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COMPETITION AND PRICE DISCRIMINATION: EVIDENCE FROM THE PARKING GARAGE INDUSTRY*

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We study the relationship between competition and price discrimination through an empirical examination of hourly price schedules in the parking garage industry. We find that the degree of price schedule curvature decreases with competition, implying a greater proportionate drop in low-end prices than in high-end prices when competition intensifies. Our findings suggest that competition constrains a firm's capacity to exercise price discrimination, confirming the classic textbook theory. We also offer possible explanations for our findings, including a search cost explanation, for which we find some support in the data.

I. INTRODUCTION

WILL INCREASED COMPETITION ENHANCE OR DIMINISH a firm's capacity to price discriminate? The classic textbook conjecture is that market power enables a firm to exercise price discrimination. However, existing literature, both empirical and theoretical, has delivered mixed findings regarding the relationship between competition and price discrimination.[1] We revisit this question through an empirical examination of hourly parking price schedules (i.e., parking prices for 1 to 12 hours) in the parking garage industry.

The parking garage industry proves an interesting setting to examine the relationship between competition and price discrimination. First, parking prices usually vary nonlinearly with the length of parking hours. There is

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[1] See, for example, Stole [1995], Stavins [2001], Rochet and Stole [2002], and Borzekowski, Thomadsen, and Taragin [2009].

little doubt that the marginal cost of providing each additional hour of parking is zero.[2] As a result, nonlinearity in observed prices could be readily attributed to price discrimination.[3] Second, consumer search behaviors can play a crucial role in determining equilibrium prices in the parking garage industry, where firm heterogeneity is largely geographical. Increased competition lowers search costs due to shortened travel distances between garages, which could have a disproportionate effect on the search behavior of short term parking customers compared to that of long term customers, leading to a change in the curvature of price schedules.[4] Finally, the feature of zero marginal cost in this industry conveniently allows us to draw a direct inference regarding the relationship between competition and price discrimination by examining the curvature of price schedules, whereas such a conclusion is difficult to draw in other studies due to a lack of reliable data on costs.

We first investigate how the intensity of competition affects hourly parking prices. Using a cross-sectional dataset of parking garages in Manhattan, New York, in 2004, we find that competition drives down overall price levels.[5] We then examine how increased competition alters the curvature of a parking garage's hourly price schedule. Following the identification strategy established by Busse and Rysman [2005], we find that price schedules become less curved as competition intensifies, indicating that short term parking prices drop proportionally more than those of long term parking. Our findings are robust to alternative competition measures, alternative sample selection methods, and alternative functional forms regarding the relationship between competition and price curvature. Given that the marginal cost of an additional hour of parking is zero, our findings imply that increased competition leads to less variation in price-cost margin and therefore less price discrimination in the parking garage industry. Our study lends empirical support to the classic textbook theory that competition constrains a firm's capacity to exercise price discrimination.

[2] This holds true when the capacity constraint is not binding, which is likely the case in our data according to anecdotal evidence. Note that garages are unlikely to offer parking after reaching the capacity constraint due to large costs associated with strengthening the constraint.

[3] We expect almost no substitution between drastically different parking durations (e.g. between 2 and 8 hours of parking) when compared to the usual amount of substitution between the top and bottom of a nonlinear price schedule; the parking industry sees a combination of second and third degree price discrimination. See more discussions in Section IV(i).

[4] In this paper, long term parking refers to parking of relatively *longer hours*, while short term parking refers to parking of *shorter hours*. We only examine price schedules of hourly parking. Weekly and monthly parking do not fall within the scope of our investigation.

[5] As we will discuss in detail below, we define a market as encompassing the area within a radius of 0.2 miles from the center garage, or an alternative radius of 0.3 miles. We construct a measure of competition using a distance-weighted number of garages owned by rival companies in the market. We also use alternative measures of competition for robustness purposes.

We offer a possible explanation for our findings by difference in search behaviors between short and long term parking customers. We hypothesize that long term parking customers tend to search more intensely than short term parking customers. This is because long term customers, such as commuters who park for work, are more familiar with the area (so they bear lower search costs) and more likely to be repetitive users (so they have larger incentive to price shop). When competition intensifies through the entry of garages into a market, search costs are reduced due to shortened travel distances between garages. These lowered search costs are likely to lead to an increase in search intensity and therefore an increase in the fraction of informed customers and a consequent decrease in overall prices.[6] Moreover, the increase in the fraction of informed customers is not as large for long term parking users because most of them may have already searched prior to an increase in competition. The fact that short term customers respond more to changes in competition leads to a larger competitive effect on prices of short term parking than on long term parking. We present some empirical evidence in the data to support this search explanation.

Our paper is closely related to the study by Busse and Rysman [2005], which examines price nonlinearity in the *Yellow Pages* advertising market. It is worth mentioning that our study is able to interpret the relationship between price discrimination and competition, while such an inference is difficult to draw in the study of Busse and Rysman [2005] due to a lack of cost information.[7] Our findings also differ from those of Busse and Rysman [2005] in that they find competition drives down prices more for large ads than for small ads. We discuss and provide several explanations to reconcile the difference in our findings.

