) non-zero, i.e. $\left(\partial s_j^B/\partial p_k^B\right)\left(p_k^B/s_j^B\right) \neq 0, j \neq k,$. However, its magnitude is so small (the mean cross elasticity is less than 0.001) that its impact on advertising pricing and markups are negligible.

Table 7 reports per-issue marginal costs and markups. I report per-issue estimates to make them comparable with prices reported in table 4. On the left panel I report marginal costs and markups in the one-sided model where platforms maximize profits on each side separately. The reader-side estimates imply the median marginal cost for producing an over 100-page magazine is 0.40 euros and it costs less than 0.60 euros to produce a 200-page magazine (the 5^{th} quintile magazine). The median markup is 62 percent with close to 80 percent of magazines having higher than a 50 percent markup. The median markup in the one-sided advertising market is 73 percent with the mean markup equal to 84 percent.

On the right panel I report marginal costs and markups that account for the two-sidedness. Very different markup structures are seen on the reader side when the advertising side is accounted for. Although demand estimates do not change significantly, publishers' profit-maximizing behaviors are drastically different. The median cost is now 3.39 euros, which results in a negative markup (-2.39 euros). In fact, 90 percent of magazines are estimated to incur a loss from selling their magazines. However, this loss is fully recovered from selling advertising space. Magazines, on average, earn about 20,000 euros from selling one advertising page. The average percentage markup is 83 percent, slightly lower than the one-sided model estimate. Combining the two sides, magazines, on average, make about 65,000 euros per issue with 445,000 euro loss from selling magazines and 510,000 euro profit from selling advertising space.

However, magazines do not always incur a loss from selling their copies. Six magazines made profits on the readers' side in at least one quarter during the sample period. Four of these magazines are published by BMK, which owns the highest number of magazines. This suggests

publishers make positive pro…ts but the average markup is close to one. My choice of 1.4 is the lowest value that makes all publishers earn positive pro…ts over the entire sample period.

5.4 Merger Simulations

In this section I analyze how equilibrium prices and market shares (the number of participations) change when the market becomes more concentrated. In particular, I focus on the shift from the one-sided market model. The price increase is from as small as 3 cents to as large as 12 cents. The right panel of the table shows changes in copy prices and advertising prices in the two-sided market setting. The magnitude of copy price changes is similar to the one-sided market but they move in either direction. The magnitude of advertising price changes is much bigger, although it is smaller in the percentage term.

Market shares change as a response not only to price changes but also to market share changes on the other side. For this reason higher prices do not necessarily result in smaller market shares. Table 9 shows market share changes for the same magazines in the same period as table 8. It shows that lower copy prices result in higher magazine sales, but more advertisers join platforms despite higher advertising prices. This implies that on the advertiser side the demand shifts out so much that its e¤ects dominate price e¤ects.

These results suggest that mergers could be much less harmful for readers than what the one-sided market model predicts and that consumers may even bene…t from them. For the third quarter of 2004 the one-sided model predicts that readers' welfare goes down by 5 percent while the two-sided model predicts a 0.14 percent welfare decrease. Whether consumers bene…t from mergers depends on the magnitudes of copy price and advertising changes, although the latter

e¤ect is relatively marginal. A clo0(sam98(A)-385(-598(A)-tumers)-438(ertisin)]TJ-381(s)-

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 o¤ in more concentrated markets.

References

[1] Argentesi, E. and L. Filistrucchi (2007), "Estimating Market Power in a Two-sided Market: The Case of Newspapers," *Journal of Applied Econometrics*, 22, 1247-1266.

[2] Armstrong, M. (2006), "Competition in Two-sided Markets," *RAND Journal of Economics*, 37, 668-691.

[3] Berry, S. (1994), "Estimating Discrete Choice Models of Product Di¤erentiation," *RAND Journal of Economics*, 25, 242-262.

[4] Berry, S., J. Levinsohn, and A. Pakes (1995), "Automobile Prices in Market Equilibrium," *Econometrica*, 63, 841-890.

[5] Chandra, A. and A. Collard-Wexler (forthcoming), "Mergers in Two-Sided Markets: An Application to the Canadian Newspaper Industry," *Journal of Economics and Management Strategy*.

[6] Jeziorski, P. (2011), "Merger Enforcement in Two-sided Markets," unpublished manuscript, Johns Hopkins University.

