Competition and Price Discrimination in Yellow Pages Advertising *

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Abstract

This paper examines the effect of competition on second degree price discrimination in display advertising in Yellow Page directories. Recent theoretical work makes conflicting predictions about the effect of competition on curvature. Our main empirical finding is that competition increases the curvature of the price schedule, meaning that purchasers of the largest ads see their prices fall the most in response to competition. We also present evidence of menu costs in adjusting pricing schedules and address this issue in estimation. The magnitudes that we find could be relevant for welfare calculations in the face of price discrimination.

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1 Introduction

As a general rule, competition drives down prices. But how much so can be complicated when firms offer a menu of prices that vary according to the characteristics of a buyer, or according to the quality or quantity of the product that the buyer purchases. To the degree that competition affects firms' ability to price discriminate, competition is likely not only to lower the level of prices, but also to change prices within a menu relative to one another. This paper examines empirically how competition affects price discrimination in the market for Yellow Pages advertising. We test whether prices fall relatively more for larger or for smaller ads, and discuss how our results would inform welfare calculations.

We see two potentially important implications of price discrimination for determining the welfare effect of changes in competition. Determining the changes in both the distribution of surplus and in aggregate surplus depend on knowing how changes in price vary across buyer types. Welfare analysis that is based on changes in an average or representative price (as would be typically used by a merger authority) is almost certain not to account for these issues.

Measuring the effect of competition on price discrimination is particularly important because the theoretical literature that examines the link between competition and second degree price discrimination does not yield a clear prediction as to whether high- or low-valuation customers should benefit more from an increase in competition (Stole 1995, Rochet and Stole 1999). This paper consequently aims to determine empirically which customers are affected most by competition, and to see which theoretical argument seems better supported.

For several reasons, Yellow Pages advertising is well suited to examining the link between competition and price discrimination. First, in the great majority of markets, advertising prices vary nonlinearly with the size of the advertisement purchased and so represent a form of second degree price discrimination. Second, Yellow Pages advertising markets vary in competitiveness. While all markets are served by a telephone company publisher, many markets are also served by a varying number of independent publishers. Finally, publishers offer a standard range of advertisements, making products comparable across markets. Our data set consists of a cross-section of almost all Yellow Pages directories in the United States in 1997. For each directory, we observe the prices for advertisements of various sizes and colors as well as other directory-level information, including distribution area.

We find, as might be expected, that price levels are lower in more competitive markets. However, the sizes of these reductions are not uniform across buyers. Instead we find that more competition leads to the largest proportional decline in prices for the purchasers of large advertisements.

Our empirical results are consistent with the predictions of the model of Rochet and Stole

(1999). In this model, more fully described below, the highest valuation customers benefit most from competition because they are best able or most willing to seek out substitutes. Competition can be seen as giving these customers leverage or bargaining power that results in lower prices for them relative to smaller customers. On the other hand, our results are inconsistent with the model of Stole (1995) in which high valuation customers are assumed to also have the greatest brand loyalty. We also discuss other explanations for our results.

The remainder of the paper proceeds as follows. Section 2 describes recent theoretical developments that give some insight into price discrimination by oligopolists. Section 3 describes the identification strategy we use to test the effect of competition on price discrimination. Section 4 describes the Yellow Pages advertising industry. Section 5 describes the data we use. Section 6 presents our results. Section 7 presents some tests of the robustness of our approach. Section 8 concludes.

2 Theory and Related Literature

In this section, we discuss the current theoretical literature on competition and price discrimination. In particular, we are interested in how competition affects the different portions of price schedules differently. We conclude with a discussion of relevant empirical work.

For the purpose of comparison, we begin by considering second degree price discrimination, or nonlinear pricing, under monopoly.[1] In a general model, a monopolist faces consumers who vary in their valuation of marginal changes in quantity (or quality). The monopolist must choose a menu of quantities and associated prices to maximize profits subject to participation and incentive compatibility constraints. Under the well-known solution to this problem, the highest valuation customer receives the economically efficient quantity (or quality), and is charged a price that is just low enough to persuade her not to buy the next lowest available quantity. At the opposite extreme, the lowest valuation customer has her consumption distorted below the efficient level and is charged a price that extracts all of her consumer surplus (Maskin and Riley 1984, Mussa and Rosen, 1978). One important characteristic of this solution is that the highest valuation customers are the most profitable to serve.[2]

In order to incorporate competition, a model of second degree price discrimination must be substantially more complicated in two ways (Rochet and Stole, 2000). First, modeling competition requires moving from a single principal setting to a multi-principal setting. Second,

[1] See Wilson (1993) for an excellent overview.

[2] To see this, consider that the highest type customer's allocation is priced just low enough to keep her from buying the next lowest allocation. If the monopolist makes more profits off that next lowest allocation, it should no longer offer the highest allocation, letting the highest type pool with the next lower type.

it requires that buyers have two dimensions of heterogeneity. Buyers must differ in their valuations for the product, or there can be no meaningful discrimination between them, and they must vary in their tastes for consuming the products of the two sellers, or pricing will devolve into Bertrand competition. In what follows, we focus on two models that make differing predictions about how competition affects price-cost margins over the price schedule, Stole (1995) and Rochet and Stole (1999).[3]

In the model of Rochet and Stole (1999), agents vary along two uncorrelated dimensions of their utility functions. The first dimension can be thought of as the intensity of brand preference, or travel costs in a Hotelling model. The second dimension of an agent's utility, which is uncorrelated with the first, can be thought of as willingness to pay for incremental quantity, or valuation for the product category. An implication of Rochet and Stole's model is that in equilibrium, competition will cause a greater price decrease for large quantities than small quantities. The intuition for this is the following. Under monopoly, higher valuation customers receive more surplus than lower valuation customers. As a result, they would be able to expend some travel cost to buy their less preferred product, and still receive positive net surplus. Competition, therefore, will drive down the price for these customers. However, there may be only one firm that can profitably serve low valuation consumers who have moderately strong brand preferences. Because the nearby firm is essentially a monopolist over those consumers, competition does not affect their choices. Thus the model implies that there is a much larger relative effect of competition at the top of the price schedule. [4] This effect is similar to the effect that would result from assuming that larger customers have greater bargaining power than smaller customers. If the presence of a competitor makes bargaining power more effective, then competition would reduce prices more at the top of the price sequence than at the bottom.

An alternative avenue through which competition could have a similar effect on price discrimination is via the feedback loop between advertising and usage documented in Rysman (2002). To the extent that a directory with larger advertisements gets more usage (which ultimately leads to more advertising sales for that directory), publishers may have a greater incentive to sell large ads in the face of competition than they do as monopoly publishers. The effect of competition on prices would then be most pronounced for the largest ads.[5] A

[3]Some of the earliest work in this area was done concurrently by Stole (1997) and Martimort (1992, 1996). These models are general models of multi-principal contracting that are more directly applicable to regulation than to competitive price discrimination. In particular, they emphasize the difference between complementary and substitute contracting activities. While these models show that price levels decreases in competition and that the slope of the price sequences change, they do not make predictions about the relative effects of competition on price discrimination in the sense that we describe here.

[4]If firms are close enough in the Rochet and Stole model, competition leads to efficient "cost-plus" contracts, where consumers pay a fixed cost to purchase but then may purchase quantity at marginal cost. Armstrong and Vickers (1999) show the same result under a different methodology.

[5]Even if competing directories are neither complements nor substitutes from the point of view of an advertiser,

final reason for prices to fall relatively more for large ads under competition is that entering publishers may seek out the most profitable sales first, possibly because new publishers are capital constrained. Since the largest ads are the most profitable, competition would be most intense, and prices therefore most affected, for large ads.