Our paper contributes to the literature on price discrimination and price dispersion by examining the role of competition. The existing theoretical literature yields mixed predictions about how competition affects a firm's incentive to price discriminate (e.g., Stole [1995]; Armstrong and Vickers [2001]; Rochet and Stole [2002]). The ambiguity in theoretical predictions has inspired a growing body of empirical literature.[8] In a recent study, Gerardi and Shapiro [2009] examine airline ticket prices and find that competition has a larger negative effect on the top portion of the price

[6] See, for example, Varian [1980], Wilde and Schwartz [1979], Salop and Stiglitz [1977], and Stahl [1989].

[7] Whether competition increases or decreases price discrimination in the Yellow Pages advertising market depends on the relative costs of offering large versus small ads.

[8] For example, Borenstein [1991] examines price discrimination in the competitive retail gasoline market and finds that a decrease in the number of gasoline stations offering leaded gas leads to an increase in the margins of leaded gas, relative to the margins of unleaded gas. Verboven [1999] finds a price premium for optional engine power in car segments. Borenstein and Rose [1994] and Stavins [2001] both look at the relationship between competition and pricing in the airline industry. Borzekowski, Thomadsen, and Taragin [2009] examine second

distribution than on the lower portion, especially on routes with customers characterized by relatively heterogeneous elasticities of demand. Seim and Viard [2011] study how the market entry of competitors affects nonlinear pricing strategies (i.e., the number of different pricing plans offered) in the U.S. cellular telecommunications market. They find that additional competition leads to increased plan variety and causes prices to drop more for high-valuation consumers. Dai, Liu, and Serfes [2014] find a nonmonotonic relationship between competition and price dispersion in airline ticket prices. Our study provides insights from the parking garage industry.

Additionally, our paper contributes to the existing literature on consumer search behavior and equilibrium pricing (see Baye, Morgan, and Scholten [2006] for a review). Existing search literature typically assumes fixed search costs, which may contribute to the positive relationship between competition and equilibrium prices (e.g., Satterthwaite [1979]; Rosenthal [1980]; Varian [1980]; Stiglitz [1987]; Stahl [1989, 1996]; Schulz and Stahl [1996]; Janssen and Moraga-González [2004]). One important exception is a recent study by Lach and Moraga-González [2012], which allows for arbitrary heterogeneity in the amount of price information among consumers. Lach and Moraga-González [2012] derive a sufficient condition under which all percentiles of the price distribution decrease when competition intensifies. More interestingly, they also show that competition has a differential effect on prices along the price distribution. Note that Lach and Moraga-González [2012] do not fully specify the mechanisms through which price information is changed due to an increased number of competitors in a market. Our study highlights one possible mechanism: reduced search costs. In markets where the number (and location) of firms is closely tied to the distribution of the price information among consumers, enhanced competition is associated with lower search costs, which could lead to a greater intensity of search and therefore a higher proportion of informed customers. The increase in informed customers would strengthen the business-stealing effect, inducing firms to attach more importance to attracting these customers. As a result, enhanced competition might lead to lower prices, if the business-stealing effect dominates the surplus-appropriation effect.

The remainder of the paper is organized as follows: Section II describes the data and explains how we measure the intensity of competition; Section III examines the relationship between price and competition; Section IV studies how price curvature responds to changes in competition and presents robustness tests; Section V discusses our findings and provides possible explanations; Section VI concludes.

and third degree price discrimination in the mailing lists market. Also, see Cohen [2008] for a structural analysis of price discrimination in the paper towel market and an excellent review of other structural studies in the literature.

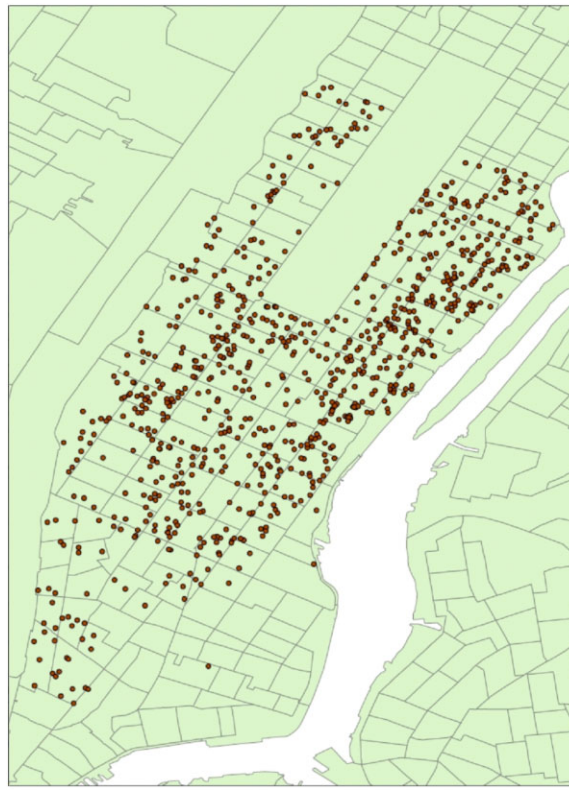

Figure 1
Garage Locations

II. DATA

II(i). *Data Source*

Our primary data set contains detailed information about locations, price schedules and attributes such as ownership for over 800 parking garages in Manhattan, New York, in 2004. This data set accounts for more than 80% of all the parking garages in Manhattan at that time.[9] Figure 1 provides a map of the garage locations covered in the data.

