Product Differentiation in Two-Sided Markets*

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January 15, 2010

Abstract

Both sides of two-sided markets are mostly presented as undifferentiated markets, though often it will be profit maximizing to differentiate one or two sides in two or more types. In a simple theoretical model, we show that this decision crucially depends on the reception of these differentiated types by the other side. We argue that this reception consists of two parts: a preference for one type over another and a preference for the entire composition of the platform. The relation between both preferences drives the monopolist decision to engage in product differentiation and if so, in which ratio.

We test this conceptual framework in an empirical study on Yellow Pages. We find that Yellow Pages publishers offer large ads even though users don't value them. The economic rationale for this is that each advertisement type contributes directly (by the price paid for it) and indirectly (by increased usage) to revenues. Large ads are mainly set for this direct contribution, small ads for this indirect contribution. If a platform can choose the size, it will make the size difference between small and large ads as large as possible, in order to attract as much users as possible, but also to induce self selection among advertisers.

Keywords: two-sided markets, product differentiation, Yellow Pages
JEL Codes: L12,L86

1 Introduction

Two-sided markets literature is booming nowadays. These markets are mostly presented in the same way: one or more platforms, two sides of the markets, and all members of each side join the platform in the same way. But why is there no product differentiation in these markets, i.e. why can members of each side not join the platform in different ways? Often, a platform can attain a higher profit if it differentiates one or two sides in two or more types.

Take the example of Yellow Pages. A publisher is faced with two distinctly different demands: users searching for a good or service and firms announcing their goods or service

*We are grateful for helpful discussions with Peter Van der Hallen and seminar participants at the Media & Communication Conference of the AEA in Paris, 2007 and the Monetary & Information Economics Workshop in Leuven (2007 and 2009).

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to potential users. Both sides value each other's presence at the platform. A publisher can choose to offer an undifferentiated product, i.e. each side joins the platform in the same way. Though, this is not what we observe in reality. Advertisers can select one out of many possibilities to join the platform: buy a small or large ad, buy a colour or black and white ad, add only text or also a picture.

We set up a simple model with two types on one side of the market, e.g. advertisers can choose a small or a large ad. This model is presented as a Yellow Pages model for the ease of using that terminology, but can easily be applied to other markets. The platform is a quantity setter. In his decision on both quantities, he faces two constraints: quantities cannot be negative and he cannot place more quantities than there are firms. If none of these constraints is binding, he offers both types and both are generating profit. But if the non-negativity constraint is binding, he decides to offer only one type. This replicates the idea of many theoretical papers and some real life example where no differentiation takes place. He can also decide to include every firms, the smallest quantity is given away for free.

Which result prevails is crucially determined by how these types are welcomed by each side of the market. Take the Yellow Pages again. We argue that users might have a double preference for different ad types. First, when they open the directory, they might easier look at large advertisements because they attract the attention or they contain more information. Second, when they decide whether to use the directory or not, they look at the entirety of the directory and might prefer a thinner directory because it is easier to overview and handle. Therefore they prefer small ads over large ads. The first preference will be labeled the comparison effect, the second the composition effect. When the users decides whether to join the platform or not, it is the composition effect that plays a role. The first effect, the comparison effect, comes in *after* one side has decided to join the platform. Once they are on the platform, it is not the composition that counts, but the comparison between the different types. The other side of the market, the advertisers, choose under which type they join the platform and are affected by both effects: the composition effect determines how many users join; the comparison effect tells how large their chance is to be seen or chosen once the users have joined. Since an individual advertiser cannot affect the composition of the platform, its decision is mainly based on the comparison effect.

Whether the platform, which is a monopolist in our model, decides to offer differentiated types, or only one single type, is determined by the interplay of the comparison and composition effect. If large ads contribute more to usage (composition) than users look at them (comparison), then the platform will only large ads to advertisers. If the reverse holds, then small and large ads will figure next to each other, except when te size difference between both sizes is small. If the size difference is large, then every firm is on the platform and small ads will not be charged.

In our empirical application on Yellow Pages in Europe, we measure the composition effect. We find that readers use the directory because it contains listings and small ads; but the number of large ads does not have an effect on readership. It might seem puzzling why 18% of the firms in our sample buy a large ad. Our theoretical model correctly predicts that even though no one likes large advertisements, the directory includes them because they are an important source of revenues. Our results naturally extend to other media platforms and other two-sided markets, such as shopping malls, job agencies, auction platforms and other advertisement-related platforms.

Related Literature

The explained double effect of comparison and composition will only prevail in markets with product differentiation and network externalities. If there is no product differentiation, then there are no types to compare. The presence of two distinctive sides of the market allows comparison and composition effects as seen from the other side of the market. We discuss two-sidedness and product differentiation below and relate them to the literature. We illustrate both characteristics with the example of Yellow Pages, because this makes it easier to link our theoretical model with our empirical work in section 4.

Two-Sidedness In two-sided markets, platforms bring together two distinctly different customers who value each other's presence on the platform. Examples are credit cards (bringing together merchants and customers), operating systems (software developers and end users), shopping malls (sellers and buyers) and media outlets (readers and advertisers). Yellow Pages can be seen as a particular type of a media outlet.

Issuers of Yellow Pages target two clearly distinct groups: users and advertisers. For users, Yellow Pages is a device to find businesses. Though there are a number of alternatives, e.g. word-of mouth or company websites, Yellow Pages are still extensively used for their convenience. For advertisers, Yellow Pages is a device to reach potential clients. Especially for smaller firms who lack the possibility of direct marketing, Yellow Pages are a valuable device. It is clear that both sides are interdependent: advertisers value eyeballs (i.e. the looks their ads get) while the users of the Yellow Pages value information on the suppliers that figure in each book entry.

Rysman (2004) examines the Yellow Pages market in the United States. He uses data on 419 directories for the year 1996. He estimates a simultaneous model on both sides of the market. The conclusion of his research is that there is a statistically and economically significant positive feedback loop effect. The willingness to pay of advertisers increases if there are more users and usage increases if there are more advertisers in a directory. This creates the feedback loop between advertisers and users: more ads means more users which in turn increases the number of ads. This result favors a monopolistic market situation because it generates a larger welfare surplus through the internalization of the network effect. But, an oligopoly reduces market power, and is therefore also a force that generates welfare surplus. His empirical study reveals that the latter effect dominates, therefore, from welfare viewpoint, a more competitive market is preferable. For the empirical model, we rely on the structural framework of Rysman (2004), but we do not investigate the competition issue because pronounced consolidation already has induced one operator per country in Europe.

Rochet & Tirole (2003) include both network theory and multi-product pricing to build their seminal two-sided market model. They investigate the price allocation between the two sides of the market under a (monopolistic) platform and under two (competitive) platforms. They discuss the implications of profit vs. welfare maximization. Armstrong (2006) focuses on a similar analysis as Rochet & Tirole (2003). In his theoretical model, he mainly stresses the single versus multi-homing behavior of the market. If there are several platforms, both demand types can decide to join just one or different platforms. A characteristic example in his article is when one side of the market single homes (=joins just one platform) whereas the other side multi-homes. To some extent, the newspaper market is such a market: most readers buy only one newspaper, many advertisers buy advertisement space in several papers. Armstrong (2006) shows that the *bottleneck side* (the single-homing side) is cross-subsidized by the multi-homing side. In the Yellow Pages market, users pay no fee and are therefore subsidized, though that is not necessarily the consequence of single/multihoming behavior.

We start from a simple two-sided markets model, but we remove some features and add some other. We remove the bottleneck discussion by assuming that there is no competition. This is true for the Yellow in many Europeans countries. Also, we assume that one side doesn't pay to use the platform, which equally fits reality in Yellow Pages since users don't pay. Modeling a null price is equivalent with a relative high elasticity for the reader side. To the two-sided markets model, we add product differentiation.

Product differentiation Product differentiation is a well-known strategy to distinguish a product from a competitor's product, or from the own products. There are two types of product differentiation. Horizontal differentiation serves other tastes but same quality (e.g. a white versus a red car). In our model, we focus on vertical product differentiation. Products then differ in quality, e.g. large ads are more interesting for advertisers because they attract more viewers. In this sense, product differentiation can also be labeled quality differentiation.

This differentiation is common to all Yellow Pages editions. Even casual inspection of a directory shows that different types of advertisements figure next to each other. Some are large ads in color that contain a lot of persuasive information. Other entries merely have the contact details of the business involved. Advertisers are offered a menu of advertisements and can freely choose the advertisement which maximizes their utility. The interesting questions here are how advertisers self select their ad type and to what extent usage plays a role in this decision. It is also interesting to investigate how and to what extent types of advertisement affect usage.

Busse & Rysman (2005) investigate the effect of competition on second-degree price discrimination in the Yellow Pages market. With roughly the same data set as Rysman (2004), they find that competition does not only affect the price level, but also the price curvature. Their results suggest that the price of large ads is more affected by competition: in regions with only one player, the largest ad is 13.51 times more expensive than the smallest ad, compared to 12.54 and 11.63 in regions with two or three players, respectively. Similarly, an additional competitor triggers a decrease in the price for a full-page ad of 12.8%, for smaller ads this is substantially less (double quarter-column ad and quarter-column ad: 7.7% resp. 5.9%). Busse & Rysman (2001) provide three reasons for this observation. First, since new entrants are capital constraint, they may seek out the most profitable sales which are the largest ads. Second, large advertisers have a greater bargaining power (Rochet & Stole 2002); therefore they reap the largest benefits from competition. Finally, given the existence of a feedback loop effect, directories with more larger advertisement can get higher usage[1].

There are a number of theoretical papers that allow for quality differentiation on at least one side of the market. The clearest example is Viecens (2006), a paper inspired by shopping malls. There are two types of shops: high quality and low quality. Viecens (2006) argues that for the buyers, not only the volume but also the identity of the shops matters. Dependent on the importance of identity versus size of the shopping mall, the market structure will be monopolistic or competitive. Damiano & Hao (2008) compare the welfare effects of monopolistic versus duopolistic match makers. While monopolistic match makers can use prices to sort high and low types, their duopolistic counterparts are involved too much in price competition and are less efficient. In Viecens (2006), shops cannot switch from the high to the low type or vice versa. Similar to Damiano & Hao (2008), we allow advertisers to self-select their type. Contrary to both papers, we model the platform as a monopolist and do investigate the effects of competition only at the margin.