Stole (1995) considers a similar set-up to Rochet and Stole (1999), but assumes that consumers' product category valuations are positively correlated with intensity of brand preferences (that is, the cross-partial of consumer utility with respect to valuation and brand proximity is positive). In this case, competition reduces prices at the bottom of the price schedule proportionally more than at the top. Because the highest valuation customers are also the most brand-loyal, the price reductions necessary to attract them to their less preferred brand are so large as to be unprofitable. Lower valuation customers, who are less brand loyal, can be persuaded to switch brands for smaller price reductions, and thus see their prices fall. For reasons of incentive compatibility, reduced prices for low valuation customers force principals to reduce prices for high valuation customers as well, but prices fall most dramatically for low valuation customers.[6]

Figure 1 shows stylized depictions of the different effects that the two models predict that competition could have on price. In the first picture, it is obvious that prices fall proportionally more for sizes above the midpoint than below the midpoint. Even among higher sizes, we have drawn the picture such that the higher prices fall proportionally more than for the sizes near the kink. In the second picture, the proportional price drop is constant for sizes up to the midpoint, and decreasing afterwards (because the absolute price drop is constant above the midpoint). [7]

There are a growing number of empirical examinations of second degree price discrimination. Shepard (1991) identifies price discrimination at gas stations that have both self-serve and full-serve capacity. Ivaldi and Martimort (1994) analyze price schedules for electric utilities in France. Leslie (1998) considers the welfare implications of non-linear pricing at a Broadway theater. McManus (2000), Cohen (2000a) and Clerides (2000) all consider oligopoly markets (coffee shops, paper towel manufacturers, and book publishers, respectively) and show that

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the presence of the feedback loop between advertising and usage can create a scenario where competition affects a publisher's choice of price sequence.

[6]Rochet and Stole (1999) and Stole (1995) consider the case in which a consumer can choose to contract with one principal but not both. While this restriction does not hold in Yellow Pages advertising, we expect the implications for price schedules and competition to extend to the more complicated case.

[7]The pictures are very stylized. For instance, none of the parametric examples in the theoretical papers would generate linear price schedules over any range. The kink in the second picture does reflect results in Stole (1995), which shows that an otherwise differentiable price sequence can have a kink where the effects of competition begin (or end). However, we believe that the presence of the kink is due to the assumption that consumers are restrained to choose one producer or the other. Even so, we expect the general statement about relative changes in price to carry through to the case where consumers can contract with multiple producers.

firms use product quality as a screening device.

The most similar paper to ours is Borenstein (1989), which finds some evidence that competition affects low fares more than proportionally in airline pricing (although that is not the main focus of the paper). We find the contrast between this result and our result to be explained by the theoretical work: It is believable that brand preferences are more important to high valuation customers in airline travel (as in Stole, 1995), than in Yellow Pages advertising (as in Rochet and Stole, 1999). Other similar empirical papers are Borenstein (1991) and Cohen (2000b) which also take a reduced form approach to analyze second degree price discrimination, although they do not check for differential effects of competition on the price schedule. There is also a literature on third degree price discrimination, such as Borenstein and Rose (1994), but many of the tests in those papers are not directly applicable to the case without discrimination on observable features.

3 Identification

We define price discrimination to exist when the price-cost ratio changes over the price schedule.[8] However, we do not observe the marginal cost of an advertisement. As a result, we take a difference-in-differences approach. We test two basic hypotheses. Our first test is straightforward: we test whether the price-cost ratio decreases as the number of competitors increase. Let $P_m(s)$ be the monopoly price for a given size s and $c_m(s)$ be the marginal cost to a monopolist of selling an advertisement of size s. Let $P_d(s)$ and $c_d(s)$ be similarly defined for duopoly. We want to know if:

$$\frac{P_m(s)}{c_m(s)} > \frac{P_d(s)}{c_d(s)}.$$

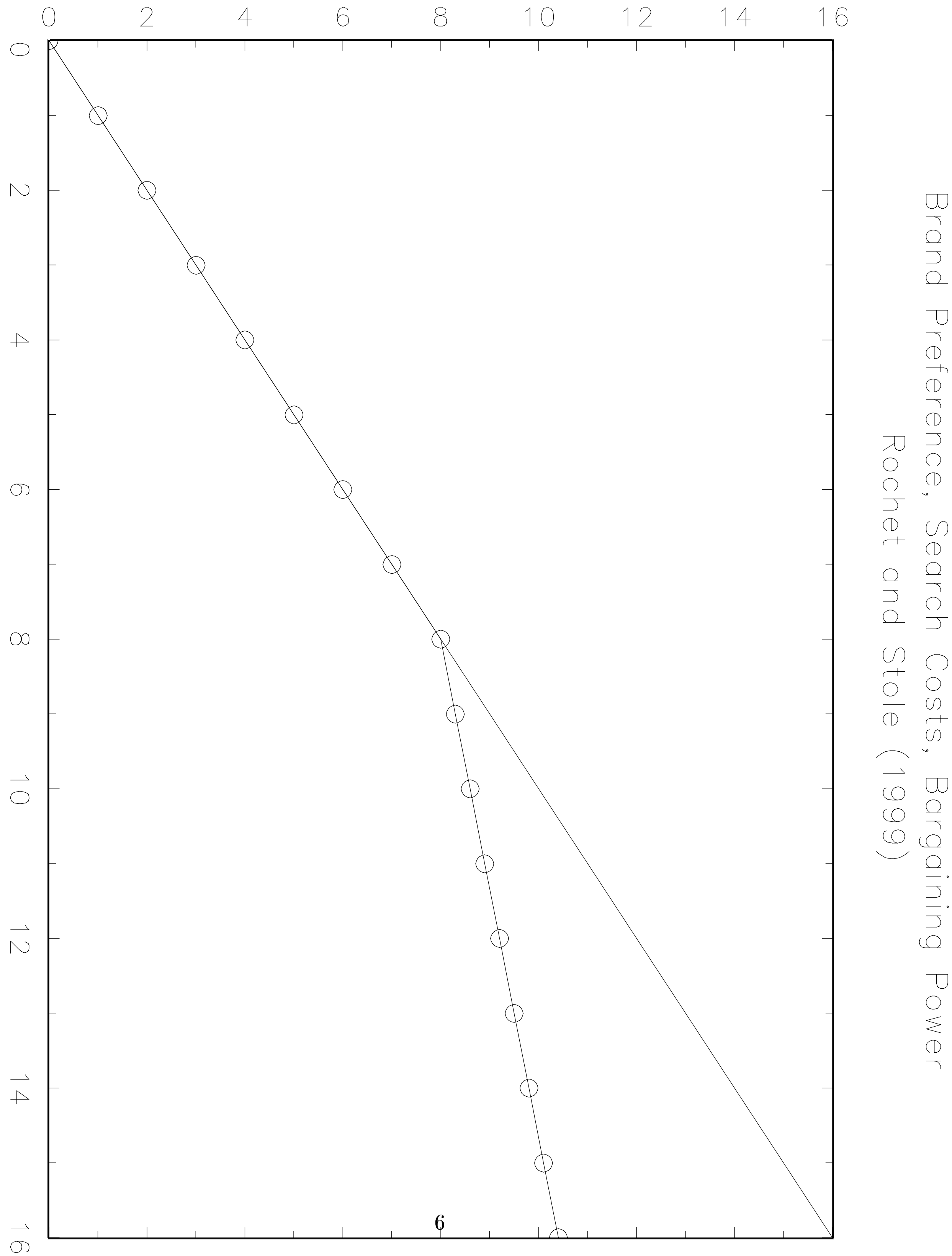
We assume that the cost of producing an ad of a given size does not change with competition: $c_m(s) = c_d(s)$. Imposing this assumption and taking the log of the above generates our first test:

$$\ln(P_m(s)) - \ln(P_d(s)) > 0 \tag{1}$$

Our second hypothesis is that the slope of the price-cost ratio changes under competition; in other words, we hypothesize that competition affects price discrimination for high and low valuation customers differently. We want to know if, for $h > l$ where h is the size of a bigger

[8] There is not a single, generally-accepted definition of price discrimination. Tirole (1988), for example, states that "it is difficult to offer an all-encompassing definition [of price discrimination]" (pg. 134). Clerides (2000) offers a helpful comparison of the price-cost ratio and the price-cost margin.