We use ArcMap (a Geographic Information Systems software) to geocode the address of each parking garage. Based on the geocoded coordinates and area boundaries, we assign a neighborhood, census tract, tax block, and tax lot to each garage in the data. We obtain neighborhood

[9] This is a cross-sectional data set compiled by the founders of the website *www.bestparking.com*. Our data coverage is not complete in several areas, which we discuss in more detail in Section II(iv).

boundaries from the Community Studies of New York, Inc. We take census tract boundaries and demographics from the U.S. Census Bureau, and the tax blocks, tax lot boundaries, and other attributes from MapPluto, which is compiled by the New York City Department of City Planning. We associate each garage with the attributes and demographics of the area in which the garage is located.

II(ii). *Price Menu*

Garages usually provide a number of rate options. We observe that a typical garage posts five different rates, with 90% of garages offering between three and eight rates. In the Appendix we present a sample price menu in which a garage lists seven rates. These rates generally fall into one of the following four categories: basic, overnight, maximum, and special rates. Basic rates specify prices for parking up to a given duration (l hour, 2 hours, 12 hours, etc.). In addition to basic rates, approximately 90% of the garages have an 'overnight from' rate, which specifies a price for parking beyond a specific time, but with a total parking duration of less than 24 hours. This 'overnight from' rate overrides basic rates when applicable. About a quarter of garages in the data also offer a maximum rate for not parking past the posted closing time. In addition, nearly 60% of the garages offer at least one daily special rate. A common example of a daily special rate is the 'early bird special,' a discounted price for customers who enter a garage during a specific time window, leave before a particular time, and stay less than a given number of hours. Special rates imply that parking prices depend not only on how long a person parks, but also when that person enters a garage.[10]

There exists heterogeneity in different groups of customers and in the availability of outside options based on entering time. Parking garages could offer price menus based on entering time to target different groups of customers. It is a reasonable assumption that customers who park early in the morning to get to work have different preferences than those parking at night to dine. They may differ in their relative valuations of various parking durations (i.e., customers who park to work would value 8-hour parking much more than 2-hour parking; however, customers who park to dine might prefer 2-hour parking). Moreover, outside options vary with different entering times. At night, street parking that is not available during

[10] Here is a simple example to illustrate how prices could depend on entering time. Assume that a customer parks her car for 8 hours in a garage that opens at 6 A.M. and closes at 12 midnight This garage has l-hour, 2-hour, 10-hour, 'overnight from 12 midnight,' and 'early bird special' rates. If she enters the garage during the 'early bird special' hours, then she pays the 'early bird special' rate. If she enters during non 'early bird special' hours and leaves before midnight, she pays the 10-hour rate. If she enters the garage at 10 P.M. and leaves at 6 A.M. the next morning, she pays the 'overnight' rate.

daytime hours may become available, which could alter a customer's willingness to pay for garage parking.

Given the above characteristics, it is important to study price menus for a given entering time in order to compare prices across garages. In this paper, we focus on price menus for the entering time of 12 noon, when very few garages (7.8%) offer daily special rates.[11] We also focus our analysis on Monday price menus, because price menus for a given entering time exhibit little variation across weekdays and the variation between weekdays and weekends is also minimal. We construct a price menu for 1 to 12 hours parking for each garage based on the posted rates. We exclude durations of longer than 12 hours because not all garages operate 24 hours a day, so including parking durations longer than 12 hours would result in missing prices.[12] The Appendix includes an example that illustrates how we construct the price menus based on posted rates.

We present the summary statistics of hourly parking prices based on the constructed price menus in Table I. Price for 1-hour parking ranges from \$4.22 to \$32.85, with an average of \$13.21. Price for 12-hour parking ranges from \$6.76 to \$52.38, with an average of \$26.87. Overall, prices increase non-linearly with parking durations, with longer durations exhibiting price discounts.

II(iii). *Relevant Markets and Competition Measures*

Constructing the appropriate competition measure is critical. We assume that a customer only travels within a certain distance from her preferred location for parking services. For example, garages on the Upper East Side generally do not compete with those in the East Village. In light of this consideration, we restrict competition for a particular garage to garages located within a given radius from its location. Garages within this radius are referred to as the 'relevant competing garages.'[13]

Our main competition measure for a garage i is constructed by calculating the total number of competing garages owned by rival firms within a given radius from that garage, weighted by a distance function:

[11] The results for 8 A.M. entering, when the proportion of garages that offer special rates is the highest (54.4%), are similar and are presented in the Appendix.