With our theoretical model, we contribute to the already extensive literature on two-sided markets, by adding product differentiation. Besides the effect of this differentiation on the differentiated side of the market (by inducing self selection), we explicitly investigate the effect of this differentiation on the other side of the market. We argue that the other side has a direct preference for one type over another and an indirect preference for the contribution of each type to the composition of the platform. It is exactly the potential difference between both effects that determines the equilibrium outcome. To our knowledge, we are the first authors that exploit this feature to investigate the effect of product differentiation in two-sided markets.

Our contribution is not only novel in a theoretical perspective. Empirical studies on Yellow Pages are scarce; and none of them contain all the features described above. Rysman (2004) investigates two-sidedness but excludes product differentiation. Busse & Rysman (2005) do take into account product differentiation but exclude readers (and therefore two-sidedness). In our industry study, we focus on both, though we are mostly interested in what readers like.

The remainder of the paper is organized as follows. In Section 2, we introduce our theoretical model. We present the simple model and compute the optimal quantities of a profit maximizing monopolist. Further we discuss some extensions, such as the optimal quantities of a welfare maximizing monopolist, price discrimination and endogenous size choice. Section 4 describes the industry study. We collected data on Yellow Pages publishers in five small European countries and test which advertisements are valued by Yellow Pages readers. Further, we reconcile our empirical findings with our theoretical findings. Finally, we conclude in Section 5.

2 Theoretical Model

Our theoretical model is presented as a Yellow Pages model, while it is much more general and can easily be applied to other markets as well. We do so because of the ease of

[1]This last explanation contradicts with our theoretical and empirical findings. If larger ads are more popular than smaller ads, then the directory will only publish large ads. Empirically we find that a strong positive effect on usage from small ads, but no effect from large ads.

explanation. With this approach we follow many theoretical papers, such as Rochet & Tirole (2003), that focus on a real life example to explain a general model.

2.1 Set-Up

The Yellow Pages industry is characterized by three players: advertisers, readers and publishers. Advertisers are retailers or companies that use the directory to connect with users in order to sell their products or services. Readers are consumers that use the directory to connect with advertisers in order to buy their products or services. The publisher is the platform that connects readers and advertisers.

Our analysis is focused on the last player, the platform. We assume that the platform is a quantity setter[2] and investigate the quantity decision of a monopolistic platform: how many small and large ads will be published in the directory?

Readers Yellow Pages readers get the directory for free, but that does not mean that every potential reader will use it. Readers use the directory if it generates more utility than the outside option to search for a good or service. This can include contacting a company one already knows, calling a friend, or driving to a city and searching randomly for retailers. If we treat this outside option as an opportunity cost, the net utility of using the directory is equal to:

$$U^R = \max(r_1 q_1 + r_2 q_2 - k, 0) \tag{1}$$

where q_1 are the small ads, q_2 are the large ads and k is the opportunity cost. The parameters r_1 and r_2 represent the valuation of readers for each type of ads. Readers are homogenous in these valuations but are heterogeneous in their opportunity cost. If there is a mass one of potential readers and the opportunity cost k is uniformly distributed between 0 and 1, then the number of readers reads:

$$q^R = r_1 q_1 + r_2 q_2 \tag{2}$$

A directory without advertisements will have no readers.

Advertisers Firms, i.e. potential advertisers, value looks at their advertisement since they generate profit π from each look. The number of looks for each ad depends on the size of the ad s_i and the number of readers:

$$\begin{aligned} L_1 &= s_1 q^R \\ L_2 &= s_2 q^R \end{aligned} \tag{3}$$

We assume that large ads attract more readers than small ads $(s_2 > s_1)$[3]. Further we assume that each firm buys at most one ad. Contrary to readers, advertisers pay a price p to use the platform. The net benefit of an advertiser reads:

$$\pi L_i - p_i \tag{4}$$

[2] While publishers have a tradition of announcing list prices each year, the practice learns that they adjust these prices with discounts to accommodate the number of advertisers, i.e. list prices can be seen as maximum prices but can differ substantially from the real prices.

[3] This assumption can be made without loss of generality. If it would be the case that small ads attract more attention than large ads, then small ads can be relabeled q_2 and large ads q_1.

with $i = 1, 2$ the type of ads. Advertisers are of mass one and are heterogeneous in their profit per look π which is uniformly distributed between 0 and 1. Define $\hat{\pi} \equiv \frac{p_2 - p_1}{L_2 - L_1}$ to be the profit level where firms are indifferent between both ad types, and $\hat{\pi}_1 \equiv \frac{p_1}{L_1}$ is the lowest profit for which the firm's net benefit is positive. Then

$$\begin{aligned} q_1 &= \hat{\pi} - \hat{\pi}_1 \\ q_2 &= 1 - \hat{\pi} \end{aligned} \tag{5}$$

Since we model the platform as a quantity setting monopolist, we transform the demand functions to inverse demand functions:

$$\begin{aligned} p_1 &= (1 - q_1 - q_2) L_1 \\ p_2 &= (1 - q_2) L_2 - q_1 L_1 \end{aligned} \tag{6}$$

Publisher The platform maximizes its profit:

$$\Pi = p_1 q_1 + p_2 q_2 \tag{7}$$

To simplify the analysis, we assume that the platform has no costs, i.e. there is no cost difference between small and large ads[4]. The platform is a quantity setting monopolist, so it optimizes its profit with respect to the quantities q_1 and q_2. While deciding on these two variables, a platform has to take into account the direct and indirect effects of quantity level and structure. The effect of an increase in quantity on profit depends on the decrease in prices. This problem is complicated by the product differentiation. Another indirect effect is the effect of quantity on usage. An increase in the number of ads increases the number of readers and therefore increases the willingness to pay. This effect, the feedback loop effect, reduces the negative price effect.

2.2 Results for a Private Monopolist

In this section, we present the results of our model for a private monopolist. In order to present these optimal quantities clearer, we define three new parameters: $r = \frac{r_1}{r_2}$, $R = r_1 + r_2$ and $s = \frac{s_1}{s_2}$ Thus r is the relative appreciation of q_1 versus q_2 (i.e. the composition effect), whereas s is the relative attention-attraction of q_1 versus q_2 (i.e. the comparison effect). We replace r_1, r_2 and s_1 to obtain expressions that contain only r, R, s and s_2[5]. The platform's profit function is maximized subject to the constraints $q_1, q_2 \geq 0$ and $q_1 + q_2 \leq 1$.

Proposition 2.1 *There are four possible results for a monopoly platform:*

1. *Large ads only platform*
2. *Small ads only platform*
3. *Full coverage platform (i.e. everyone advertises)*
4. *Differentiated platform (i.e. small and large ads offered at a positive price)*

[4] For a discussion of this assumption, see section 3.7

[5] We replace r_1 by $\frac{rR}{1+r}$, r_2 by $\frac{R}{1+r}$ and s_1 by ss_2.

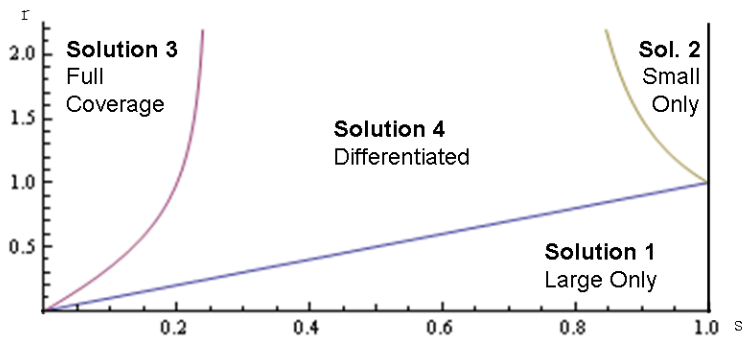

Figure 1: Different solutions in the r-s-space.

The solutions depend on the relation between r and s, but not on R and r_2. These results will prevail, respectively, when:

1. $r < s$
2. $\frac{3}{4} < s < 1$ *and* $r \geq \frac{s}{4s-3}$
3. $s < \frac{1}{4}$ *and* $r \geq \frac{s-4s^2+2\sqrt{s^2(1-5s+4s^2)}}{1-4s}$
4. *otherwise*

Proof All proofs can be found in the appendix.

From these solutions, we can easily deduct some possible scenarios.

Corollary 2.2 *r-scenarios*

- *if $r_1 < r_2$, then the platform always offers large advertisements*
- *if $r_2 < r_1$, then the platform always offers small advertisements*
- *if $r_2 = r_1$, then the platform always offers both advertisements*

s-scenarios

- *if $s \leq \frac{3}{4}$, then the platform always offers large advertisements*
- *if $s \geq \frac{1}{4}$, then advertisements are always paid (i.e. never for free)*

Figure 1 shows these scenarios graphically in the r-s-space. As can be seen, the boundaries between solutions 3 and 4, $r = \frac{s-4s^2+2\sqrt{s^2(1-5s+4s^2)}}{1-4s}$, and between solutions 4 and 2, $r = \frac{s}{4s-3}$, go asymptotically to $\frac{1}{4}$ and $\frac{3}{4}$.

Performing a comparative statics analysis, allows us to formulate three interdependent statements on the impact of R and s_2, r and s on the equilibrium quantities and profit.

Proposition 2.3
- *The levels of the parameters (e.g. R, s_2) affect the profit positively, but do not affect the optimal quantities.*
- *The proportion of r_1 and r_2 ($=r$) does affect the optimal quantities, but only in the full and differentiated optimum. The bigger r_1 relative to r_2, the higher the amount of small ads and the lower the amount of large ads.*
- *The proportion of s_1 and s_2 ($=s$) does affect the optimal quantities, but only in the differentiated optimum. If r_1 is substantially larger than r_2, an increase in s increases q_1 and decreases q_2. If r_1 is smaller than r_2, an increase in s decreases q_1 and increases q_2.*

An important remark on these comparative statics is that the effect of r and s does not play only within these solutions, but also affects which solution is optimal. A change in r or s can induce a solution shift. This can be easily seen in figure 1. Quantities and profits shift continuously, except shifts that cross the 45 degree line.

3 Extensions to the Model

3.1 Negative Utility from Advertisements

In section 2, we implicitly assumed that r_1 and r_2 are positive though it is likely that in some markets this assumption is violated. Especially in media markets, advertisements are often seen as a nuisance (Anderson & Coate (2005) and Peitz & Valletti (2008)). In Yellow Pages, this is less likely since advertisements contain relevant information for users, though it might be that some advertisement types do not contribute to usage, on the contrary, they decrease usage (see section 4.3 for a discussion).