Figure 1: Competition and Price Discrimination



ad and l the size of a smaller ad:

$$\frac{\frac{P_m(h)}{c_m(h)}}{\frac{P_m(l)}{c_m(l)}} \lesseqgtr \frac{\frac{P_d(h)}{c_d(h)}}{\frac{P_d(l)}{c_d(l)}}$$

This term reduces to:

$$\frac{P_m(h)}{P_m(l)} \lesseqgtr \frac{P_d(h)}{P_d(l)} \frac{c_d(l)}{c_d(h)} \frac{c_m(h)}{c_m(l)}$$

A sufficient condition to proceed is that $c_m(s) = c_d(s)$. However, we can make the less restrictive assumption that the ratio of costs does not change with the number of competitors. That is, if competition changes the cost of all advertisements by a multiplicative constant, our test is still valid. Consequently we test:

$$\ln(P_m(h)) - \ln(P_m(l)) \lesseqgtr \ln(P_d(h)) - \ln(P_d(l)) \tag{2}$$

Implicit in this approach is the assumption that demand is such that price schedules are comparable across geographies – that is, relative demand for different sizes of advertisements is approximately constant across markets. In summary, this test determines if the slope of the price schedule changes due to competition. The above derivations relate the price schedule back to price-cost ratios, given particular assumptions on cost.

4 Industry Characteristics

The Yellow Pages industry is characterized by competition between small groups of asymmetric publishers. Most publishers publish directories yearly and distribute them for free, one to every phone line. Figures 2 and 3 show the distribution of the number of directories a person receives and the distribution of the number of publishers from which a person receives directories. Publishers can be divided into three categories: RBOC (Regional Bell Operating Company) publishers, independent telephone company publishers, and non-utility publishers (see Table 1). The largest category in terms of sales is made up of publishers affiliated with the RBOCs – one publisher for each of the seven RBOCs. These publishers represent 1,852 directories. Independent telephone companies publish the largest number of directories, 2,099. These non-RBOC telephone companies provide about 30% of telephone service in the US. They are often very small and normally contract out their Yellow Pages publishing. These contract publishers specialize in serving non-RBOC phone companies and can be quite large. For instance, Consolidated Directory Services is the 6th largest publisher in our data, publishing 285

Figure 2: Number of directories per person

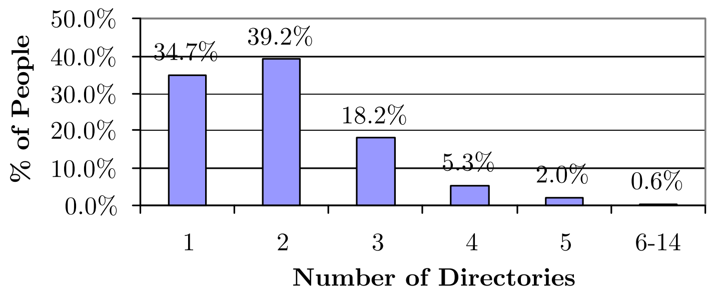
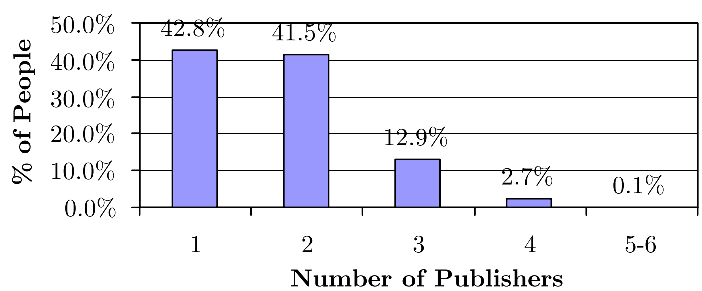


Figure 3: Number of publishers per person



directories in 38 states, all for independent telephone companies.

A telephone company, whether it is an independent or an RBOC, usually does not distribute its directory in territories already covered by another phone company, although in some cases an RBOC will cover the area of a small independent telephone company. In our data, 16% of the population is covered by 2 utility publishers, and less than 1% is covered by more than 2. Instead, the competition in this industry is driven by the non-utility publishers. These publishers purchase data on potential advertisers from telephone companies or third-party sources. [9]

Non-utility publishers mimic the utility publishers' practice of distributing one directory

[9] Telephone companies are generally willing to sell such information because independents could alternatively use the telephone companies' own directories to find potential advertisers. In 1992, the Supreme Court ruled that White Pages are not copyrightable. This outcome seems to have been widely expected, as independent Yellow Pages publishers have existed for decades.

Table 1: Directories by type of publisher

	Telephone company	Independent publisher	Total
RBOC	1852	0	1852
Non-RBOC			
- Large (10+ directories)	1821	425	2246
- Small (1-9 directories)	278	633	911
Total	3951	1058	5009

to every phone line in a distribution area. Most also match the utility publishers by bundling White Pages with Yellow Pages directories, either in the same volume or as separate volumes that are delivered together. Non-utility publishers differentiate their books from those published by utilities by choosing different distribution areas and by including different information or organizing their book in a different way. Non-utility publishers typically locate in suburban areas and distribute to larger areas than utility publishers. There are 1,058 directories from non-utility publishers in the data set. Most are relatively small, although Yellow Book Co. publishes 107 directories (all in Florida and New York) and TransWestern Publishing publishes 106 (in 10 states).

Figures 2 and 3 characterize the level of competition in the industry. The figures show that the median person is served by two directories from two separate publishers, and that more than 15% of people are served by three or more publishers. Utility directories typically dominate their markets, both charging more and selling more pages of advertising. The average price for a double quarter column advertisement at a utility directory is $1,177 while the average price at an independent is $926. Rysman (2002) reports (in a smaller data set) that telephone directories are larger in terms of page size and garner substantially more usage. Rysman (2002) ascribes this asymmetry to consumer preference for telco directories and the presence of a positive feedback loop between advertising and usage. For purposes of this paper we take the asymmetry as given and analyze the effect on prices.

5 Data

Our data are compiled from several sources. The centerpieces of the data are prices and distribution areas for directories. Prices come from the *Rate and Data* publication of the Yellow Pages Publishers Association (YPPA), an industry trade group that represents 95% of the sales in the industry. This data contains every price for every type of advertisement sold at every directory that appeared in 1997 and is a member of the YPPA. Directories sell on average 71 different types of advertisements. These vary in sizes and colors, ranging from a listing in bold letters to a full color back cover.

We focus on display advertisements without special colors. This category is the most common across directories and is closely watched in the industry. Advertisements in this category vary in size (quarter-column, double quarter-column, half page, full page, etc.), with directories offering on average 6.8 different sizes. Seventy-five percent of directories offer from 6 to 10 sizes in this category and 99% offer from 3 to 10. Additional data from the YPPA reports the number of columns in a directory. This allows us to convert the ad sizes to a per page equivalent. For example, a double quarter column in a four-column directory is equal to an eighth of a page.