[12] For example, if a garage closes at midnight, parking for longer than 12 hours (until the garage reopens the next morning) is not available for a customer who enters the garage at 12 noon; thus prices for parking longer than 12 hours would be missing.

[13] Some studies on entry and market concentration, such as Bresnahan and Reiss [1991], require markets to be completely isolated, so competition only comes from within a market and is not affected by firms in other markets. One concern related to our market definition is the existence of multimarket contact, which might affect firms' pricing behavior. We augment our analysis by controlling for proxies for multimarket contact and find very similar results, which we do not report in the interest of paper length.

TABLE I
SUMMARY STATISTICS OF PRICING

	min	median	mean	max	s.d.
Prices					
1 hour	4.22	12.67	13.21	32.85	4.53
2 hour	5.26	16.05	16.95	43.08	5.87
3 hour	6.76	21.12	21.18	50.75	7.45
4 hour	6.76	21.96	22.40	52.38	7.62
5 hour	6.76	21.96	22.50	52.38	7.51
6 hour	6.76	21.96	22.74	52.38	7.44
7 hour	6.76	21.96	22.83	52.38	7.35
8 hour	6.76	21.96	23.00	52.38	7.33
9 hour	6.76	22.81	23.48	52.38	7.44
10 hour	6.76	22.81	23.48	52.38	7.45
11 hour	6.76	26.19	26.85	52.38	8.48
12 hour	6.76	26.19	26.87	52.38	8.41
Operating Length (hours)	8	24	21.66	24	3.55
Number of Posted Rates	1	5	5.50	13	1.48
Competition Measures within 0.2 Miles					
Number of rivals' garages	0	13	13.78	34	6.64
Number of rivals' garages (weighted)	0	4.55	4.74	12.38	2.48
Number of rivals' capacity (weighted)	0	0.62	0.63	1.55	0.34
HHI by ownership	0.05	0.16	0.18	1.00	0.12
Number of rivals	0	9	9.11	24	4.26
Four firm concentration ratio	0.28	0.66	0.65	1	0.16
% of garages owned by the center garage's firm	0.03	0.13	0.19	1	0.16
Competition Measures within 0.3 Miles					
Number of rivals' garages	1	28	28.59	58	12.07
Number of rivals' garages (weighted)	0.43	9.68	10.07	21.79	4.46
Number of rivals' capacity (weighted)	0.03	1.36	1.34	2.78	0.58
HHI by ownership	0.04	0.12	0.14	0.82	0.08
Number of rivals	1	15	15.73	35	6.80
Four firm concentration ratio	0.30	0.58	0.59	1	0.12
% of garages owned by the center garage's firm	0.02	0.10	0.14	0.9	0.14

$$(1) \qquad comp_i = \sum_{j \in \Omega(-i)} I\left(dist_{ij} \leq \alpha\right) * f\left(dist_{ij}, \alpha\right)$$

where $\Omega(-i)$ is the set of garages owned by rivals in the market for garage i, I is an indicator function, α is the cutoff distance beyond which competition between i and j is assumed to be zero, and f is a weighting function that is decreasing in distance between garage i and garage j, expressed as follows

$$(2) \qquad f\left(dist_{ij}, \alpha\right) = 1 - dist_{ij}/\alpha$$

The weighting function is decreasing in distance to account for the fact that garages located closer are expected to impose greater competition pressure on the center garage. We consider the distance-weighted number of rivals' garages as our preferred competition measure because the level of competition facing a garage obviously depends on how many rival garages are in the same market and how closely they are located. Another advantage of this competition measure, which we will cover in more detail in Section V,

is that it ties closely to the search theory that we will offer as one possible explanation for our empirical findings.

In our study, we choose a radius of 0.2 miles to identify a relevant market for a given garage. In Manhattan, 0.2 miles is approximately the distance of 4 blocks, which normally takes about 4–5 minutes to walk. Note that our distance measure is a straight-line measure between two points. Given that one has to walk along streets or avenues to travel between two locations, the walking distance is usually greater than the straight-line distance calculated in our analysis. In addition to 0.2 miles, we also use larger radii, such as 0.3 miles, to define markets for robustness purposes.

We report summary statistics for our main competition measures in Table I. We focus on the non-weighted count of garages owned by rivals in discussing how competition varies and the source of such variation. Using a 0.2-mile radius, the number of rivals' garages in a market ranges from zero to 34 in the data, with the 25th, 50th, and 75th percentiles being 9, 13, and 19, respectively. The standard deviation is 6.64, which is around half of the mean. The variation in competition observed in the data comes from two sources: ownership and location. Regarding ownership, there is large heterogeneity in ownership in the data: a handful of firms own a large fraction of garages. For example, the two biggest firms (ICON and CENTRAL) operate more than 35% of the garages in our sample. The four biggest firms (ICON, CENTRAL, GMC, and IMPERIAL) own about 50% of the garages, and the six biggest firms own about 60% of the garages in the data. Among the remaining garages, about 15% are operated by another 20 companies that own multiple garages, and the remaining 25% are operated by individual companies that each own only one parking garage.