In our model, it should hold that at least one of the advertisement types contributes to usage, i.e. either r_1 or r_2 is positive. Otherwise there would be no usage on the platform. But the model can perfectly cope with one negative parameter (either $r_1 < 0$ or $r_2 < 0$).

Proposition 3.1
- *If $r_1 < 0$ and $r_2 > 0$, then the platform only offers large advertisements.*
- *If $r_2 < 0$ and $r_1 > 0$, then the platform always offers small advertisements. The platform will also offer large advertisements if the size difference is large enough.*

This proposition is visualized in figure 2. On the left panel, below the x-axis, we plotted the case where $r_1 < 0$; on the right panel the case where $r_2 < 0$. As be seen from the graphs, the border $r < s$ extends to negative values of r as well in the case where $r_1 < 0$. Since small ads are less profitable and are disliked by users, they do not appear any more in the directory. In the case $r_2 < 0$, things are somewhat more complicated. The platform will keep out the large advertisements only if s is large; more precisely if $r > \frac{s}{4s-3}$ (and for all r-values if $r < 0$ and $\frac{3}{4} < s < 1$). Small ads will be offered for free if $|r| \geq \frac{s-4s^2 \pm 2\sqrt{s^2(1-5s+4s^2)}}{1-4s}$.

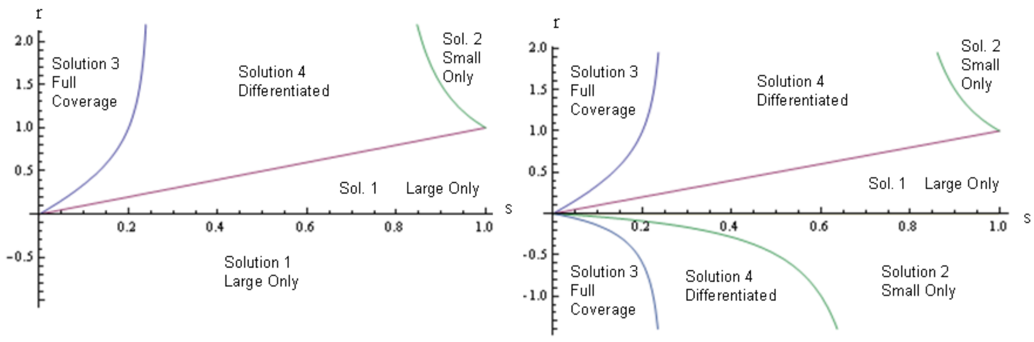

Figure 2: Different Solutions in the $r - s$-space. Left panel: if $r < 0$, then $r_1 < 0$, right panel: if $r < 0$, then $r_2 < 0$

3.2 Endogenizing r (as a function of s_1 and s_2)

The comparison effect s and the composition effect r were treated independently in section 2, though one can argue that they are related. In our Yellow Pages example, we argued that users might easier choose a large advertisement when they compare both types. Though when deciding on using the directory or not, users might prefer smaller ads because these ads make the directory easier to handle and overview. We related the first preference, on the comparison, directly to the size. One can argue that the composition preference is also related to the size. After all, it is exactly the size of the advertisements that makes the directory thicker and harder to browse. Therefore, we can alter usage equation 2 in order to include the nuisance effect of size.

$$q^R = v(q_1 + q_2) - n(s_1 q_1 + s_2 q_2) \tag{8}$$

The first term, with parameter v, captures the taste for variety, i.e. the pure network externality of adding another advertiser to the platform. The second term, with parameter n, captures the nuisance of the thickness of the directory. To simplify the analysis, we normalize n to 1. Note that we can rewrite equation 8 as $q^R = (v - s_1)q_1 + (v - s_2)q_2$, i.e. $r_1 = v - s_1$ and $r_2 = v - s_2$. The ratio r is equal to $\frac{v - s s_2}{v - s_2}$. Since $s_1 < s_2$, $r_1 > r_2$ always holds. Therefore, we can use the right panel of figure 2 to analyse an endogenized r.

Proposition 3.2

- *If $v \leq s_1$, there will be no platform since there are no users.*
- *In all other cases, the platform will offer small ads. If $s_1 < v \leq \frac{4s_1}{3}$, then the platform offers only small ads. If $v > \frac{4s^2 s2 - 2\sqrt{s^2(1-5s+4s^2)s2^2}}{-1+5s}$, then the platform implements the full coverage solution. If $\frac{4s_1}{3} < v \leq \frac{4s^2 s2 - 2\sqrt{s^2(1-5s+4s^2)s2^2}}{-1+5s}$, then the platform is differentiated.*

In figure 3, the implemented solutions are shown in function of v and s. The straight line is the size of the large advertisement s_2. Three out of the four solution of our model in section 2 apply to this adapted model. In addition if the taste for variety is not large

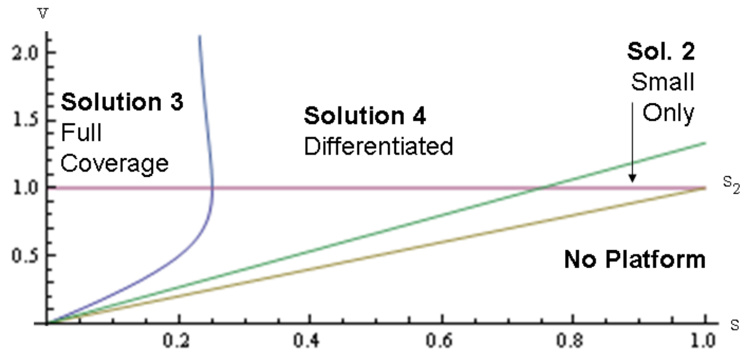

Figure 3: Different solutions in the v-s-space.

enough, then there will be no platform on the market. The claim that the absolute size of the advertisements does not matter in the choice of the quantities does not hold anymore.

Proposition 3.3 *If size is seen as a nuisance to the composition of the platform, than an increase in s_2 will lead to an increase in small advertisements and a decrease in large advertisements.*

This proposition holds for solutions 3 and 4 (full coverage and differentiated platform). In the case where only one ad type is offered, all parameters have no influence on the solution. Note that an increase in s_2 can also induce a shift between the solutions and makes it likelier that there will be no platform in the market.

If size is not seen as a nuisance to the composition, but as a plus-point, then the results change drastically. We can write the usage function as $q^R = v(q_1 + q_2) + n(s_1 q_1 + s_2 q_2)$. Therefore the r of section 2 now reads as $r = \frac{v+s_1}{v+s_2}$ or $r = \frac{v+ss_2}{v+s_2}$.

Proposition 3.4 *If size generates a positive effect on usage, then the platform always offers both types. If the size difference is large enough, then the small advertisement is offered for free. (If $v = 0$, then only large ads will be offered.)*

Since $r = \frac{v+ss_2}{v+s_2}$ and $0 \leq s < 1$, for every combination between $v \geq 0$ and $s_2 \geq 0$, it holds that $s \geq r < 1$. If we have a look at figure 1 again, then we see that the only possible solutions are the full coverage and the differentiated solution.

3.3 Endogenous Size Decision

In our analysis, we treated size as exogenous, which gave us a good insight in the interplay between r and s. Though in reality, platforms can choose the size of the advertisements. Since we assumed that there are no costs in our model, platforms will set the level parameter s_2 of the advertisements as high as possible. It is more interesting, though, to look at the choice of s. Except for special cases $r = 0$ or $r = \infty$, the profit maximizing monopolist sets $s = 0$, i.e. it reduces the attention-attraction of the small advertiser as much as possible. The profit maximizing monopolist implements solution 3, i.e. it offers readers a directory with all potential advertisers ($q_1 + q_2 = 1$). It offers two possibilities to readers: a large ad that attracts readers, or a small ad that attracts no readers. The latter is offered for free[6].

Proposition 3.5 *If a profit maximizing monopolist can choose the size of the advertisements, it makes the large advertisement as large as possible and the small advertisement as small as possible. It offers readers a directory with all potential advertisers.*

This proposition has an important corollary in the debate whether a government should impose a universal service provision constraint. A universal service provision exists in the White Pages (people's directory)[7]. It says that everyone has the right to be included in the directory for free[8]. Such a constraint is not present for the Yellow Pages, though in every country we examined, publishers include firms for free. This basic listing is as small as possible (one line) and contains only address and telephone number.

Corollary 3.6 *A universal service provision constraint is not necessary in Yellow Pages, since profit maximizing firms will always choose to open the directory for all potential advertisers.*

The main reason why it might be necessary to implement a universal service provision in White Pages, but not in Yellow Pages, is the distribution of profits per view. For a people's directory, this profit is nearly zero, while businesses can easier generate profit from being contacted. In other words, in White Pages, there is not enough advertisers that can cross-subsidize the less profitable types (see also our discussion on price discrimination in section 3.4).

If we add more advertisement categories in our model, as is the case in actual Yellow Pages, then the likely result would be that the largest advertisement is as large as possible, the smallest as small as possible. This is similar to the quality degradation models of Mussa & Rosen (1978), Maskin & Riley (1984) and Besanko, Donnenfeld & White (1988). In these models, a monopolist deteriorates the quality offered to the groups with the lowest willingness to pay for quality. If a regulator judges a mere listing as a product with too low quality, it can still implement regulatory corrections, such as minimum quality standards though this is not always welfare improving (Besanko, Donnenfeld & White 1988).

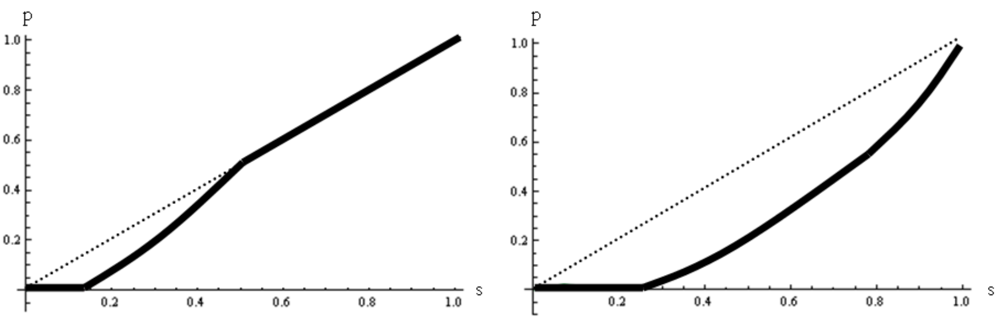

Figure 4: Relative prices ($p = \frac{p_1}{p_2}$). Left panel: r=0.5, right panel: r=1000

3.4 Price discrimination

If one advertisement of size one costs one euro, than we would expect that an advertisement of twice the size would cost less than two euro. If this does not hold, every advertiser can buy two advertisements and obtain the same effect. This phenomenon is well-described in microeconomics and explains why the bundle costs less than the sum of the individual parts. Busse & Rysman (2005) find the existence of this second degree price discrimination and link it to competition. If there are more platforms in the market, then the price discrimination is larger, i.e. large ads are relatively cheaper vis-à-vis small ads.