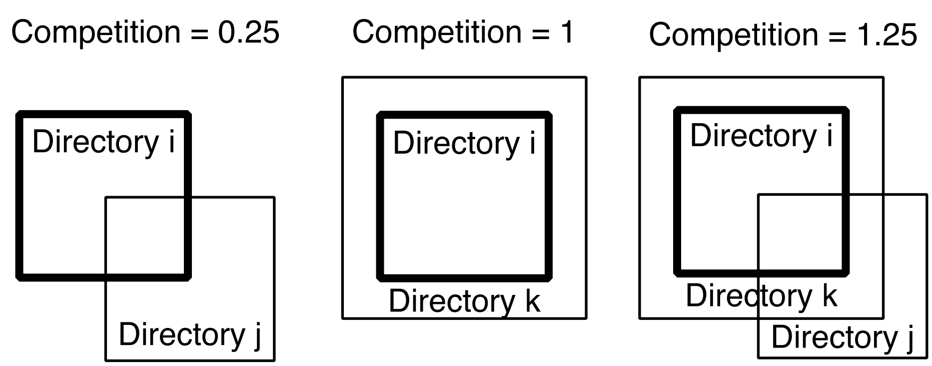
We augment these data with detailed information about directory distribution areas. Claritas Inc. collects directory distribution areas as maps that we match with 5-digit zip code centroids. Centroids are map points that represent population centers of zip codes. We assume that if a publisher distributes to a centroid, it delivers to an entire zip code. Directory distribution areas match up closely, and in some cases exactly, with zip code areas. Claritas also supplied us with population data at the 5-digit zip code level for 1997.

The distribution data allows us to construct measures of the number of competitors each directory faces, weighted by population. For a particular directory i, we calculate the effective number of competing directories as

$$\sum_{j \in J_i} \frac{n_{ij}}{N_i} \tag{3}$$

where N_i is the number of people who receive directory i, n_{ij} is the number of people who receive both directories i and j, and J_i is the set of all directories $j \neq i$ that are distributed to recipients of directory i. Figure 4 gives examples of the calculation. In each case in the figure, the competition measure is calculated for directory i, assuming that the population is uniformly distributed in the directory distribution area. This measure could equivalently be thought of as the expected number of additional directories a recipient of directory i receives.

Figure 4: Hypothetical Examples of Competition Measure



In practice, a publisher may publish multiple directories, including in overlapping markets. We therefore calculate separately the number of competing directories and the number of competing publishers. We expect that overlapping directories published by the same publisher will be associated with smaller competitive effects.

We also use county-level demographic data to account for geographic price variation. We use the geographic data from the 1995 County USA CD-ROM, compiled from census data. We use the directory distribution data to determine what portion of each directory's population lies in a given county and then construct directory-level demographic data as a population weighted average of county-level data. Industry sources suggest that people who recently move use Yellow Pages relatively more, as do educated, high-income people who own their own home. In contrast, people who live in cities or take public transportation use Yellow Pages less. To the extent that advertising prices are driven by the amount of usage, we expect these variables to predict prices. Table 2 lists the demographic variables, and gives descriptive statistics. Our data set covers 5009 directories across the entire United States.[10]

In principle, a publisher is free to set its prices individually for each directory it publishes. Presumably, if publishers could costlessly optimize they would determine price schedules independently for each directory, taking into account the competitive environment and other characteristics of the directory's market. However, the data indicate that this is not entirely the case. On the one hand, publishers *do* charge different prices in different markets. For example, among the 4738 directories that offer full page ads and that are distributed by publishers offering at least two directories, 3656 (77%) have a full page ad price that is unique within the publisher. On the other hand, publishers appear to use a single shape for price schedules in many of their markets (i.e., a single configuration of relative prices for different ad sizes). For example, Figure 5 shows pricing patterns at the first 12 directories of Bell Atlantic (ordered alphabetically) in Pennsylvania and New Jersey. The graphs compare the price-per-quarter-column for regular display advertisements to the size of the advertisement at each directory. While Bell Atlantic appears to tailor the *level* of prices to each market, it has applied a single pattern to most directories within a state. Figure 6 shows similar graphs for three small publishers.

We interpret this as evidence that publishers are constrained in tailoring price schedules to each market by what we label "menu costs." Such menu costs may arise from difficulties in creating, administering, or marketing multiple sets of price schedules. We pay particular

[10] We excluded directories for which important data were missing. There are 684 directories that appear in the pricing data, but are not found in the directory distribution data. Another 158 directories report no prices for our category of interest. In addition, there are 147 directories that appear in the directory distribution data but not the pricing data and there are 8 directories for which we do not have population data.

attention to the implication of menu costs for the interpretation of our empirical results in Section 6.3. Note that industry sources say that pricing at RBOC's is often handled at the level of the 22 Bell Operating Companies (BOC) that were aggregated into the 7 RBOC's in the break-up of AT&T. That explains why Bell Atlantic uses the same pattern within two states but different patterns across states. Therefore, when we use publisher fixed effects, we use separate identifiers for each BOC at the RBOC publishers.

6 Estimation and Results

Our results come in three parts. First, we analyze the effect of competition on price levels. Because we have strong priors on the direction of these effects, this analysis is helpful for verifying that our measure of competition captures at least some of the effect of competition on price. The second part studies the effect of competition on price curvature, and is the focus of the paper. The third part addresses menu costs in setting price curvature.

6.1 Price levels

We calculate price levels as a directory's median per page rate over all sizes offered by the directory. We regress the log of this median rate on two measures of competition, the effective number of competing publishers and the effective number of competing directories, as defined in Section 5. We also use a variety of demographic variables, described in Table 2, to control for variation in price levels across markets that is unrelated to competitive interactions.[11]

The results of this regression are reported in Table 4. The main result from the table is that increasing competition lowers the median price. The results in the first column indicate that adding the equivalent of one additional publisher covering a directory's entire market lowers the log of its median price by 0.076, which implies a 7.2% decrease in the median price itself. In column 2, the effect of additional publishers is allowed to be nonlinear, but the results are similar; the estimated coefficients imply that each increment in competition decreases the price by 7.2% to 9.4%. Similarly in column 3, adding the equivalent of a competing directory over the entire market would decrease the median price by 6.5%. Column 4 shows much the same result when the effect is allowed to be nonlinear.

In these regressions endogeneity will be a problem if prices are high in a particular area for reasons that are unobservable to the researcher and if such prices encourage entry, measured in our case as greater competition. However, this endogeneity would bias the coefficient on

[11] Our results are very similar if we use the rate of a particular size ad–for example, a full page or a double quarter column–in place of the *median* per page rate.

Table 2: Summary statistics for directory markets

Variable (5009 observations)	Mean	Std Dev	Median
Population (thousands)	107.95	212.11	47
Population growth (percentage growth 1990-1995)	5.67	6.40	4.17
Business establishments (per capita)	2.39	0.63	2.32
Income (thousands per capita)	19.12	5.11	17.84
Earnings (thousands per capita)	1.23	0.60	1.11
College graduates (percentage)	17.17	7.85	14.92
High school graduates (percentage)	73.49	9.01	74.90
Housing occupied by owner (percentage)	69.14	9.14	71.06
Lived in the same house for last five years (percentage)	49.49	8.91	50.82
Moved from different county in last five years (percentage)	9.21	4.19	8.51
Moved from different state in last five years (percentage)	8.55	4.77	7.40
Live in urban area (percentage)	55.27	28.16	54.11
Population density (hundreds per square mile)	91.02	358.41	10.42
Regular users of public transportation (percentage)	1.39	3.33	0.28

the number of competitors to be positive. Thus, if anything, the true effect is larger than what we estimate. Another reason that these estimates could be understated is measurement error. Given the heterogeneous nature of Yellow Pages publishers, the number of competing publishers or directories is an imperfect proxy for the level of competition. Seeing the negative effect of competition on price assures us that our measure is capturing some important aspect of market structure.