Regarding location, one source of variation is the historical difference in buildings and lots and the resulting difference in space in which parking garages or lots can be constructed.[14] Another source of variation is NYC zoning law, which often stipulates the number of garages that are allowed to operate in certain areas.[15] To get a sense of how location contributes to the variation in competition, we construct the number of other garages (excluding the center garage and within a radius of 0.2 miles) in a market, which exhibits a large amount of variation. For example, the number

[14] In Manhattan, where multi-story stand-alone parking facilities are rare due to limited land space, parking garages are usually underground facilities that are an integral part of buildings. Thus, the construction and opening of a parking garage in Manhattan to a large extent depends on the construction (or renovation) of buildings to which the garages are architecturally affiliated. The historical difference across areas in buildings, and the space that would allow for an opening of parking garages, are main sources of exogenous variation in competition in this market.

[15] For more detailed description of zoning regulation on off-street parking, please refer to the New York City Department of City Planning (*http://www.nyc.gov/html/dcp/pdf/zone/art01c03.pdf*, last accessed November 16, 2013).

ranges from 0 to 34, with the 25th, 50th, and 75th percentiles being 11, 15, and 20, respectively. The mean is 15.50 and standard deviation is 6.72. The above statistics suggests that location constitutes an important source of exogenous variation in competition.

We use several alternative competition measures for robustness purposes. The first measure is the total count of competing garages owned by rivals (without weighting by distance).[16] The second is the number of parking spots (capacity) owned by rivals weighted by distance, which captures difference in the sizes of garages. Our third competition measure uses the Herfindahl-Hirschman index (HHI) by summing the squared fractions of garages owned by each company in each market. Our last competition measure is the number of competing firms in a market.

We also offer a brief discussion of these alternative competition measures. The number of rivals' parking spots weighted by distance (divided by 1000) has a mean of 0.63 and standard deviation of 0.34. The HHI averages 0.18 with a standard deviation of 0.12.[17] The median number of competing companies within a 0.2-mile radius is 9. The four-firm concentration ratio based on the fraction of garages owned by companies in a market ranges from 0.28 to 1, with a median of 0.66.[18] We also report the fraction of garages owned by the center garage's company as a measure for the center garage's market power. We include this as an additional explanatory variable, so our estimation measures how a change in market competition affects prices for the center garage, after controlling for the center garage's market dominance. Our results do not change if this measure is excluded.

II(iv). *Sample Selection and Market Characteristics*

Our data cover more than 80% of the garages in Manhattan. Since our data do not cover areas above West and East 100th Street, the calculated competition measures for garages that are located close to 100th Street are inaccurate. For this reason, we exclude all garages north of 95th Street from our final analysis. In addition, our data coverage is incomplete in certain areas (e.g., the Financial District and Chinatown). We thus exclude garages close to the boundaries of those areas using garage location information. In the end, our final sample consists of garages south of 95th Street

[16] We also use a more sophisticated nonlinear weighting function $f = (1 - dist_{ij}/\alpha)^2$ for robustness purposes. The results are consistent and not reported out of consideration for paper length.

[17] Note that we calculate the HHI by summing the squared fraction of garages owned by each company; therefore, a value of 1 denotes a monopoly firm. The HHI has been used in previous studies examining price and price discrimination, such as Borenstein and Rose [1994] and Gerardi and Shapiro [2009].

[18] The four-firm concentration ratio provides another competition measure. The estimation results using this competition measure are similar and are not reported in the paper.

TABLE II
SUMMARY STATISTICS OF THE AREAS WHERE THE GARAGES ARE LOCATED

Variable	min	median	max	mean	s.d.
Land Value (in $1000s per sq. ft.)	0	0.18	2.15	0.28	0.31
Median Income of Census Tracts (in $1000's)	12.17	69.67	188.70	72.33	26.76
Total Population (in 1000's)	0.01	6.79	15.35	6.04	3.80
Zoning Density	1	5	9	3.96	2.74
Commercial Zone Dummy	0	1	1	0.59	0.49
Residential Zone Dummy	0	0	1	0.34	0.47
Manufacturing Zone Dummy	0	0	1	0.07	0.25

and north of 25th Street.[19] Table II provides summary statistics for the areas in which garages are located. The average land value is $281 per square foot. The average income of a census tract is about $72,000, and the average population size is about 6,000. About 59% of the garages are located in a commercial district, about 34% in a residential district, and the remainder in a manufacturing district.