Using our model, we can have a look at the price ratio in function of the size ratio. We note that the absolute size (s_2) has no influence on prices. Prices are only determined by the size difference (s) and the liking difference (r).

Proposition 3.7 *If both types are offered, then large advertisers always pay more per view than small advertisements. There is a cross-subsidization from large advertisers to small advertisers.*

The reason behind this cross-subsidization is that, in the case two types are offered, the relative contribution of small advertisements to usage is larger than their visibility ($r > s$).

[6]Note that in solution 3, q_1 is always offered for free, even if $s > 0$.

[7]There are three generally accepted telephone directories: White Pages, Yellow Pages and Grey Pages. The first type contains an alphabetical list of persons, with address and telephone number. The directory is divided in regions. Yellow Pages is synonymous with a business directory. It classifies firms by their business type or goods or services provided. Grey Pages are less known. These are so-called reverse telephone directories where one can browse the numbers and find the associated customer details. The latter was mostly used by emergency services, phone companies, law enforcement, and public libraries. All types are found online nowadays; it is likely that the less profitable printed White and Grey Pages will vanish first.

[8]See Directive 2002/22/EC of the European Parliament and of the Council of 7 March 2002 on universal service and users' rights relating to electronic communications networks and services (Universal Service Directive).

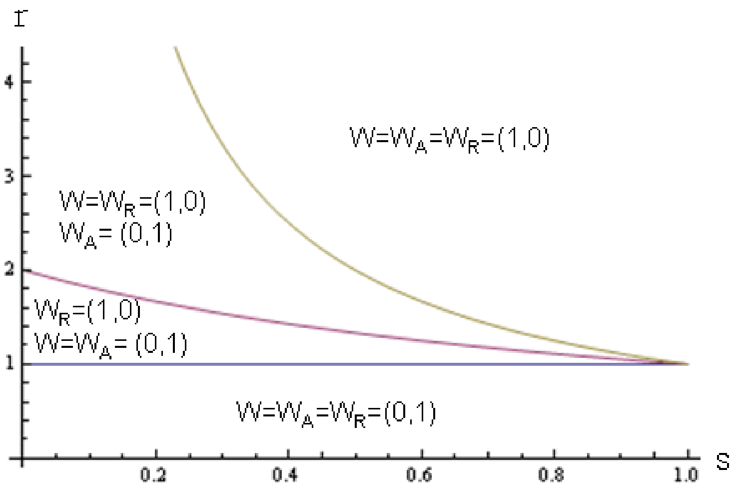

Figure 5: Optimal welfare solutions in the r-s-space. Between brackets, the optimal values for q_1 and q_2 are shown.

Figure 4 shows the curvature, under $r < 1$ (left panel) and $r > 1$ (right panel). On the horizontal axes is the ratio of size ($s = \frac{s_1}{s_2}$). On the vertical axes, you find $p = \frac{p_1}{p_2}$, the ratio of prices. If there is second degree price discrimination, we would expect a price ratio above the 45 degree line. In both situations, we observe the reverse: if the size difference is maximal (s=small), then $p_1 = 0$ and therefore $p = 0$. The ratio gradually increases towards 1 when the size is the same.

One of the reasons why we don't find price discrimination is that we impose that advertisers buy at most one ad. Hence it is not possible to substitute a large ad by several small ads. Multiple advertisements are seldom observed in Yellow Pages, though this does not tell anything about the possibility. In sum, our model falls short in explaining the observed second degree price discrimination in Yellow Pages. On the contrary, it predicts relative higher prices for the large ads.

3.5 Results for a Ramsey Planner

We contrast the optimal quantities of the private monopoly with a public monopoly platform that maximizes welfare under a break-even constraint. Therefore, it takes into account the welfare of readers and advertisers. The welfare of the readers is equal to the sum of the net utilities (see equation 1). The welfare of the advertisers is also the sum of the net utilities and consists of two parts: small advertisers and large advertisers (see equation 4). α and β are parameters that present the importance of advertiser welfare versus reader welfare. The objective function of the Ramsey planner reads:

$$W = \alpha W_A + \beta W_R \tag{9}$$

We impose the same restrictions as in the private monopoly case: $q_1, q_2 \geq 0$ and $q_1+q_2 \leq 1$.

Proposition 3.8 *A welfare maximizing monopolist will always offer its advertisements for free and fully cover the market, though it offers only one type. The platform will offer only small ads if $r < \rho \equiv \frac{s_2\alpha+R\beta}{ss_2\alpha+R\beta}$; only large ads if $r \geq \rho$.*

Note that if the Ramsey planner cares only about readers ($\alpha = 0$), then $\rho_4 = 1$. If he cares only about advertisers ($\beta = 0$), then $\rho_4 = \frac{1}{s}$. If $r < 1$ or $r > \frac{1}{s}$, then there is no conflicting interest between readers and advertisers: the optimal solution is the same. But if $1 < r < \frac{1}{s}$, then the Ramsey planner has to disappoint either the readers or the advertisers. This can be seen in figure 5.

If a Ramsey planner can choose the size endogenously (see section 3.3, then he chooses $s = 0$ if $r > \rho \equiv \frac{s_2\alpha + R\beta}{ss_2\alpha + R\beta}$ and $s = 1$ otherwise. In other words, $s = 0$ is implemented if $q_2 = 1$, $s = 1$ if $q_1 = 1$.

3.6 Competition

Probably the most investigated issue in industrial economics is the structure of a market. We assumed that the market is a monopoly, i.e. there is a single platform. Though, we can use our framework to examine what happens if two or more platforms enter the market.

Suppose that users singlehome, i.e. they use at most one platform to perform their searches. Competition will maximize the utility of the users. Therefore, platforms will offer only one ad type and give it away for free. If there exist an infinitesimally small entry cost, then the incumbent monopoly stays a monopoly but it makes no profits anymore[9].

Proposition 3.9 *If users singlehome and an infinitesimally small entry cost exist, then the incumbent monopolist becomes a contested monopolist. He will only offer the advertisement type that readers like most and will provide it for free.*

This proposition is partly driven by the fact that users are homogenous (except for their opportunity cost). Therefore, they all choose the platform with the largest gross utility. This result can be altered if heterogeneous users are introduced.

Note that competition causes the contested monopolist to implement solutions that are similar to the welfare solutions.

Corollary 3.10 *If the monopoly is contested, then it implements the optimal quantities that prevail under welfare optimizations. Though, this does not hold if* $1 < r < \frac{s_2\alpha + R\beta}{ss_2\alpha + R\beta}$. *In this case, it offers the optimal welfare solution for readers only, but not for total welfare.*

This corollary can easily be deducted from figure 5. We assumed that readers singlehome, competition is focused on this side of the market. Since readers pay no price, the only option is to maximize welfare for them, leading the monopolist to implement always the reader welfare solution. The only conflict zone of reader welfare and total welfare is when $1 < r < \frac{s_2\alpha + R\beta}{ss_2\alpha + R\beta}$. Again, this result can be altered too, e.g. when singlehoming on the advertisement side is introduced.

3.7 Further Research

In this section, we discuss some future avenues that might improve the model we introduced above. We also suggest another example that can be applied to our framework.

[9]If there is no entry cost, results depend on how users decide using a certain platform or not when utility is exactly the same. If the market is split evenly among the platforms, there will be several platforms that all offer exactly the same directory.

Costs If a firm produces two goods with different quality, it is common to assume that production costs will be different. Normally, it will be costlier to produce the high quality product. Therefore, costs can be one of the drivers too of the platform decision to offer one or two types, and in which quantities. We exclude costs by setting them equal to zero for two reasons. First, we want to know the platform decision on quantities in a market with readers with double preferences and advertisers who self select their type. Introducing costs would add little value to the model; on the contrary, it would make it more difficult to disentangle the reader and advertiser effects. Second, introducing costs complicates the mathematical computation and would make the model intractable. It is possible to solve this model numerically, though this would probably not add novel insights.

Congestion The visibility of ads remains unchanged if the number of ads increases. This means that there is no congestion effect or push away effect of other advertisers. It is unlikely that this holds in reality. We would expect that the chance of a look is reduced by an increase in advertisements. This extension captures a negative own side effect.

The two-sided market literature towards congestion, or own-side effects, is mixed. Some articles ignore congestion while others put it at the heart of their exposition. Church & Gandal (1992) argue that software providers weigh the network effect (cross-group externality) with the competition effect of more agents on your side of the market, generating a lower chance of being seen or chosen. The same question pops up in the empirical paper of Tucker & Zhang (2008): should platforms announce the number of sellers or not? On the one hand, a high number of sellers signals that there are also a high number of buyers (cross-group externality). On the other hand, it signals harsher competition for these buyers (congestion or own-side effect). Rochet & Tirole (2003), on the contrary, assume that both sides of the market always interact once, irrespective the number of agents on each side. This means that a potential congestion effect is absent.

Theoretically such a congestion effect can easily be operationalized in our model by making the look functions L_1 and L_2 dependent on the quantities. The problem is similar to adding costs: by adding two or four additional parameters the model becomes intractable.

Other Applications Another interesting avenue for further research is applying this framework to other markets. These markets should have the following in common. There should be two distinctly different demand sides that value each other's presence. One side can access the platform under different forms and it is important that they can self-select their type. The other side values one type over another in the direct comparison, but potentially values them differently on their contribution to the platform.

One example is a shopping street. Consider a shopping street as a platform that connects buyers with shopkeepers. Assume now that shops are differentiated by their show windows. Shops with large windows are more interesting to shopkeepers because they have a larger chance to be visited. It is a priori unclear whether buyers prefer small or large windows. Buyers can have a double preference for the size of the show windows. On the one hand, a shop with a large show window is more attractive than a shop with a small window (comparison effect). On the other hand, if a buyer considers the entirety of shops, i.e. the shopping street, the large show windows might be relatively annoying because they reduce the overview and make the shopping street considerably longer (composition effect). Similar to the Yellow Pages example, the equilibrium number of shops with large and small show windows can be described by parameters r and s, at least if there is one platform that controls all the shops in a certain area[10].