In addition to the competitive effect, the control variables generally have the expected sign. Directories published by utilities have the highest prices on average, about twice those of non-utility publishers (an increase in log price of 0.75 for RBOCs and 0.69 for independent utilities). Prices are higher in larger and wealthier markets, and lower in urban markets and markets in which more people use public transportation. Markets in which there are more business establishments have lower prices, although the number of business establishments may indicate urbanity. Somewhat surprisingly, the fraction of residents who have recently moved does not have a statistically significant effect on price.[12]

The fact that utility publishers have systematically higher prices than do non-utility publishers suggests that there are important differences among publisher types. One kind of difference is associated with a utility's incumbent-like position as the telephone service provider. This established recognition could lead to greater advertiser loyalty, greater user loyalty, and there-

[12]There are two sets of somewhat paradoxical results. First, markets in which more residents have been in the same house for at least 5 years tend to have higher prices, while those in which a greater percentage of housing is owner occupied tend to have lower prices. (The correlation of these two variables is 0.346.) Second, the percentage of college graduates has a negative effect on prices, while the percentage of high school graduates has a positive effect.

Table 3: Joint distribution of competition by publisher type

	PUB0=1 *No competing publishers*	PUB1=1 *Competing pub.* $\in (0,1]$	PUB2=1 *Competing pub.* $\in (1,2]$	PUB3=1 *Competing pub.* > 2	Total
RBOC	416	823	543	70	1852
Independent utility	315	803	788	193	2099
Non-utility	0	352	567	139	1058
Total	731	1978	1898	402	5009

fore a superior product offering, via the feedback loop established by Rysman (2002). This differentiated position could well lead to differences across publisher types not only in average price levels, but also in how price levels respond to changes in competition.

A second kind of difference is more mechanical. In the data, there are no non-utility publishers that are monopolists. (Table 3 shows the distribution of competition by publisher type.) Also, it is fairly uncommon for utility publishers to compete with each other. To a rough approximation, therefore, the data consist of markets in which there are monopoly utility-published directories, and markets in which there is competition between one utility-published and one or more non-utility-published directories. One might suppose that since, in the sample, what the competition measure means depends in part on the publisher type, the measured effect of competition on price could well vary across publisher types. To accommodate this, in Table 5 we re-estimate the price level regressions allowing the effect of competition to vary over different types of firms. We also include fixed publisher effects in some of the specifications to account for publisher level heterogeneity in factors that would affect price, such as design expertise or sales force skill.

Before we describe the results in Table 5 we note that the absence in the sample of any non-utility monopolies may explain in part why the estimated effect on price of being an RBOC or independent utility is so high in Table 4. These coefficients capture not only the price differences arising from substantive differences between the products offered by utilities and non-utilities, but also differences in price that arise because non-utilities are never monopolists.

Allowing the effect of competition on price levels to vary across publisher types gives results, as reported in Table 5, that differ somewhat from the pooled estimates of Table 4. In column 1, which does not control for firm fixed effects, the estimates indicate that competition affects prices for all publisher types. Specifically, the coefficients imply that for each additional competitor, prices fall by 8.8% for RBOCs, by 6.3% for independent utilities, and by 7.0% for non-utilities. As in Table 4, non-utilities' prices are predicted to be substantially lower on average than prices offered by utility publishers (coefficients of 0.876 and 0.805 on RBOC and independent utility dummies respectively), but it is not possible to decompose this into separate effects for being a non-utility and for always being in competitive markets.

In column 2, which controls for publisher-level fixed effects, there is no longer a statistically significant effect of competition on price for RBOCs. The estimated effect for independent utilities is statistically significant, but smaller than when not controlling for publisher fixed effects. For non-utility publishers the estimated effect is now much larger than in column 2; the coefficient implies that median price decreases by 19.1% for each additional competitor.

In summary, the results of this section suggest that price levels do fall in response to competition. Because of the make-up of Yellow Pages advertising markets, namely, single utility publishers with or without competing non-utility publishers, much of the effect of competition on price is captured in the persistent price differences between utility and non-utility publishers. It appears that utility publishers' prices are affected by competition, with a price decrease of approximately 6-10% for each additional competitor. Non-utility publishers set prices that are lower by half or more, controlling for market characteristics, than utilities publishers' prices. They also lower their prices somewhat more than do utility publishers in response to competition from additional non-utility publishers.

6.2 Price Curvature

The focus of our paper is on understanding how competition affects price discrimination. We begin with a simple comparison of two prices, and then present our main estimation method and results. The two most common prices in our data set are the double-quarter column rate and the full page rate, both present at 4915 directories. We restrict our sample to these directories and regress the log of these two prices on demographic data as in Table 4, along with dummy variables for the two sizes and interactions of the dummy variables with the level of competition. The results appear in Table 6. Competition has a much larger effect on the price of the full page advertisement then on the double-quarter column advertisement – -0.133 relative to -0.014. These parameters are statistically different from each other.

This result suggests that competition has a larger effect on big advertisements then small advertisements. However, there are some problems with this regression. As decribed above, there may be endogeneity between missing demographic data and the number of competitors. Furthermore, by only looking at two prices, we have ignored a number of directories and dropped a great deal of price information. We now develop a more robust and comprehensive method for estimating the effect of competition on curvature.

We first specify a tractable functional form to describe the shape of the price schedule. We use the function $P_{ij} = A_i s_j^{\beta_i}$, where P_{ij} is the price of an advertisement of size j at directory i and s_j is the size in quarter columns, to characterize the price schedule for each directory.

This function allows a variety of shapes including linear pricing ($\beta_i = 1$), quantity discounting ($\beta_i < 1$), and quantity premia ($\beta_i > 1$). In practice, we estimate the log version of this function, namely,

$$\ln(P_{ij}) = \alpha_i + \beta_i \ln(s_j) + \epsilon_{ij} \tag{4}$$

where ϵ_{ij} is mean independent of $\ln(s_{ij})$. In this formulation, α_i captures the price level and β_i captures the degree of curvature at each directory.

Our main objective is to find out how price discrimination, or in our operationalization, how β_i, varies with competition. If the effect of competition is to increase all prices by the same proportion, then β_i will not vary with competition. Prices would remain unchanged relative to one another along the schedule, and thus, by our measure, there is no change in the pattern of price discrimination. If the effect of competition is to lower prices for large ads by a greater proportion than prices for small ads, β_i decreases with competition. We identify this as a change in price discrimination toward greater quantity discounting.[13] Under this functional form, our test specified in Equation 2 of Section 3 is equivalent to testing $\beta_i \lesseqgtr \beta_j$. where directories i and j differ based on the level of competition they face. Theorems 1 and 2 in the Appendix show formally that testing for changes in the curvature of price schedule (as measured by β_i) is equivalent to testing whether high or low prices fall proportionally more.

Table 7 reports the distribution of β_i for all directories. [14] The mean is 0.91 and about 79% of the sample practices some form of quantity discounting. Nonetheless, many directories are close to 1 and a significant portion is quantity extorting. Note that our measure of the price schedule fits best when per-unit prices are monotonic, either increasing or decreasing. This is not always the case. About 5% of the directories have monotonically increasing per unit price schedules, 10% have effectively constant slope, and 15% are monotonically decreasing. The remaining schedules are generally downward sloping, although not monotonically. Nonetheless, the R-squared statistics from estimating Equation 4 are remarkably high: the mean across directories is 0.9899 with a standard error of 0.0338, suggesting that our functional form assumption is not at great odds with the data.

Our primary interest is to understand how β_i, which represents the curvature of the price schedule or the extent of price discrimination, changes with competition. We estimate this rela-

[13]It is interesting to compare our measure of the price schedule to other potential measures. We rejected the price range, coefficient of variation of per unit price, or the standard deviation of per unit prices because it is possible for them to increase but for β_i to decrease. Furthermore, they do not clearly distinguish between level changes and curvature changes. Interestingly, the coefficient of variation on price (not per-unit price) is monotonic in β_i (for reasonable values of β_i). We focus on β_i because of its clear interpretation as curvature.