[7] Jin, G. and M. Rysman (2010), "Platform Pricing at Sports Card Conventions," unpublished manuscript, Boston University.

[8] Kaiser, U. and J. Wright (2006), "Price Structure in Two-Sided Markets: Evidence from the Magazine Industry," *International Journal of Industrial Organization*, 24, 1-28.

[9] Rochet, J.-C. and Tirole, J. (2003), "Platform Competition in Two-Sided Markets," *Journal of the European Economic Association*, 1, 990-1029.

[10] Rochet, J.-C. and Tirole, J. (2006), "Two-Sided Markets: A Progress Report," *RAND Journal of Economics*, 37, 645-667.

[11] Rosen, J. (1965), "Existence and Uniqueness of Equilibrium Points for Concave n-person Games," *Econometrica*, 33, 520-534.

[12] Rysman, M. (2004), "Competition between Networks: A Study of the Market for Yellow Pages," *Review of Economic Studies*, 71, 483-512.

[13] Rysman, M. (2009), "The Economics of Two-Sided Markets," *Journal of Economic Perspective*, 23, 125-143.

Table 1: Average Price and Market Share in Equilibrium

	Logit Model	Single-Homing		Competitive Bottleneck	
	Group A	Group A	Group B	Group A	Group B
Platforme					

Table 2: Average Price and Market Share with Di¤erent Market Sizes

	Single-Homing				Competitive Bottleneck			
	Group A		Group B		Group A		Group B	
Platform	Price	Share	Price	Share	Price	Share	Price	Share
1	0.740	0.133	0.016	0.177	0.255	0.035	0.891	0.450
2	0.915	0.128	0.186	0.171	0.060	0.062	3.188	0.365
3	1.092	0.126	0.363	0.172	-0.317	0.139	10.547	0.416
4	1.239	0.132	0.496	0.186	-0.569	0.282	26.380	0.427
5	1.398	0.134	0.679	0.183	-0.653	0.460	51.699	0.421

The market size is set to $M_{\boldsymbol{A}}/M_{\boldsymbol{B}} = 10$ for the single-homing model and $M_{\boldsymbol{A}}/M_{\boldsymbol{B}} = 20$ for the competitive bottleneck model.

Table 3: Average Own-Price Elasticities

	Single-Homing				Competitive Bottleneck			
	Group A		Group B		Group A		Group B	
Platform	Direct	Total	Direct	Total	Direct	Total	Direct	Total
1	-1.283	-1.312	-0.292	-0.299	-0.850	-1.115	-1.585	-1.930
2	-1.604	-1.637	-0.468	-0.476	-0.975	-1.336	-1.460	-1.880
3	-1.913	-1.954	-0.683	-0.695	-0.965	-1.494	-1.107	-1.589
4	-2.161	-2.210	-0.885	-0.904	-0.900	-1.466	-0.953	-1.379
5	-2.427	-2.483	-1.168	-1.192	-0.774	-1.255	-0.949	-1.273

The market size is set to $\boldsymbol{M_A}$=$\boldsymbol{M_B}$ = 10 for both models*:*

Table 4: Summary Statistics

	No. of	Magazine Price†		Advertising Price‡		Circulation (in 1,000)		Content Pages		Advertising Pages	
Time	Magazines	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
1992	10	0.96	0.20	24,879	13,457	2,233	974	1,066	178	375	168
1993	11	1.00	0.29	26,253	13,122	2,041	912	1,072	165	351	153
1994	12	1.00	0.30	27,082	12,454	1,976	860	1,081	191	318	167
1995	14	1.02	0.28	26,353	12,419	1,830	814	1,100	215	275	147
1996	14	1.00	0.27	26,870	12,606	1,894	844	1,131	238	278	155
1997	12	1.03	0.27	28,140	13,134	1,953	840	1,160	200	304	193
1998	12	1.04	0.28	29,539	13,900	1,917	845	1,178	254	308	200
1999	15	1.04	0.26	26,377	13,658	1,673	752	1,125	313	295	205
2000	15	1.06	0.28	26,682	13,779	1,646	746	1,135	307	317	220
2001	15	1.08	0.29	27,371	13,930	1,642	752	1,122	290	261	177
2002	15	1.16	0.27	27,949	13,802	1,583	736	1,093	326	254	163
2003	16	1.18	0.26	28,646	13,732	1,508	708	1,079	361	232	143
2004	16	1.21	0.25	29,026	13,728	1,434	676	1,127	373	246	141
2005	17	1.20	0.27	29,239	14,035	1,430	676	1,122	388	234	121
2006	15	1.17	0.26	30,216	14,409	1,480	723	1,150	400	227	117
2007	15	1.18	0.28	32,576	15,437	1,452	718	1,131	381	204	104
2008	15	1.21	0.29	33,236	16,003	1,438	716	1,126	359	174	86
2009	15	1.24	0.28	34,488	16,678	1,393	695	1,098	348	157	70
2010	15	1.25	0.28	35,220	17,212	1,398	701	1,119	350	157	68