Another example might be a dating event. Suppose that men and women are looking for a partner. Women are not charged. Men are charged but they can choose out of two types: they can appear at the event in suit or casual wear. If they compare them directly, women prefer men in suits over casually dressed men. But when they consider to go to the dating event or not, they might prefer an event with more casual men, because it means that they don't have to dress formally themselves. Again, the potential difference between direct comparison and contribution to the entirety of the platform might drive the decision of the platform to differentiate or not.

Other examples might include media markets and online selling platforms.

4 An Empirical Investigation into the Yellow Pages Industry

Since our results crucially depend on the relation between the comparison and composition preference (r and s), it is interesting to measure them in an industry that fits our model. Therefore, we measure r and reconcile our findings with our theoretical model.

First, we describe the main characteristics of the industry and the data. Then we discuss the identification of the two sides of the market and we present the results. We conclude with a comparison of our empirical and theoretical results.

4.1 Industry Characteristics

When a printer in Cheyenne, Wyoming, United States, ran out of white paper, yellow paper was used instead (Kane, Anzovin & Podell 2006). Invented by accident in 1883, Yellow Pages became a universal expression for telephone directories. Yellow Pages are still big business today. The total Yellow Pages revenues worldwide are estimated at 30.9 billion US dollar in 2008 (Kelsey 2009). Yellow Pages attract 5.2 % of the global advertising market and employ 82300 people, nearly half of them are sales representatives.

Print media are in turmoil everywhere in the world, and also the print Yellow Pages do not escape the crisis. Yellow Pages companies hold out relatively well, with revenues declining only 2.3% vis-à-vis 2007, but share prices nosedived at the end of the first decennium of the third millennium. If we compare the shares of the beginning of 2010 with the beginning of 2005, Seat (Italy) lost 99.7% of its price. Yell (UK) lost 91% and Pages Jaunes (France) 56%.

The reason for this decline, besides worldwide financial problems, is clear cut: the internet. In 2008, Yellow Pages companies got 85% of their revenues from their print division and 15% from online outlets. It is likely that the print edition will vanish, though the decline is slowed by two facts[11]. First, Yellow Pages are still seen as more reliable and

[10] While this is not so likely in an older city, it might be true in a shopping mall or newly developed area. For the implications of monopoly versus dispersed ownership of shops, see Nocke, Peitz & Stahl (2007)

[11] The Economist, *Dial I for internet*, May 22nd 2008

extensive than online search engines. Second, firms are loyal to Yellow Pages, helped by an extensive sales force.

While the online market is characterized by many players, most European markets for print Yellow Pages are monopolistic. In Europe, 70% of the countries has only one player in print[12]. Some countries have two publishers. These countries include the bigger countries (UK, Spain), Scandinavian countries (Sweden, Denmark, Finland) and alpine countries (Austria, Switzerland). A notable exception is Germany which has more than twenty active companies. We can expect further consolidation as was recently the case in the Netherlands (merger approved in 2008)[13].

All Yellow Pages worldwide have the same appeal. Yellow Pages classify every business in different categories according to the goods or services it sells, such as plumbers, lawyers and swimming pool builders. Within each category, there are three main types of advertisements. The largest group is the free listings, which contains the basic information such as address and telephone number. The second largest group is the in column advertisements: small ads that fit into a directory column and add company details such as a url, opening hours or brand logo. The third type is the large ads. These advertisements span more than one column and contain besides additional information also persuasive content such as pictures and slogans.

Below, we describe the data, discuss the relevance of the advertisement types and present the results of our empirical study on Yellow Pages.

4.2 Data

To test the mutual effect of usage and advertisements in Yellow Pages, the first thing we need are data on usage and ads. Data on usage and advertisements are rare, even for those who advertise. Therefore, we contacted several companies to collect data.

We received book level data on advertising, i.e. quantities, list prices and real prices. The latter is important because it is common practice to give a discount off the price. This creates a gap between list prices and real prices. Since advertisers decide on real prices and not on list prices, we use real prices in our model.

Considering usage, we have book level data on distribution, but surveys on book usage are only available at the country level. To approximate the number of users, we multiply the percentage of people frequently using the book with the circulation in a certain area. Because the lack of detailed usage data, we carry out our analysis on country level and not on book level.

We also have data on country characteristics which are used as control variables. These data are obtained from international sources, such as IMF, OECD and Eurostat.

The sample includes 5 European countries. Those countries are relatively homogenous in population and market structure. It is dominated by countries with a single market player. In two countries, there is some competition, e.g. from local city directories, but we

[12]Data collected from the EADP website (EADP.org). EADP is the European Association of Directory and Database Publishers and coordinates most European Directory Publishers. We counted for each country the number of publishers in the category Telecommunication Directories that publish print directories. For most countries, the market structure is not monopolistic if one considers the market for internet Yellow Pages.

[13]NMa Decision 6246, case European Directories – Truvo Nederland

Table 1: Variables: summary statistics

Variable	**Mean**	**Std.**
Quantity Persuasive Ad	20937	10955
Quantity Informational Ad	96805	67842
Quantity Free Ad	657706	694509
Price Persuasive Ad	1622	1092
Price Informational Ad	310	199
Usage Penetration	0.40	0.12
Internet Penetration	0.29	0.17
Circulation	5807407	2423109
Population Density	213	137
Inflation (Index=100 in 2000)	101	8
Education	0.61	0.20
Income per Capita	26038	5511

treat those countries as monopolies too. The earliest data point is 1995, the latest 2006. Since the data is compiled from different sources, we often lack data for the complete time span; i.e. the data set is an unbalanced panel. The statistics of the variables are summarized in table 1.

4.3 Identification

Reader Side Most users pick up the Yellow Pages to find a particular company or a particular good or service. If the directory is used to find a company which is already known to the user, then this is labeled as known search. If the directory is used to find new suppliers, then this is unknown search. The distinction between both types of look-ups can have a substantial impact on usage.

At one extreme, one might argue that the users only value "raw" information: the name and phone number of each supplier, be it classified by the category of the good or service that is supplied. In such a setting, it even might be the case that the users would pay for receiving a well classified directory that alphabetically lists all the suppliers in a certain category. This would be the case when each consumer is in a satisfactory or even optimal relationship with a certain supplier. The directory then is an ideal instrument for retrieving the coordinates of the particular supplier a consumer wants to patronize. But it merely serves the "administrative" purpose of an organized inventory of one's business contacts. Large colored ads floating around then could disturb the user that is only interested in finding the coordinates of his trusted supplier. Hence these large ads might reduce the attractiveness of the directory.

At the other extreme, the large flashy ads in the directory serve to persuade consumers that have no relationship with a supplier yet, or look for change. These ads aim at the starting of a relationship with the particular supplier that uses the directory for this purpose. In this setting, larger and flashy ads may convey information that this type of user is keen for. It could separate the good suppliers from the bad in a signaling environment: the most efficient suppliers who have substantial turnover can pay for the larger ads, while the less efficient or inexperienced suppliers can not. The "nuisance" then comes from the small entries that merely provide for contact data. Since they signal no quality, they are not looked at and hence redundant. They could be dismissed entirely by the phone directory provider, wouldn't it be for the obligation that he needs to list the phone numbers of all businesses in the area in the directory, for compliance with regulations.

In the case of the first extreme, people only use the directory as an index: only the company name and number suffices. In the other extreme, people use the directory to find out the reputation of a company: only persuasive ads count. But perhaps there is also a category in between: informative ads. Users do not search only for the telephone number, but also for more information about a company, i.e. fax number, e-mail or web address, opening hours or mobile number. Besides, it can also be interesting to have additional information about the activities of the company. If you are looking for a replacement of your central heating, you look in the category central heating but from a simple list of companies and telephone numbers, you can not find out whether a supplier is specialized in gas heaters or oil-fired central heating. An informative ad can provide you more information.

We can model Yellow Pages as a usage generating market. By choosing the right amounts of quantities, a platform manages to create look-ups for the advertisers. One potential production function is a Cobb-Douglas function.

$$U = BQ_0^{\beta_0} Q_1^{\beta_1} Q_2^{\beta_2} \prod_i control_i^{\beta_i} \tag{10}$$

If we take logs, then we obtain:

$$\ln(U) = \beta + \beta_0 \ln Q_0 + \beta_1 \ln Q_1 + \beta_2 \ln Q_2 + \sum \beta_i \ln control_i \tag{11}$$

We will estimate this equation in 4.4.

Usage is captured by the percentage of people answering yes on the survey question "Have you used the printed Yellow Pages last month?". These are considered regularly users of the directory. To count the number of persuasive ads, we add up the larger advertisements with logo or graphic. The informational ads are smaller ads that still fit into one column. These ads are in the within category alphabetical list of companies. Large persuasive ads are always accompanied by a regular entry in the alphabetical list, with a reference to the ad (e.g. see also advertisement on previous page). We don't have data on the free listings, i.e. what companies get if they don't advertise, but we can approach them by subtracting the total number of ads of the total number of companies in a country.

Advertiser Side Rysman (2004) treats ads as a homogeneous service and explains the amount or volume of advertising chosen by an individual business, but not the type. Equilibrium is reached when two offsetting network effects keep each other in balance. On the one hand, more advertising leads to increased usage of the directory, i.e. users like ads in Yellow Pages unlike what seems to be the case in other media. And since advertisers like eyeballs, they buy more advertising as usage increases. This is the positive feedback loop that links the two sides of the market. A countervailing force exists because of the negative network effect of congestion that takes place when too much advertising crowds a category: an overwhelming number of large ads for plumbers running over several pages of a directory is not likely the medium that still another plumber will choose to list his services in. The two effects taken together lead to directories in which not every business decides to buy ad space.

As noticed above however, the type of ad that is requested by advertisers can be quite different and hence this can result in a different impact regarding the network effects just mentioned. Large ads may attract more potential possible customers, but are perhaps annoying for users. At the same time they trigger the possibility that another business' ad becomes unnoticed or that trade is diverted rather than created.

The small ads on the other hand probably convince fewer potential clients. But because they contain additional information in a condensed and surveyable way, they probably contribute more to the usage of the directory. By this, they might inflict a positive externality on the other advertisers of the directory. At the same time they might steal less business from the larger ads. In this respect, they might be complementary to larger ads, and the directory that has one large and two small ads might be a better product than the directory of the same size that is composed of two large ads.