[14]For these purposes, we drop the 29 directories with fewer than 3 prices in the display category.

tionship between competition and the shape of the price schedule by regressing β_i on measures of the directory's competitive environment. Specifically, we estimate:

$$\beta_i = \gamma_0 + \gamma_1 \mathsf{competition}_i + \nu_i \tag{5}$$

using several different measures of competition. The parameter γ_1 is the parameter of primary interest. One way to estimate Equation 5 would be to use estimates of β_i from our directory-by-directory estimation of Equation 4 as the left hand side variables in Equation 5. Instead we substitute Equation 5 into Equation 4 to get:

$$\ln(P_{ij}) = \alpha_i + \gamma_0 \ln(s_j) + \gamma_1 \mathsf{competition}_i \cdot \ln(s_j) + \nu_i \ln(s_j) + \epsilon_{ij}. \tag{6}$$

We estimate Equation 6 via Amemiya's (1978) GLS method for estimation when random coefficients are assumed to be the dependent variables of another regression equation. Amemiya's technique accounts for heteroskedasticity introduced by the interaction of ν_i and $\ln(s_j)$. In this case, α_i is captured by directory-level fixed effects. Note that estimating Equation 6 is analagous to repeating the estimation in Table 6 with directory dummy variables instead of demographic variables and size entered in a log linear way instead of via dummy variables.

Column 1 of Table 8 reports γ_0 and γ_1 for the case where the measure of competition is the number of competing publishers. The table shows that the coefficient on the number of publishers is precisely estimated at -0.027. That is, β_i is lower in markets with more competitors, implying that the price schedule is more curved in those markets. These numbers can be interpreted in the following way: Most directories have 4 columns, so that a full-page advertisement is 16 times as large as a quarter column advertisement. The estimate of the constant term at 0.939 implies that, in monopoly markets, the price of a full-page ad is 13.51 times as large as that of a quarter column ad. In duopoly markets, the full page is 12.54 times as large and in triopoly markets it is 11.63 times as large. That is, the ratio of prices between the smallest and largest ad decreases by 7.7% upon entry of each competitor. One can also interpret these results as follows: The average β for monopoly markets of 0.939 in Table 8 corresponds to a 6.1% decrease in the per page price when an advertiser doubles the size of its ad. For each additional publisher covering the entire market, that discount rises by 2.7 percentage points, or about 44%.

We have interpreted these results as indicating that competition has proportionally more effect in the high value end of the market (i.e. buyers that purchase large ads). While it would be possible to get this numerical result if competition leads firms to increase prices for small ads, Table 4 shows that the overall price level decreases in competition. Together these results suggest that prices for large ads decrease more than proportionally to small ads under competition. Our interpretation is also supported by unreported regressions using prices only for full page and quarter column ads, the largest and smallest ad sizes and also the most commonly available. In these regressions, full page ads were estimated to have significantly larger price decreases as a result of competition than quarter column ads, which is further evidence that our interpretation is correct, and that our functional form assumption is not too restrictive.

In column 2, the effect of increased competition is allowed to be nonlinear. In this specification, price schedules again show increased size-discounting with increased competition. The coefficients of the three competition variables in column 2 are statistically significantly different, and their magnitude is fairly similar to what is estimated in column 1, where the effect of competition on β_i is assumed to be linear.

Columns 3 and 4 use a similar specification, but measure competition in terms of the number of competing directories instead of the number of competing publishers. The results are very similar to those in the first two columns. The primary difference is that DIR2 and DIR3 are not significantly different from each other.[15]

A potential concern in Table 8 is the endogeneity of entry with prices. The directory fixed effects should absorb the standard endogeneity between entry and prices. There may still be endogeneity between the number of competitors and the curvature of prices, but there is no theoretical guidance as to how this should work. Furthermore, the presence of menu costs in setting curvature, as discussed in the next subsection, should greatly mitigate any such effect.

In terms of the theories described in Section 2, these results give support to the model of Rochet and Stole (1999) in which the highest valuation customers, who buy the largest ads, benefit most from competition because they are best able to seek out substitutes. Competition can be seen as giving these customers leverage or bargaining power that results in lower prices for them relative to smaller customers. These results are also consistent with the network externalities results of Rysman (2002), which suggest that competition should increase publishers' incentives to attract large advertisements, or with entering publishers pursuing large advertisers first. These results are inconsistent with the model of Stole (1995) in which high valuation customers also have the greatest brand loyalty.

The sizes of the effects could be important in welfare calculations. Consider a competition authority that wanted to determine the welfare effects of a merger. A standard approach would be to regress a closely watched price, such as the price of a double-quarter column

[15] We also tried these regressions with demographic variables on the right hand side of Equation 5. Although it is difficult in these regressions to interpret coefficients of demographic variables, we could often reject the hypothesis of joint insignificance. However, the coefficient on the number of competing publishers and its standard error changed very little from the addition of demographic variables, except in cases where the degrees of freedom became very low.

advertisement, on the number of competitors (similar to the regressions we present in Table 4). In this case, the authority would find that prices increased 7.7% upon merger. However, the results from column 1 of Table 8 imply that the price of a quarter-column advertisement would increase by only 5.9% whereas the price of a full page advertisement would increase by 12.8%. These results, along with data on quantities of advertisements sold for different sizes, could seriously impact aggregate welfare calculations. Furthermore, if the authority was interested in the distribution of welfare, it would be crucial to know the different price changes.[16]

6.3 Price Curvature under Menu Costs

In Section 5, we noted that publishers frequently use the same shape for price schedules in multiple markets. Price levels appear to change fairly fluidly from market to market, but a very similar pattern of relative prices for different ad sizes prevails for multiple directories of a given publisher. We ascribed this to "menu costs," or costs that make it undesirable to administer multiple prices. This suggests that there are publisher-level fixed effects in curvature; in some sense, the shape of the price schedule is "sticky" across a publisher's directories. Because of this, the relationship between curvature and competition will be driven primarily by differences between publishers in the average competitive environment each publisher faces and less by the variation in the competitive environment among the directories of a given publisher. For this reason we now analyze the effect of competition on curvature looking separately at within and between publisher effects.

If menu costs make the between publisher comparison the primary driver of the competition-curvature relationship, we would expect to see evidence of this relationship most strongly among the small publishers. The reason for this is that small publishers face more uniform environments than do large publishers. (In our sample, the publisher-level standard deviation of the competition measure is on average 0.64 for RBOC publishers and 0.70 for large publishers (10+ directories), compared to 0.35 for small publishers.) Econometrically, this means that even if a small publisher uses a single shape of price schedule for most of its directories, that schedule is likely to be close to the schedule that would have been set for each directory in the absence of menu costs. Furthermore, there is greater variation between small publishers than between large publishers in how competitive their markets are. (In our sample, the publisher-level average of the competition measure–the explanatory variable of interest in the between regression–has a standard deviation of 0.34 for RBOCs and 0.18 for large publishers, compared

[16] Even in the absence of detailed data, a competition authority might be able to infer something about welfare by taking guidance from the theoretical work mentioned in Section 2. We are encouraged on this front because ours and Borenstein's (1989) results confirm Rochet and Stole (1999) and Stole (1995) in cases where intuitively those models are applicable. See Section 2.

to 0.55 for small publishers.) In short, in the between regression, the small publishers have more variation in the explanatory variable of interest and the correlation between this variable and curvature will be closer to what would be observed in the absence of menu costs.