III. PRICE LEVEL AND COMPETITION

In order to establish a valid relationship between price and competition, one has to control for demand and costs shifters, observed and unobserved, that affect both price and competition. The level of competition is not predetermined; firms decide to enter and exit a market based on their conduct and performance, including prices. This feedback behavior implies that any factor affecting prices may be correlated with the level of competition (Evans, Froeb and Werden [1993]). In the analysis below, we use census tract fixed effects to control for unobserved heterogeneity at the census tract level.[20]

The empirical model regarding the relationship between price and competition is specified as follows:

$$\ln(p_{ik}) = \beta_0 + \beta_1 \ln(comp_{ik}) + \beta_2 landvalue_{ik} + \beta_3 income_k + \beta_4 population_k + \beta_5 prop\_own_{ik} + \beta_6 Z_{ik}^M + \beta_7 Z_{ik}^R + \beta_8 D_{ik} + \beta_9 Z_{ik}^R D_{ik} + Track_k + \varepsilon_{ik} \quad (3)$$

where p_{ik} is the parking price for a given duration at garage i located in census tract k, $comp_{ik}$ is the competition measure (i.e., the weighted number of rivals' garages), $landvalue_{ik}$ is the value of the land per square foot, $income_k$ is the median family income in the census tract where a garage is

[19] The area south of 20th Street is incomplete in regard to the garage data. Therefore, we exclude garages south of 25th Street out of concern that their competition measures might not be accurate. We also conduct a robustness test using an alternative sampling method where we further restrict our sample to garages located south of 90th Street and north of 30th Street. The results are very similar and not reported.

[20] The average size of a census tract in Manhattan is 0.07 square miles. The number of garages in a census tract ranges from 1 to 21 in the data, with a median of 5.

TABLE III
PRICE AND COMPETITION

	(1)	(2)
ln(competition)	0.001	–0.132***
	(0.038)	(0.046)
Land value	0.157***	0.025
	(0.039)	(0.042)
Median income	0.004***	
	(0.000)	
Total population	–0.029***	
	(0.004)	
% own company	0.194*	–0.005
	(0.112)	(0.101)
Manufacture district	–0.053	0.154**
	(0.061)	(0.066)
Residential district	–0.075	0.001
	(0.050)	(0.050)
Zoning density	0.011	0.028***
	(0.008)	(0.009)
Zoning density * residential district	–0.008	–0.027**
	(0.010)	(0.011)
Census-tract-fixed effects	No	Yes
Number of garages	602	602
R-squared adjusted	0.302	0.561

Notes: ***P < 0.01, **P < 0.05, *P < 0.1.

located, and $population_k$ is the census tract population. We take the natural logarithm of prices and our competition measure for easy interpretation of our results. The variable $prop\_own_{ik}$ is the fraction of parking garages owned by the center garage's firm in a market. Z_{ik}^M and Z_{ik}^R are the zoning dummy variables for manufacturing and residential districts, respectively. D_{ik} denotes the zoning density, which captures the permitted bulk and land-use intensities; $Track_k$ is the census tract fixed effects. As density values vary with different zoning districts, we also include an interaction of zoning density and the residential district dummy.[21]

Table III reports the estimation results for 1-hour price at the noon entering time using a market radius of 0.2 miles.[22] Results in Column 1 (without census tract fixed effects) largely differ from those in Column 2

[21] For a commercial district, zoning density ranges from 1 to 6, where $D = 1$ or 2 refers to areas with small retail and service shops, and $D = 5$ or 6 refers to central business districts, such as Midtown and Lower Manhattan. For a residential district, zoning densities of 1–5 are low-density areas, and 6–10 refer to moderate and high density areas. Manufacturing districts do not have density measures. For more detailed description of the zoning density for various zones, please refer to (*http://www.nyc.gov/html/dcp/html/zone/zonehis2.shtml*, the New York City Department of City Planning, accessed October 09, 2012).

[22] In addition to 1-hour price, we also conduct analyses for other prices (i.e. 2-hour to 12-hour prices). We find consistent results that all prices decrease when competition intensifies. We also find that prices of longer duration parking decrease to a lesser extent compared to shorter duration prices. Note that some existing theories, such as Lach and Moraga-Gonzalez [2012], predict that high-end prices might increase or decrease with competition under different conditions.

(with census tract fixed effects). If favorable demand factors that lead to high prices also attract more garages to enter a market, ignoring these factors might lead to an upward bias in the estimation of the coefficient for competition. The inclusion of census tract fixed effects helps address such endogeneity issues. Note that income and population vary at the census tract level, so their effect on price levels cannot be identified when census tract fixed effects are included in the model.

We focus on Column 2, our preferred specification, in discussing the results. We find that an increase in competition drives down prices. If the weighted number of rivals' garages increases by 10%, holding everything else equal, the 1-hour parking price will drop by 1.32% on average. Alternatively, a one-standard-deviation increase in competition will lead to an average 6.9% drop in 1-hour price. The coefficient on the land value, which controls for the cost of operating a garage, is neither statistically nor economically significant, possibly because the inclusion of census tract fixed effects has accounted for most of the variation in the land value. The variable *prop_own* aims to control for the market dominance of the center garage's firm in a market, for which we find no significant effect. There is no significant difference in prices charged by garages located in commercial versus residential districts. However, prices are much higher in manufacturing districts. Prices in the highest-density commercial districts (with a density measure of 6) are 14% higher than those in the lowest density areas (with a density of 1).