† The average price magazines charge for one issue.

‡ The average price magazines charge for one page of advertising in one issue.

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	0.727*	0.727*	0.900*
		(0.160)	(0.242)	(0.233)
	Content Page	-0.102*	-0.102*	-0.110*
		(0.010)	(0.012)	(0.011)

The market size for readers is set to 40 million and the market size for advertisers to 200.
The magazine …xed e¤ects and the time e¤ects are included in all estimations.
Standard errors are reported in parenthesis.
*signi…cant at the 5 % level.

Table 6: Price Elasticity

	One-Sided		Two-Sided			
	$\frac{\partial S}{\partial p}\frac{p}{s}$	$\frac{\partial S}{\partial p}\frac{p}{s}$	$\frac{\partial s}{\partial p}\frac{p}{s}$	$\frac{\partial s}{\partial p}\frac{p}{s}$	$\frac{\partial s}{\partial p}\frac{p}{s}$	$\frac{\partial s}{\partial p}\frac{p}{s}$
Median	-1.64	-1.38	-1.69	-1.43	-0.04	-2.58
Mean	-1.68	-1.31	-1.77	-1.37	-0.05	-2.32
20% QU*	-1.21	-1.02	-1.30	-1.11	-0.02	-1.04
80% QU	-2.12	-1.60	-2.17	-1.63	-0.08	-3.28

The market size for readers is set to 40 million and the market size for advertisers to 200.
A refers to the reader side and *B* refers to the advertiser side.
*QU refers to a quintile.

Table 7: Magazine Market Power

		One-Sided			Two-Sided		
Markets		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

The market size for readers is set to 40 million and the market size for advertisers to 200.
*QU refers to a quintile.

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

	One-Sided		Two-Sided	
	Single	Monopoly	Single	Monopoly
Readers				

Table 9: Participation Changes from the Single Magazine Onwership to the Monopoly

		One-Sided		Two-Sided	
		Single	Monopoly	Single	Monopoly
Readers					
	Magazine 1	0.0033	0.0031	0.0032	0.0036
	Magazine 2	0.0089	0.0085	0.0090	0.0085
	Magazine 3	0.0015	0.0014	0.0014	0.0015
	Magazine 4	0.0011	0.0010	0.0010	0.0011
	Magazine 5	0.0050	0.0048	0.0050	0.0047
	Magazine 6	0.0030	0.0028	0.0030	0.0028
	Magazine 7	0.0024	0.0023	0.0022	0.0024
	Magazine 8	0.0032	0.0030	0.0029	0.0034
	Magazine 9	0.0040	0.0038	0.0040	0.0037
	Magazine 10	0.0042	0.0040	0.0042	0.0039
Advertisers					
	Magazine 1			0.0733	0.0788
	Magazine 2			0.1746	0.1727
	Magazine 3			0.0435	0.0460
	Magazine 4			0.0144	0.0157
	Magazine 5			0.1957	0.1948
	Magazine 6			0.1468	0.1436
	Magazine 7			0.0636	0.0673
	Magazine 8			0.0395	0.0464
	Magazine 9			0.1419	0.1384
	Magazine 10			0.0930	0.0885

Appendix I: Alternative Speci…cations for the Advertiser Pro…t Function

In this section I explore alternative speci…cations for the advertiser's pro…t function. The …rst alternative speci…cation (*Alt I*) to consider is

$$^{B}_{ijt} = \quad ^{B}_{i} !_{jt} \quad p^{B}_{jt}$$

where $!_{jt}$ denotes the magazine quality perceived by advertisers. Recall that in the original speci…-cation the magazine quality perceived by advertisers is at a per-reader level so that the advertising bene…t for magazine j is $^{B}_{i} !_{jt} n^{A}_{jt}$. In this alternative speci…cation, the advertising bene…t for magazine j is $^{B}_{i} !_{jt};$ and $!_{jt}$ is a function of n_{jt} and other magazine characteristics.