Table 9 presents an analysis of the regression of β_i on the number of publishers that directory i faces. The table looks at different subsets of the data and for each subset, reports the results of the standard regression, the within estimator and the between estimator. The within estimator is formed by introducing publisher/BOC fixed effects into Equation 5 and estimating 4 and 5 simultaneously via Amemiya (1978). For the between estimator, we estimate Equation 4 separately for each directory and then take the average of β_i and the average of the number of competing publishers at each publisher. Using these publisher averages, we estimate Equation 5. The table reports only the coefficient on the average number of publishers (γ_1), not the constant term. The table also reports the number of prices, which is the number of observations for the full and within regressions, the number of publisher/BOC's, which is the number of observations for the between regression, and the number of directories which is the number of fixed effects in the within regression.

The within column of Table 9 shows that very little of the response to competition occurs within a given publisher. This result is consistent with the descriptive evidence in Figures 5 and 6. It seems that publishers choose a particular shape for their price schedule and apply it to many of their directories regardless of the competitive environment that an individual directory faces. This result contrasts with the case of price levels, where we saw significant within effects, especially at non-utility publishers.

Although the within-publisher effects seem to be minimal, the coefficient in the between estimator is strongly significant. This result suggests that publishers do take into account their average competitive environment when picking the price schedule. In the between column of Table 9, we see that between effects are important, especially at non-RBOC and smaller publishers. Results are similar for other cuts of the data, for instance defining small publishers to be producers of 4 directories or fewer. Interestingly, the distinction between utility and independent publishers does not seem to be nearly as important as that between big and small publishers (see Table 10).

7 Robustness

This section considers two tests of the robustness of our results. The first considers a similar set of tests to the ones above but looking at the difference in prices over color instead of size. The second test tries to account for possible misspecification in the pricing approximation.

Price discrimination in Yellow Pages advertising can happen not only across sizes but also colors. Many directories offer advertisements with red, green and blue individually and in combination. This provides another dimension along which to check for the effects of competition on price discrimination. Since the most common offering is red advertisements, we compute the ratio of the red price to the standard price for each ad at each directory and then calculate the median ratio for each directory. The mean of this ratio across directories is 1.38 with a standard deviation of 0.10. We regress this ratio on a constant term and the average number of publishers that the directory faces. Table 11 shows that competition drives down the premium for red. The first row of Table 11 shows that increasing the number of competitors that a directory faces by 1 leads to a decrease in the premium for red by 0.7 percentage points (the constant term is 1.38 for this regression, and varies from 1.30 to 1.43 for the regressions in the table). This result is statistically, but probably not economically, significant. However, increasing the number of competitors that a publisher faces throughout its region leads to a decrease in the ratio of 6 percentage points, from 1.39 to 1.33. As before, we find that competition drives down the price of the high value item relative to the low value item. We also find that menu costs seem to prevent publishers from adjusting prices schedules individually for each directory but that publishers respond strongly to the average competition they face.

One concern with our estimates is that by fitting the pricing function $P_{ij} = A_i s_j^{\beta_i}$, we are assuming that the price schedule passes through the origin. While it seems reasonable to assume that the price of advertisement of size 0 is 0, the assumption can affect our estimates. Suppose that directories respond to competition by shifting price schedules up or down by an additive constant. Then competition would affect β_i even though competition only caused "level" changes. Note that under our definition of price discrimination, such level changes do represent a change in the structure of price discrimination because high prices are shifted by proportionally less. Even so, in order to be sure that such changes were not driving our results, we renormalized each price sequence so it passed through the origin. We did this by subtracting off the lowest price and size from the remaining prices and sizes at each directory separately. We then recomputed β_i for each directory and re-ran our tests. The results were very similar to those reported.

8 Conclusion

This paper has examined the effect of competition on the price-size schedule offered for display advertisements in Yellow Pages directories. Our primary finding is that price schedules generally offer size discounts, and that increased competition between directories increases the rate of discounting. Our estimates imply that an additional competitor causes the price of a full page advertisement to drop by more than 12% whereas the price of a quarter column advertisement drops by less then 6%. In our sample, small publishers' price schedules are most responsive to competition, while RBOC publishers are fairly insensitive to competition. We discuss theoretical explanations and implications for welfare calculations.

9 Appendix

This section formalizes the equivalence between testing for changes in curvature (as measured by β_i) and testing whether high or low prices change relatively more. The first theorem shows that, in comparing 2 log-linear price schedules, the one with the higher curvature (lower β_i) has proportionally lower high prices and proportionally higher low prices. The second theorem shows the converse: that if two price schedules have only 2 prices in them, then whether the high price or low price is proportionally higher determines whether a log linear regression would find that the schedule has a higher or lower curvature (β_i).

Theorem 1 *Consider two price schedules:* $p = A_1 s^{\beta_1}$ *and* $p = A_2 s^{\beta_2}$*. Then:*

$$\mathsf{sign}\left[\frac{p_{1h}}{p_{2h}} - \frac{p_{1l}}{p_{2l}}\right] = \mathsf{sign}\left[\beta_1 - \beta_2\right]$$

Proof:

$$\frac{p_{1h}}{p_{2h}} - \frac{p_{1l}}{p_{2l}} = \frac{A_1 s_h^{\beta_1}}{A_2 s_h^{\beta_2}} - \frac{A_1 s_l^{\beta_1}}{A_2 s_l^{\beta_2}} = \frac{A_1}{A_2}\left(s_h^{\beta_1-\beta_2} - s_l^{\beta_1-\beta_2}\right)$$

Because $s_h > s_l$, the result follows.

Theorem 2 *Consider 4 prices:* $p_{1h}, p_{1l}, p_{2h}, p_{2l}$*. Define* A_i, β_i *such that:*

$$p_{ih} = A_i s_h^{\beta_i} \ \mathsf{and} p_{il} = A_i s_l^{\beta_i}$$

Then:

$$\mathsf{sign}\left[\frac{p_{1h}}{p_{2h}} - \frac{p_{1l}}{p_{2l}}\right] = \mathsf{sign}\left[\beta_1 - \beta_2\right]$$

Proof: The definition of β_i implies that:

$$\beta_i = \frac{\ln(p_{ih}) - \ln(p_{il})}{\ln(s_h) - \ln(s_l)}$$

Therefore,

$$\mathsf{sign}\left[\beta_1 - \beta_2\right] = \mathsf{sign}\left[\frac{\ln(p_{1h}) - \ln(p_{1l}) + \ln(p_{2h}) - \ln(p_{2l})}{\ln(s_h) - \ln(s_l)}\right]$$

$$= \mathsf{sign}\left[\ln(p_{1h}) - \ln(p_{1l}) + \ln(p_{2h}) - \ln(p_{2l})\right]$$

$$= \mathsf{sign}\left[\ln\left(\frac{p_{1h}}{p_{2h}}\right) - \ln\left(\frac{p_{1l}}{p_2 l}\right)\right]$$
$$= \mathsf{sign}\left[\frac{p_{1h}}{p_{2h}} - \frac{p_{1l}}{p_{2l}}\right]$$

The first equality is by definition, the second is because $s_h > s_l$, and the last follows because the log is a monotone transformation which cannot change the sign. In practice, the price schedules we observe have more then 2 prices in them. The equivalence between changes in curvature and proportional changes in price could be wrong to the extent that the log-linear approximation is a poor one. However, the log-linear regressions seem to fit the data very well.