We use the fixed effects approach to control for unobserved heterogeneity that might confound the relationship between price and competition. However, the endogeneity problem might still remain. Here is a simple illustration. Assume that Garages A and B are located in the same census tract, but Garage A is close to a city landmark located in another census tract. Garage A charges higher prices than Garage B does, due to a large volume of tourism and a high demand for parking. Meanwhile, Garage A faces more competition because the existence of the landmark attracts more garages to operate in the area. It is the census tract that contains the landmark that drives the co-movement of competition and prices for Garage A. Nevertheless, our empirical model controls for unobserved heterogeneity only at the garage's census tract level. The co-movement discussed in the above example could not be fully controlled for with the inclusion of our census tract fixed effects. Therefore, additional caution needs to be taken in interpreting our pricing coefficients.

Since most previous studies report a toward-zero bias due to the endogeneity of market structure (e.g. Manuszak and Moul [2008]; Mazzeo [2002]), the magnitude of the competitive effect on price levels in our model might be underestimated. In this study, we do not rely on the exact magnitude of the competitive effect to draw conclusions about the relationship between price curvature and competition. Instead, a general conclusion

that competition drives down prices will suffice for our purpose. In this regard, an underestimation, if any, will not contaminate our investigation of price curvature, which is the focus of our study.

As will be discussed below, the pricing results presented here are an integral part of our study because they are necessary for interpreting the findings on the relationship between price curvature and competition. In addition, these results support, to some extent, the appropriateness and validity of our competition measures.

IV. PRICE CURVATURE AND COMPETITION

In this section, we first discuss how we relate nonlinearity in hourly price schedules to price discrimination. Next, we examine the distribution of price curvature across garages in the data. We then study the relationship between price curvature and competition. Finally, we offer a brief discussion of robustness tests, with detailed results reported in the Appendix.

IV(i). *Parking Price Schedules and Price Discrimination*

Parking prices increase nonlinearly with parking durations, exhibiting discounts at the high end. We argue that what underlies the nonlinearity in parking prices is likely a combination of second and third degree price discrimination.[23] On the one hand, prices of parking durations in close proximity exhibit second degree price discrimination. For example, people parking near a restaurant to dine self-select into a 2 or 3 hours parking option based on their valuation of the incremental parking hour. On the other hand, parking of distant durations appears to target distinct groups of customers. It is unlikely that people who park to dine would consider 8-hour parking favorable, whereas commuters who park for work would not choose 2 or 3 hours short-term parking. Parking durations, if considerably different, automatically divide customers into different segments. Price discrimination to easily identified customer groups is third degree price discrimination. In light of the discussion above, the curvature of parking price schedules seems to exhibit both second and third degree price discrimination, and largely the latter as our study of price curvature focuses on comparison between short and long term durations.

IV(ii). *The Distribution of Price Curvature*

We follow Busse and Rysman [2005] and assume that a price schedule takes the following functional form:

[23] The combination of second and third degree price discrimination has also been studied in Broadway theater (Leslie [2004]) and mailing lists (Borzekowski, Thomadsen, and Taragin [2009]).

TABLE IV
SUMMARY OF THE ESTIMATED CURVATURE COEFFICIENTS

	Entering at 12 noon
Mean	0.246
Standard Deviation	0.114
Minimum	0
Maximum	0.978
Percentiles	
5%	0.085
25%	0.18
50%	0.237
75%	0.302
90%	0.372
% Significantly Different from 1	99%
Number of observations	797

Notes: When calculating the curvature coefficients, we include all garages from the original data. Narrowing the sample to 602 garages in the final sample delivers very similar results.

$$p_{it} = v_i h_t^{\gamma_i} \tag{4}$$

where p_{it} is the price for t-hour parking at garage i, v_i is a garage-specific component that determines overall prices, h_i is the parking duration of t-hour, and γ_i is the garage-specific curvature parameter. Price schedules exhibit discounts for long durations if γ_i is smaller than 1. The smaller the curvature parameter, the more curved the price schedule. In order to avoid confusion, throughout the paper we refer to the degree of curvature as how curved a price schedule is. Thus, a small curvature parameter γ_i presents a large degree of curvature for a given price schedule.

We first examine the distribution of γ_i across garages in the data. We take the natural logarithm of Equation (4) and estimate the following equation for each garage:

$$\ln(p_{it}) = \alpha_i + \gamma_i \ln(h_t) + \varepsilon_{it} \tag{5}$$

where $\alpha_i = \ln(v_i)$, and ε_{it} are independent and identically distributed (*i.i.d.*) across hours with a garage-specific variance σ_i^2. Table IV reports the distribution of γ_i for the entering time of 12 noon, when we see significant discounts for long-term parking. The mean of the curvature parameter is 0.246. The maximum value of the coefficient γ_i is smaller than 1, implying that all garages discount longer parking durations to some degree. More than 99% of the estimated curvature parameters significantly differ from 1.