It is not hard to understand that the providers of directories will take these differences into account. The result will be inter alia a different pricing strategy for each type of ad. These pricing strategies will take into account that the contribution to usage of each type of ad is different and the effect of the ad on reaching potential customers. The congestion effect might be circumvented to some extent by including different types of ads that do not compete for the attention of the user. This leads to the claim that the different types of ads might be heterogeneous services.

Large and small ads in a sense could be independent products in that they talk to a different type of user, namely one that seeks more in depth information outside the Yellow Pages. For this user, the directory only initiates his search, as opposed to a user who wants all information in the Yellow Pages and who typically browses large ads. To the extent that a further in depth search is carried out over the Internet, the latter will be a complement to the small ad that refers further to the net, but a substitute to the large ads.

Following Rysman (2004), we model the advertising site as a Cobb-Douglas function. Similar to the usage production function, it contains the major ad type and control variables. Besides, the price also depends on the number of users U.

$$p_j = AQ_0^{\alpha_0}Q_1^{\alpha_1}Q_2^{\alpha_2}U^{\alpha_3}\prod_i control_i^{\alpha_i} \tag{12}$$

If we take logs, then we obtain:

$$\ln p_j = \alpha + \alpha_0 \ln Q_0 + \alpha_1 \ln Q_1 + \alpha_2 \ln Q_2 + \alpha_3 \ln U + \sum \alpha_i \ln control_i \tag{13}$$

We will estimate this equation in 4.4.

In this price equation, the quantities are the same as in the usage equation. As explained above we prefer real prices above rate card prices. For usage, i.e. the number of consumers, we have no direct data. Therefore, we approach this number by multiplying the percentage of people regularly using the directory with the circulation. This may lead to an underestimation of the number of users, because directories are distributed to families which consist usually of more than one person. Robustness check show though that multiplying this usage figure with average family size does not alter the results below.

Table 2: Results of 3SLS regression

	Usage	Price Inco	Price Disp
Quantity Index Ad	0.391	-0.003	0.227
	(3.86)***	-0.07	(5.23)***
Quantity Informational Ad	2.166	-0.764	2.138
	(2.72)***	(2.47)**	(7.06)***
Quantity Persuasive Ad	0.03	-0.141	-1.288
	-0.04	-0.62	(5.56)***
Internet	0.087	0.368	-0.021
	-0.21	(2.82)***	-0.16
Income per Capita	-0.805	0.364	-0.34
	-0.98	-1.29	-1.19
Population Density	8.457		
	(1.85)*		
Usage		0.196	-0.089
		(1.91)*	-0.87
CPI		-0.004	0.026
		-0.74	(4.53)***
Constant	-51.764	9.184	-5.779
	(2.29)**	(2.93)***	(1.83)*
Observations	24	24	24
R-squared			

Absolute value of z statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

4.4 Results

Reader side Do users value a directory as an index, an information device or a reputation device? In this section we test this question and present the results.

Because we work with an unbalanced panel, consisting of 5 different countries, we use a least squares estimator with fixed effects. These estimation technique allows to control possible characteristics of particular countries - even without measuring them, as long as those characteristics do not change over time.

The number of observations is quite limited, though our results appear to be quite robust to other specifications of the model (see Appendix). We apply the three stage least squares methodology on these equations, which allows us to estimate a system of equations. We do not apply instrumental variables estimators though there is a danger for endogeneity in the specification. Rysman (2004) proposed instrumental variables in his study on the Yellow Pages in the United States. In the usage equation, the advertisement level is instrumented by the number of people covered by a directory. In the advertisement equation, he instruments usage by the people that recently moved. For advertisements he uses the earnings level in a county, because this approximates the hourly wage and can be seen as a cost shifter. We do not apply these instruments because we have only a limited number of observations and we do not have the necessary data to instrument.

As can be seen from table 3, the coefficients of the quantities of the informational advertisements and the free listings are significantly differing from zero. The coefficient of informational ads is quite large: increasing the number of informational ads with 1 percent increases the number of users with 2 percent. Large persuasive ads seem to have no effect on usage.

These results indicate that readers value most the information in the book, but raw information (=only name and telephone number) is also appreciated. Large persuasive advertisements are considered as annoying and do not affect usage. While large advertisements can be interesting for advertisers because they attract a lot of eyeballs, users are not interested in the additional (persuasive) elements of them.

Advertiser side In the same table 3, the results for the price equation are given. Since price, quantity and usage are given in logs, we can easily interpret the coefficients. As expected, both ad categories have a negative and significant own elasticity.

Higher usage increases the willingness to pay in the informative ads category, though it is not significantly different from zero in the persuasive ad category. The same phenomenon pops up if we consider the cross term (quantity of other advertising category). In the persuasive ads price equation, the quantity of informational ads has a positive and significant effect on the price. This means that more informational ads increase the willingness to pay of an persuasive ad. The amount of persuasive ads has no effect on the price of informational ads. The quantity of free ads affects the price of persuasive ads positively.

The fact that internet penetration has a significantly positive effect on the price of informational ads, might be related to the fact that the internet is not a substitute, but a complement for additional information, e.g. it would be of no use to add a mail and website address if no users had internet access. As explained below, internet might rather be a substitute for large persuasive ads, because it serves the same needs: in depth search for a product or service.

Reconciling the empirical and the theoretical results With our empirical results in mind, it is interesting to look back at our theoretical model. The most interesting application of these results comes from the usage equation. If we add a third advertisement category to our theoretical model, say q_0 (which is associated with $s_0 < s_1$, then our results give estimations for r_0, r_1 and r_2. Our point estimates for these parameters are 0.39, 2.16 and 0.03 respectively. If we ignore r_0 for a moment, the estimates of r_1 and r_2 can be merged to a r estimate. Since $r = \frac{r_1}{r_2}$, $r = 72$. One can wonder, if the liking difference is really that large, why q_2 is still in the directory. The answer can be seen in figure 1. With a high r, the result depends on the value of s. If s is smaller than 0.25, then q_1 is offered for free; if s is larger than 0.752, then only q_1 is offered. Between 0.25 and 0.75 both quantities are offered and a positive price occurs in the market.

Even if no one likes the large advertisers, Yellow Pages will still offer them as long as the difference in views is large enough. If our models extends to three categories, then if the listing is small enough, then it will be offered for free and the whole market is covered. If the large advertisement is substantially larger than the small advertisement, then all three advertisements will be offered. In most directories, the free listing is only one line, which fits with our prediction that, if platforms can choose the size difference, they will make it as large as possible.

We don't have size information for all observations, though rough estimations show that the size of the average small advertisement is between 0.04 and 0.11 of size of the average large advertisement. This is relatively small but still a lot larger than the listing. The average listing is between 0.002 and 0.006 of the size of a large advertisement. With the assumptions of our model, this size difference would lead to a solution where all advertisers are included and the smallest advertisement is given away for free. Our model does not incorporate the possibility of a third advertisement type, which probably explains why small advertisements are paid in reality.

It is much harder to reconcile the advertisement estimation with our theoretical model. The reason is that we have not modeled the potential congestion effect in the directory. We have assumed that the number of rival advertisements have no influence on the visibility of the advertisement, or $\frac{ds_1}{dq_1} = \frac{ds_2}{dq_1} = \frac{ds_1}{dq_2} = \frac{ds_2}{dq_2} = 0$. Though, what we do model is the self-selection effect. Therefore, an increase in the amount of small advertisement should not only decrease the price the small ads, but also of the large ads. We do find the negative effect of an increased quantity on the own price, but we do not find an effect on the cross price. A shift in large ads has no effect on small ads, while small ads have a *positive* effect on large ads. Our theoretical model falls short in explaining this sign.

5 Conclusion

Yellow Pages readers do like small advertisements, but place no value at large advertisements. That is what we find in our case study on Yellow Pages in five European countries. It might seem puzzling why 18% of the firms in our sample buy a large ad.

One of the reasons might be the one described in our theoretical model: the discrepancy between what readers value when they compare ad types and when they look at the entirety of the platform. If readers like large ads more than they look at it, then the platform will choose to offer only large ads to advertisers. If the reverse holds, then small and large ads will be offered except when the size difference between small and large ads is small. If the difference is large, then every potential advertiser is included in the directory and the small ads are offered for free.

If platforms can choose the size difference, then they maximize it and implement the solution with full coverage in the market. This resembles to reality where every firm is included for free with a mentioning as small as possible; firms that want to attract more readers have to pay for more space. If the platform has no profit motives but wants to maximize welfare, then the platform implements a corner solution: every firm gets a small ad, or every firm gets a large ad; depending on the ratio of the parameters. Moreover, we find a cross-subsidization from large ads to small ads: the price per view is higher for large advertisers.

Future research might generalize our model by allowing for prices and costs on both sides and own side externalities (congestion effect). It might also address competition between platforms. Further it would be interesting to apply this model and test the results in other markets than Yellow Pages, such as advertisement-related industries in general, shopping malls, job agencies and auction platforms.

Appendix

Proof of Proposition 2.1 If we solve equation 7 with respect to the constraints $q_1, q_2 \geq 0$ and $q_1 + q_2 \leq 1$, we find four optimal solutions:

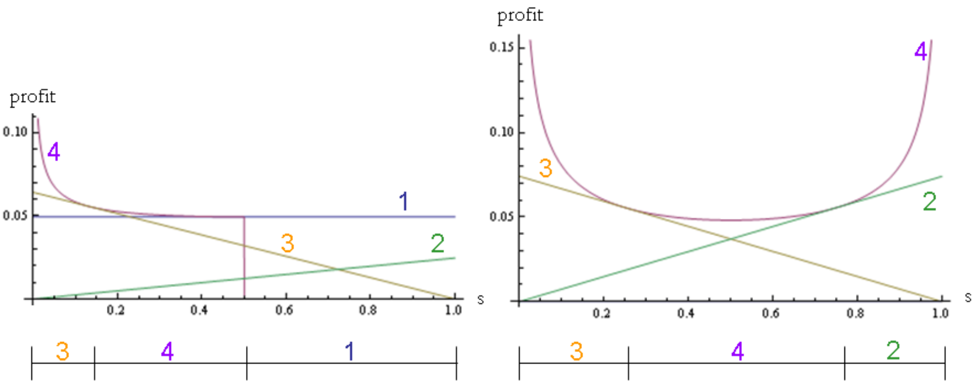

Figure 6: Platform profit. Left panel: r=0.5, right panel: r=1000

	q_1^*	q_2^*
solution 1	0	$\frac{2}{3}$
solution 2	$\frac{2}{3}$	0
solution 3	$\frac{2-r-\sqrt{1-r+r^2}}{3(1-r)}$	$\frac{1-2r+\sqrt{1-r+r^2}}{3(1-r)}$
solution 4	$\frac{r(s-1)s+s^2-s^3+\sqrt{\diamondsuit}}{6(1-s)s(r^2+s-2rs)}$	$\frac{3r^3(s-1)-8r^2(s-1)s+2s^2-2s^3-\sqrt{\diamondsuit}+r(5s^3-3s^2-2s+\sqrt{\diamondsuit})}{6(s-r)(1-s)s(r^2+s-2rs)}$

where $\diamondsuit = (r-s)^2(s-1)s(-3r^2+6rs+s^2-4s)$. As can be seen in figure 6, solution 4, the differentiated optimum, will always be profit maximizing. Though, this solution is not always feasible. Since we have solved this model with Karush-Kuhn-Tucker conditions, we should check whether and when these conditions hold.