A nice feature of this speci…cation is that advertisers' valuation on the number of readers can be directly estimated. One plausible function form for $!_{jt}$ is

$$!_{jt} = \quad n^{A}_{jt} \quad \exp(\mathrm{w}_{jt} \quad)\exp(e_{jt}):$$

where $!_{jt}$ is positive only when n^{A}_{jt} is non-zero, keeping an essential feature that magazines are valuable to advertisers only through readers. I treat n^{A}_{jt} as an endogenous variable that can be correlated with e_{jt} and use the number of readers in other magazine segments as instrumental variables. One may consider the original speci…cation as …xing at 1.

The second alternative speci…cation (*Alt II*) to consider is

$$^{B}_{ijt} = !_{jt} n^{A}_{jt} \quad p^{B}_{jt} + r_{ijt}$$

where $!_{jt}$ is the per-reader magazine quality and r_{ijt} is an i.i.d. random variable distributed normal with mean zero. In this speci…cation the mean valuation of a magazine is the same across advertisers, but each advertiser draws a random pro…t shock in each period.

An advertiser bu/F4310.9091Tf282.2630Td[()]TJ/F237.9701]magazine

Otherwise, the exponential function in the advertiser-side market share blows up. Dividing the copy price does not affect demand estimates other than scaling up the price coefficient. Also, I make the market size on the advertiser side larger than the sum of advertising pages across magazines in a given period to be consistent with the assumption in the two-sided single-homing model that advertisers choose only one magazine.

Table 11 shows estimation results in the two-sided single-homing model. The reader-side estimates using the system IV and the GMM estimation techniques are statistically significant and their magnitudes are similar to those in table 5 except for the advertising share variable. This difference mainly comes from using the advertising share variable rather than the number of advertising pages. All coefficients, nevertheless, change in the same direction as in table 5. On the advertising side the reader share variable is added in estimation. Its coefficient is positive, meaning that advertisers appreciate a larger reader base, and its magnitude goes down with instrumental variables, implying that it is positively correlated with demand shocks. Recall that the price coefficient is fixed at -1 so the reader share variable is the only endogenous variable.

One thing to notice is that the reader share coefficient is about four times larger than the advertising share coefficient. Recall that in the two-sided single-homing model, platforms charge a lower price to a smaller size group if the two group's valuation of the other group is the same. However, the data show that advertisers, the smaller size group, pay much higher prices than readers do. The larger reader share coefficient resolves this inconsistency by showing that advertisers appreciate readers more than readers appreciate advertisers.

These demand estimates seem to suggest that the two-sided single-homing model can be also used to describe the media advertising. In fact, the magazines usually charge below-cost copy prices to readers and make profits from advertisers in this model, as advertisers' appreciation of readers is much greater than readers' appreciation of advertisers. However, a loss on the reader side is much less adequately compensated by a profit on the advertiser side. That is because magazines compete to attract advertisers instead of behaving as monopolists towards them. Moreover, magazines with larger reader bases make smaller profits. This is in sharp contrast to the result in the competitive bottleneck model where magazines with larger reader bases are able to earn higher profits from advertisers.[21] These results render support to using the competitive bottleneck model in describing magazine advertising.

[21] The coefficient correlation between the two sides' markups is -0.92 in the competitive bottleneck model while it is 0.18 in the two-sided single-homing model.

Table 10: GMM Estimation with Alternative Advertising Pro…t Functions

Advertiser Side	Base	Alt I	Alt II	Alt III

Table 11: Demand Estimation in the Two-Sided Single-Homing Model

Variable		OLS	System IV	GMM
Readers	Constant	-7.001*	-5.500*	-5.092*
		(0.232)	(0.494)	(0.471)
	Copy Price	-0.020	-0.122*	-0.137*
		(0.012)	(0.028)	(0.027)
	Ads Share (in %)	0.465*	0.875*	0.799*
		(0.042)	(0.113)	(0.110)
	Content Page	0.063*	0.070*	0.063*
		(0.007)	(0.008)	(0.007)
Advertisers	Constant	-2.362*	-2.244*	-2.224*
		(0.261)	(0.382)	(0.368)