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Table 4: OLS regression of directory median prices on demographics and competition

	I	II	III	IV
Competing publishers	-0.076 (0.009)			
Competing publishers $\in (0, 1]$ (PUB1)		-0.075 (0.019)		
Competing publishers $\in (1, 2]$ (PUB2)		-0.111 (0.020)		
Competing publishers > 2 (PUB3)		-0.222 (0.028)		
Competing directories			-0.067 (0.007)	
Competing directories $\in (0, 1]$ (DIR1)				-0.070 (0.019)
Competing directories $\in (1, 2]$ (DIR2)				-0.106 (0.020)
Competing directories > 2 (DIR3)				-0.202 (0.024)
RBOC publisher	0.710 (0.018)	0.719 (0.018)	0.702 (0.018)	0.713 (0.018)
Independent utility publisher	0.662 (0.018)	0.670 (0.018)	0.657 (0.018)	0.666 (0.019)
Log population	0.430 (0.006)	0.436 (0.006)	0.428 (0.006)	0.436 (0.006)
Growth	0.000 (0.002)	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)
Business establishments	-0.037 (0.013)	-0.036 (0.013)	-0.032 (0.013)	-0.034 (0.013)
Income	0.022 (0.003)	0.022 (0.003)	0.021 (0.003)	0.021 (0.003)
Earnings	0.040 (0.019)	0.040 (0.019)	0.039 (0.019)	0.041 (0.019)
College graduates	-0.007 (0.002)	-0.007 (0.002)	-0.007 (0.002)	-0.007 (0.002)
High-school graduates	0.010 (0.001)	0.009 (0.001)	0.010 (0.001)	0.010 (0.001)
Owner occupied housing	-0.012 (0.001)	-0.012 (0.001)	-0.012 (0.001)	-0.012 (0.001)
Same house for 5 years	0.005 (0.002)	0.006 (0.002)	0.006 (0.002)	0.006 (0.002)
Moved from different county	-0.003 (0.002)	-0.003 (0.002)	-0.003 (0.002)	-0.003 (0.002)
Moved from different state	-0.000 (0.002)	0.000 (0.002)	-0.000 (0.002)	0.000 (0.002)
Urban	-0.002 (0.000)	-0.002 (0.000)	-0.002 (0.000)	-0.002 (0.000)
Density	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)
Public transportation	-0.023 (0.005)	-0.024 (0.005)	-0.022 (0.005)	-0.023 (0.005)
Constant	10.908 (0.148)	10.897 (0.148)	10.865 (0.147)	10.859 (0.147)
Observations	5009	5009	5009	5009
R^2	0.690	0.689	0.691	0.690

Table 5: OLS regression of directory median prices on demographics and competition

	I	II	III	IV
RBOC* Competing publishers	-0.092 (0.014)	-0.014 (0.014)		
Indep. utility* Competing publishers	-0.065 (0.012)	-0.024 (0.011)		
Non-utility* Competing publishers	-0.073 (0.022)	-0.212 (0.016)		
RBOC publisher	0.727 (0.039)			
Independent utility publisher	0.654 (0.040)			
Competing publishers			-0.049 (0.008)	
Competing publishers $\in (0, 1]$ (PUB1)				-0.013 (0.018)
Competing publishers $\in (1, 2]$ (PUB2)				-0.019 (0.019)
Competing publishers > 2 (PUB3)				-0.126 (0.026)
Log population	0.430 (0.006)	0.404 (0.005)	0.401 (0.006)	0.404 (0.006)
Growth	0.000 (0.002)	0.002 (0.002)	0.004 (0.002)	0.004 (0.002)
Business establishments	-0.037 (0.013)	0.030 (0.012)	0.029 (0.013)	0.030 (0.013)
Income	0.022 (0.003)	0.006 (0.003)	0.005 (0.003)	0.004 (0.003)
Earnings	0.041 (0.019)	0.006 (0.018)	0.010 (0.019)	0.012 (0.019)
College graduates	-0.007 (0.002)	-0.003 (0.002)	-0.005 (0.002)	-0.004 (0.002)
High-school graduates	0.009 (0.001)	0.008 (0.001)	0.009 (0.001)	0.008 (0.001)
Owner occupied housing	-0.011 (0.001)	-0.008 (0.001)	-0.010 (0.001)	-0.010 (0.001)
Same house for 5 years	0.005 (0.002)	0.004 (0.002)	0.006 (0.002)	0.007 (0.002)
Moved from different county	-0.003 (0.002)	-0.002 (0.002)	-0.000 (0.002)	0.000 (0.002)
Moved from different state	-0.000 (0.002)	0.003 (0.002)	0.006 (0.002)	0.007 (0.002)
Urban	-0.002 (0.000)	-0.001 (0.000)	-0.001 (0.000)	-0.001 (0.000)
Density	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)
Public transportation	-0.023 (0.005)	-0.031 (0.005)	-0.037 (0.005)	-0.038 (0.005)
Constant	10.901 (0.156)	11.483 (0.149)	11.392 (0.151)	11.394 (0.151)
Observations	5009	5009	5009	5009
Publisher fixed effects Number of publishers	No	Yes 139	Yes 139	Yes 139
Demographic controls	Yes	Yes	Yes	Yes
R^2	0.690	0.616	0.606	0.605

Table 6: OLS regression of double-quarter column and full page rates on competition

Constant	FP Dum	DQC*Comp	FP*Comp	R-Squared	Obs
4.44 (0.22)	1.68 (0.02)	-0.014 (0.008)	-0.133 (0.009)	0.84	9,830
Includes demographics and dummy variables for RBOC and independent utilities DQC Dummy is excluded Standard errors in parentheses					

Table 7: Distribution of beta

Summary

Observations	4980	Std Dev	0.13
Mean	0.91	Variance	0.02

Percentiles

1%	0.57	75%	1.00
5%	0.66	90%	1.02
10%	0.72	95%	1.05
25%	0.83	99%	1.10
50%	0.94		

Table 8: The effect of competition on curvature

	I	**II**	**III**	**IV**
Competing publishers	-0.027 (0.002)			
PUB1 (1 if competing publishers $\in (0,1]$)		-0.029 (0.006)		
PUB2 (1 if competing publishers $\in (1,2]$)		-0.045 (0.006)		
PUB3 (1 if competing publishers > 2)		-0.064 (0.008)		
Competing directories			-0.021 (0.002)	
DIR1 (1 if competing directories $\in (0,1]$)				-0.023 (0.006)
DIR2 (1 if competing directories $\in (1,2]$)				-0.049 (0.006)
DIR3 (1 if competing directories > 2)				-0.056 (0.007)
Constant (γ_0)	0.939 (0.003)	0.944 (0.005)	0.936 (0.003)	0.944 (0.005)
Observations	33,717	33,717	33,717	33,717

Table 9: Coefficients from beta regressions by publisher type

	Full	Within	Between	Prices	Directories	Pub/BOCs
Full data set	-0.027**	-0.001	-0.126**	33,717	4980	138
RBOC	-0.002	0.003	-0.048	12,890	1850	21
Non-RBOC	-0.016**	-0.003	-0.100**	20,827	3130	117
Large non-RBOC	-0.011**	-0.003	-0.060	18,812	2825	32
Small non-RBOC	-0.062**	-0.005	-0.109**	2,015	305	85

Table 10: Coefficients from beta regressions by publisher type

	Full	Within	Between	Prices	Directories	Pub/BOCs
Utility	-0.014**	0.002	-0.059*	26,926	3946	58
Independent	-0.014	0.002	-0.055**	6,791	1038	100
Non-RBOC utility	-0.003	0.001	-0.013*	14,036	2092	37
Small utility	-0.061*	0.088	-0.030*	278	43	19
Small independent	-0.060**	-0.002*	-0.069**	1,737	262	72

Table 11: Coefficients from red premium regressions by publisher type

	Full	Within	Between	Directories	Pub/BOCs
Full data set	-0.007**	0.000	-0.068**	3403	104
RBOC	-0.016**	0.003*	-0.100**	1086	19
Non-RBOC	-0.009**	-0.002*	-0.050**	2317	85
Large non-RBOC	-0.004*	-0.001*	-0.132**	2090	21
Small non-RBOC	-0.026**	-0.016	-0.039*	227	64