The only non-zero Lagrange operator related to the constraint $q_1+q_2 \leq 1$, prevails in solution 3. Therefore, if the Lagrange operator, which is equal to $\frac{R(r^3(1-4s)-3(1+\sqrt{1-r+r^2})s+r^2(-4+\sqrt{1-r+r^2}+(7-4\sqrt{1-r+r^2})s)+r(1+\sqrt{1-r+r^2}+(2+5\sqrt{1-r+r^2})s))s2}{9(-1+r)^2(1+r)}$, is positive, then solution 3 should be implemented and q_1+q_2 will be equal to 1. The corresponding price p_1 is equal to 0, i.e. small advertisers don't pay to be included.

The condition $q_1 \geq 0$ is violated if $r \leq s$, in this case solution 1 will be implemented where $q_1 = 0$. The other non-negativity condition $q_2 \geq 0$ is violated if $r > \frac{s}{4s-3}$, in this case solution 2 will be implemented where $q_2 = 0$.

Proof of Proposition 2.3 To trace back the effects of R, s_2, r and s, we perform a comparative statics analysis on the equilibrium quantities of the different solutions and on the profits under the different solutions.

First, we find that the derivatives under all solutions of quantity with respect to R and s_2 are zero: $\frac{dq_1}{dR} = \frac{dq_2}{dR} = \frac{dq_1}{ds_2} = \frac{dq_2}{ds_2} = 0$. If we derive the equilibrium profits Π^i (with index i for the solution) towards R and s_2, we obtain:

$$
\begin{aligned}
\frac{d\Pi^1}{dR} = \frac{d\Pi^1}{ds_2} &= \frac{4\alpha}{27(1+r)} \\
\frac{d\Pi^2}{dR} = \frac{d\Pi^2}{ds_2} &= \frac{4r\alpha s}{27(1+r)} \\
\frac{d\Pi^3}{dR} = \frac{d\Pi^3}{ds_2} &= \frac{\left(1-2r+\sqrt{1-r+r^2}\right)\left(-1+2r^2-\sqrt{1-r+r^2}+2r\left(-1+\sqrt{1-r+r^2}\right)\right)\alpha(-1+s)}{27(-1+r)^2(1+r)} \\
\frac{d\Pi^4}{dR} = \frac{d\Pi^4}{ds_2} &= -\frac{\alpha(-9r^3(-1+s)s+3r^2(-9s^2+9s^3+\sqrt{(r-s)^2(-1+s)s(-3r^2+6rs+(-4+s)s)})}{108(1+r)(r-s)(-1+s)s(r^2+s-2rs)} \\
&\quad -\frac{rs(-8s-11s^2+19s^3+6\sqrt{(r-s)^2(-1+s)s(-3r^2+6rs+(-4+s)s)})}{108(1+r)(r-s)(-1+s)s(r^2+s-2rs)+} \\
&\quad \frac{s(-8s^2+7s^3+s^4+4\sqrt{(r-s)^2(-1+s)s(-3r^2+6rs+(-4+s)s)}-s\sqrt{(r-s)^2(-1+s)s(-3r^2+6rs+(-4+s)s)}))}{108(1+r)(r-s)(-1+s)s(r^2+s-2rs)}
\end{aligned}
$$

with $\alpha = s_2$ in the case of $\frac{d\Pi}{dR}$ and $\alpha = R$ in the case of $\frac{d\Pi}{ds_2}$. If $r \geq 0$, $R > 0$, $s_2 > 0$ and $0 \leq s < 1$, then these derivatives are unambiguously positive. An increase in R or s_2 always increases profit.

Second, if we derive the optimal quantities to r, we obtain:

$$
\begin{aligned}
\frac{dq_1^1}{dr} &= 0 \\
\frac{dq_1^2}{dr} &= 0 \\
\frac{dq_1^3}{dr} &= \frac{-1-r+2\sqrt{1-r+r^2}}{6(-1+r)^2\sqrt{1-r+r^2}} \\
\frac{dq_1^4}{dr} &= \frac{(r-s)\left(r(-1+s)s+s^2-s^3+\sqrt{(r-s)^2(-1+s)s\left(-3r^2+6rs+(-4+s)s\right)}\right)}{3(-1+s)s\left(r^2+s-2rs\right)^2} \\
&= -\frac{-6r^3+18r^2s+4s^2+2s^3-2rs(2+7s)+\sqrt{(r-s)^2(-1+s)s\left(-3r^2+6rs+(-4+s)s\right)}}{6\left(r^2+s-2rs\right)\sqrt{-(r-s)^2(-1+s)s\left(3r^2-6rs-(-4+s)s\right)}}
\end{aligned}
$$

Results for $\frac{dq_2}{dr}$ are similar, and, as can be expected in the full coverage case, $\frac{dq_2^3}{dr}$ is exactly of the opposite sign. With the same restrictions as above, we can show that $\frac{dq_1}{dr} > 0$ and $\frac{dq_2}{dr} < 0$ in the differentiated and full coverage case.

Third, we can derive the optimal quantities towards s. It is easy to show that $\frac{dq_1^1}{ds} = \frac{dq_1^2}{ds} = \frac{dq_1^3}{ds} = 0$. The derivative $\frac{dq_1^4}{ds}$ is somewhat more complicated; and crosses the horizontal axes once in the r-space, i.e. it can be both negative and positive, depending on the value of r.

We can summarize all the comparative statics as follows:

	$\frac{dq_1}{dr}$	$\frac{dq_1}{dR}$	$\frac{dq_1}{ds}$	$\frac{dq_1}{ds_2}$
solution 1	0	0	0	0
solution 2	0	0	0	0
solution 3	$>$	0	0	0
solution 4	$>$	0	< 0 if $r < \rho_1$ > 0 if $r > \rho_1$	0

	$\frac{dq_2}{dr}$	$\frac{dq_2}{dR}$	$\frac{dq_2}{ds}$	$\frac{dq_2}{ds_2}$
solution 1	0	0	0	0
solution 2	0	0	0	0
solution 3	$<$	0	0	0
solution 4	$<$	0	> 0 if $r < 1$ < 0 if $r > 1$	0

	$\frac{d\Pi}{dr}$	$\frac{d\Pi}{dR}$	$\frac{d\Pi}{ds}$	$\frac{d\Pi}{ds_2}$
solution 1	$<$	$>$	0	$>$
solution 2	$>$	$>$	$>$	$>$
solution 3	< 0 if $r < 1$ > 0 if $r < 1$	$>$	$<$	$>$
solution 4	< 0 if $r < \rho_2$ > 0 if $r > \rho_2$	$>$	< 0 if $r < \rho_3$ > 0 if $r > \rho_3$	$>$

where ρ_1, ρ_2 and ρ_3 are parameter values above 1 where there is a switch in the comparative statics, i.e. ρ_1 is the value of r for which $\frac{dq_1^2}{ds} = 0$ and mutatis mutandis the same holds for ρ_2 and ρ_3.

Proof of Proposition 3.1 The rationale behind this proposition is similar as proposition 2.1. It can be seen as an extension or rectification of this proposition. As in proposition 2.1, solution 4 is the unconstrained optimum of the problem. The same constraints apply: $q_1 + q_2 \leq 1$ and $q_1, q_2 \geq 0$.

In the case where $r_2 > 0$ and $r_1 < 0$, it suffices to investigate $q_1 \leq 0$ since the platform will never set $q_2 \leq 0$ or $q_1 + q_2 \leq 1$, even if that would be possible. The constraint $q_1 \leq 0$ is violated if $r \leq s$, also for values $r < 0$. Therefore, the analysis is not altered.

Things are somewhat more complicated in the case where $r_1 > 0$ and $r_2 < 0$. The constraint $q_1 \geq 0$ will never be violated since this would induce a no-usage platform. To check whether $q_1 + q_2 \leq 1$ is not violated in solution 4, we have to investigate in which range the Lagrange operator is positive. We find two r-regions where the assumptions is violated: $r \geq \frac{s-4s^2-2\sqrt{s^2(1-5s+4s^2)}}{1-4s}$ if $r > 0$ and $r \leq \frac{s-4s^2+2\sqrt{s^2(1-5s+4s^2)}}{1-4s}$ if $r < 0$. We also have to check whether $q_2 = \frac{3r^3(s-1)-8r^2(s-1)s+2s^2-2s^3-\sqrt{\diamondsuit}+r(5s^3-3s^2-2s+\sqrt{\diamondsuit})}{6(s-r)(1-s)s(r^2+s-2rs)} \geq 0$ (with $\diamondsuit = (r-s)^2(s-1)s(-3r^2+6rs+s^2-4s)$). This is violated in two r-regions: $\frac{s}{4s-3}$ in both cases ($r < 0$ and $r > 0$) and for all r-values if $r < 0$ and $\frac{3}{4} < s < 1$.

Proof of Proposition 3.2 We solve the same model as in section 2, though we alter the usage equation. Since the new usage equation can be written in a similar way as the old usage equation, we obtain qualitatively the same results. Though, solution 1, where $(q_1, q_2) = (0, \frac{2}{3})$ is no optimal solution anymore. This solution can be replaced by solution 5, $(q_1, q_2) = (0, 0)$, which prevents that q^R would drop below zero.

Since we can rewrite the old parameters r_1 and r_2 as $v - s_1$ and $v - s_2$, we can interpret the solutions in the $r-s$-space. r is equal to $\frac{v-ss_2}{v-s_2}$, i.e. r is determined by s (in the graph) and v and s_2 (which are fixed in the graph). There are two cases that should be investigated. First, if $v > s_2$, then both quantities are valued positively in the usage equation. Second, if $v < s_2$, then at least one quantity is valued negatively. If $s_1 < v < s_2$, then small advertisements generate a positive effect on usage, large advertisements generate a negative effect. If $v < s_1$, then both advertisements generate a negative effect and it is optimal for the platform to offer no advertisements at all.

In figure 7, the optimal solution choice is given for $v > s_2$ (left panel) and $v < s_2$ (right panel). The $r(s)$ corresponding with the s-values is given by the straight green line. In both cases, the relative value of v versus s_2 determines the slope. If $v > s_2$, the larger v, the flatter this line. If $v < s_2$, the larger v, the steeper this line. As can be seen in the left panel, the r determination crosses solution 3 and 4 (for v set twice as large as s_2), but if v was smaller, then it would have crossed solution 2 as well. If we know the value s, then

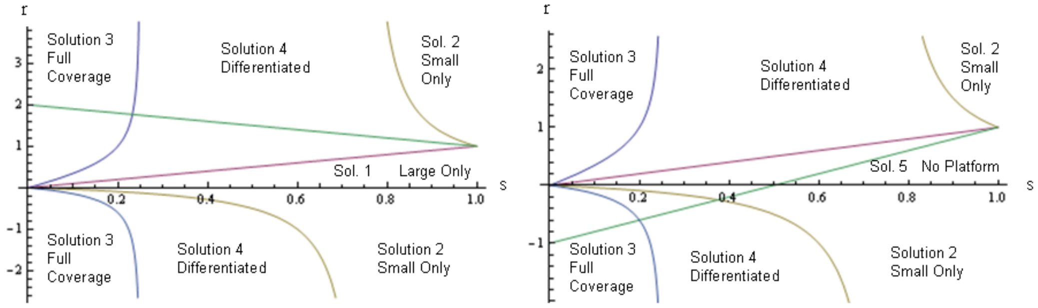

Figure 7: Different Solutions in the $r-s$-space. Left panel: if $r<0$, then $r_1<0, r_2>0$, right panel: if $r<0$, then $r_1>0, r_2<0$

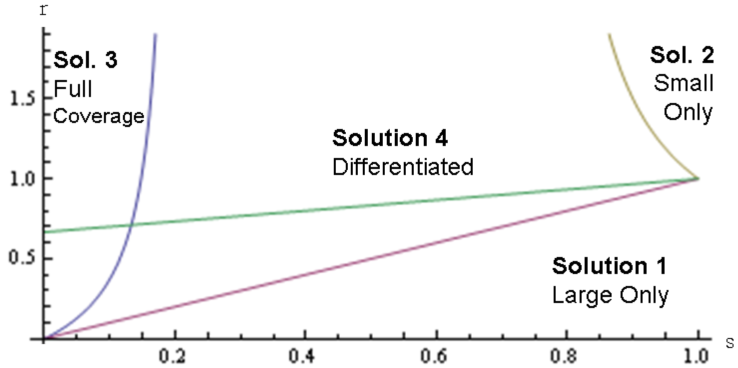

Figure 8: Different solutions in the r-s-space.

we can immediately derive from the graph which solution will prevail. The same holds for the case $v<s_2$. Note that if $r(s)>0$, this indicates that both r_1 and r_2 are smaller than zero and that no advertisements are offered in optimum. If $r(s)<0$, then the line always crosses the solution 2, 3 and 4. On the right panel, $r(s)$ is drawn for v half as large as s_2.

Proof of Proposition 3.3 In solutions 3 and 4, the optimal quantities read:

	q_1^*	q_2^*
solution 3	$\frac{(-2+s)s_2+v-\sqrt{(1-s+s^2)s_2^2-(1+s)s_2v+v^2}}{3(-1+s)s_2}$	$\frac{(-1+2s)s_2-v+\sqrt{(1-s+s^2)s_2^2-(1+s)s_2v+v^2}}{3(-1+s)s_2}$
solution 4	$\frac{s(s_2-v)v+\sqrt{sv^2(3v^2+s(4s_2^2-8s_2v+v^2))}}{6s(ss_2(s_2-2v)+v^2)}$	$\frac{ss_2(2s_2-5v)v+3v^3-s_2\sqrt{sv^2(3v^2+s(4s_2^2-8s_2v+v^2))}}{6v(ss_2(s_2-2v)+v^2)}$

If we derive these quantities to s_2, then $\frac{dq_1}{ds_2}>0$ and $\frac{dq_2}{ds_2}<0$, at least in the regions where these solutions prevail.

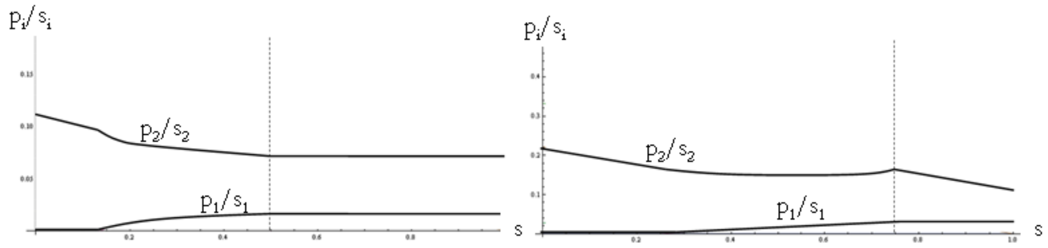

Figure 9: Price ratios. Left panel: r=0.5, right panel: r=1000

Proof of Proposition 3.4 We can draw the same graph as for proposition 3.2. The $r(s)$ corresponding with the s-values is given by the straight green line. This line always ends in point (1,1). The starting point $(0, \frac{v}{v+s_2})$ depends on the values of v and s_2 and should lie between zero and one. In graph 8, the r(s)-line is shown for $v = 2$ and $s_2 = 1$.

Proof of Proposition 3.5 To find the solution of the private monopolist who decides on quantities and size (s), we maximize equation 7 with respect these variables. We find two solutions for this problem, which are equivalent to solutions 2 and 3 of the problem in section 2.2, supplemented with a size choice of $s = 1$ in solution 2 and $s = 0$ in solution 3. Further we find that solution 3 dominates for all values of r. The only exception is $r \to \infty$; then the platform is indifferent between both solutions. In sum, one can say that $s = 0$ is optimal for all values of r. Moreover, it is the only solution if $r_2 > 0$.

Proof of Proposition 3.7 To check whether the price per view is higher for large advertisements, one simply has to check whether $\frac{p_2}{s_2} > \frac{p_1}{s_1}$, for every solution in the relevant parameter space. The ratios $\frac{p_1}{s_1}$ and $\frac{p_2}{s_2}$ are plotted in figure 9. On the left panel, $r = 0.5$, on the right panel $r = 1000$. The s-values on the left hand side of the dotted line are the relevant ones, because on the right hand side of this line only one type is offered in the market.

Proof of Proposition 3.8 We solve equation 9 with the same Karush-Kuhn-Tucker conditions as under the private monopolist, i.e. $q_1, q_2 \geq 0$ and $q_1 + q_2 \leq 1$. We obtain three groups of solutions: an unconstraint optimum, two solutions where either q_1 or q_2 is zero and two solutions where $q_1 + q_2 = 1$. We find further that only the Lagrange operator related to this last solution is always binding in the region $0 < s < 1$. Therefore, (1,0) and (0,1) are the only relevant solutions to our problem.

We obtain the critical $r = \rho \equiv \frac{s_2\alpha + R\beta}{ss_2\alpha + R\beta}$ by comparing the two welfare levels, under the first and second solution. Equivalently we can say that a Ramsey planner implements solution 1 if $s < \frac{s_2\alpha + R\beta - rR\beta}{rs_2\alpha}$ and solution 2 otherwise. The critical values for the monopolist maximizing the welfare of one side of the market only, can be found easily by setting α or β equal to zero.

Proof of Proposition 3.9 Suppose that a platform would offer a quantity combination that does not maximize reader welfare. Then another platform can offer a combination that slightly improves reader welfare and the first platform will have no users and hence no advertisers. Since there are no costs in our model, it is always feasible to offer all advertisements for free. If we introduce costs to our model, then the platform can never offer the solution where there is only one type and that type is free of charge.

Table 3: Results of 3SLS, OLS and SURE regression

	3SLS			OLS			SURE		
	Usage	**Price Inco**	**Price Disp**	**Usage**	**Price Inco**	**Price Disp**	**Usage**	**Price Inco**	**Price Disp**
Quantity Index Ad	0.391	-0.003	0.227	0.391	-0.023	0.137	0.394	-0.02	0.152
	(3.86)***	-0.07	(5.23)***	(3.25)***	-0.45	(3.02)***	(3.89)***	-0.47	(4.13)***
Quantity Informational Ad	2.166	-0.764	2.138	2.166	-0.851	1.744	2.23	-0.832	1.829
	(2.72)***	(2.47)**	(7.06)***	(2.29)**	(2.26)**	(5.29)***	(2.80)***	(2.71)***	(6.82)***
Quantity Persuasive Ad	0.03	-0.141	-1.288	0.03	-0.155	-1.352	0.006	-0.155	-1.354
	-0.04	-0.62	(5.56)***	-0.04	-0.57	(5.71)***	-0.01	-0.7	(7.01)***
Internet	0.087	0.368	-0.021	0.087	0.373	0	0.113	0.371	-0.009
	-0.21	(2.82)***	-0.16	-0.18	(2.35)**	0	-0.28	(2.87)***	-0.08
Income per Capita	-0.805	0.364	-0.34	-0.805	0.346	-0.423	-0.939	0.341	-0.446
	-0.98	-1.29	-1.19	-0.82	-1.07	-1.5	-1.14	-1.3	(1.94)*
Population Density	8.457			8.457			9.611		
	(1.85)*			-1.56			(2.11)**		
Usage		0.196	-0.089		0.253	0.17		0.247	0.141
		(1.91)*	-0.87		(3.07)***	(2.35)**		(3.66)***	(2.40)**
CPI		-0.004	0.026		-0.004	0.027		-0.004	0.028
		-0.74	(4.53)***		-0.64	(4.92)***		-0.75	(6.25)***
Constant	-51.764	9.184	-5.779	-51.764	9.905	-2.52	-56.982	9.776	-3.104
	(2.29)**	(2.93)***	(1.83)*	(1.93)*	(2.63)**	-0.76	(2.53)**	(3.18)***	-1.15
Observations	24	24	24	24	24	24	24	24	24
R-squared				0.76	0.96	0.94			

Absolute value of z statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

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