IV(iii). *The Relationship between Price Curvature and Competition*

To examine the relationship between price curvature and market competition, we use the following specification:

$$\gamma_i = \delta_0 + \delta_1 comp_i + \eta_i \tag{6}$$

TABLE V
PRICE CURVATURE AND COMPETITION

	(1)	(2)	(3)
ln(competition)*ln(hour)	0.008	0.035***	0.036***
	(0.006)	(0.002)	(0.002)
ln(hour)	0.242***	0.219***	0.226***
	(0.007)	(0.005)	(0.018)
Garage-fixed effects	No	Yes	Yes
Additional controls for curvature	No	No	Yes
Number of garages	602	602	602
Number of observations	7104	7104	7104
R-squared adjusted	0.603	0.680	0.717

Notes: ***P < 0.01, **P < 0.05, *P < 0.1. Our final sample includes a total of 602 parking garages. Among these, 27 garages close before midnight, so prices for parking longer than a certain duration (depending on when the garage closes) cannot be readily determined. For example, if a parking garage closes at 8 P.M., we treat prices of parking longer than 8 hours as missing. The results are similar if we exclude these 27 garages from our estimation.

where η_i is an *i.i.d.* error with variance σ_η^2. We are particularly interested in the sign and magnitude of the coefficient δ_1. Following Busse and Rysman [2005], we proceed by substituting Equation (6) into Equation (5) and directly estimating δ_1 using the following equation:[24]

$$\ln(p_{it}) = \alpha_i + \delta_0 \ln(h_t) + \delta_1 comp_i \ln(h_t) + \eta_i \ln(h_t) + \varepsilon_{it} \quad (7)$$

Errors η_i and ε_{it} are assumed independent; the sum of $\eta_i ln(h_t)$ and ε_{it} is the composite error term for the regression. Note that the composite error terms are not homoscedastic due to the presence of $\eta_i ln(h_t)$ and the assumption that variance of ε_{it} is garage specific. We estimate the standard errors using cluster at the garage level.

Table V reports the estimation results of Equation (7) for 12 noon entering and a radius of 0.2 miles. We focus our discussion on the parameter δ_1, which measures how a change in competition affects price curvature. Column 1 reports the results without controlling for garage fixed effects, which suggests a small and statistically insignificant relationship between competition and price curvature. However, with the inclusion of garage fixed effects, as shown in Column 2 of Table V, we find that increased competition is associated with a greater curvature parameter (which means a less curved price schedule), and the effect is statistically significant. Combined with our previous finding that prices decrease with competition, this result suggests that low-end prices drop proportionally more than high-end prices in the parking garage industry in the wake of increased competition. The magnitude of the competitive effect can be interpreted in the following

[24] An alternative way to proceed is to first estimate Equation (5) and then estimate Equation (6), but the standard errors of the estimates need to be adjusted for the second step because the dependent variable γ_i is estimated from the first step.

way. Note that the 12-hour price is on average 1.92 times the 1-hour price; if the distance weighted number of garages owned by rivals increases by 2.5 (about one standard deviation in the data), the ratio of 12-hour price to 1-hour price increases to 2.02 (or a 5% increase).

The large difference in our results between specifications with and without the inclusion of the garage fixed effects is striking. The results imply that unobserved heterogeneity might potentially confound our estimation of the relationship between price curvature and competition. One example of such unobserved heterogeneity is a garage's close proximity to a tourist attraction. High tourist traffic might attract more parking firms to enter a market. However, because tourists usually visit an attraction for only a couple of hours, demand is higher for short term parking relative to long term parking, leading to higher relative prices of short term parking. Therefore, such unobserved heterogeneity will correlate with a greater degree of curvature in price schedules (i.e., a smaller curvature parameter). In this case, ignoring such unobserved heterogeneity would cause a negative bias in the estimation of the competition effect on price curvature. Note that controlling for such unobserved heterogeneity would only reinforce our results about the relationship between competition and price curvature. Another example relates to the street parking availability in a market. Street parking, especially meter parking, is often used for short term parking. As a result, the availability of street parking could have a more negative impact on short term parking prices than on those for long term parking (increasing the curvature parameter). If competition is positively associated with the availability of street parking, this could lead to an upward bias in the estimation of the competition effect on price curvature. However, we are not aware of any evidence suggesting an association between availability of street parking and level of competition in a market.

Column 3 of Table V offers a more general treatment regarding the relationship between competition and price curvature. In addition to controlling for competition in Equation (6), we also allow other explanatory variables (i.e., those that are used in Equation (3)) to affect price curvature. This alternative specification examines whether our main results regarding price curvature are robust after controlling for other observed market level characteristics and census tract fixed effects. The inclusion of census tract fixed effects may be particularly useful, as it helps to control for unobserved market level heterogeneity that might be correlated with competition, and may also differentially affect prices of short and long term parking (thus correlated with the curvature of a price schedule). Our extended specification for the curvature parameter γ leads to an alternative specification for Equation (7). The results, as reported in Column 3 of Table V, are largely similar to our main findings.

IV(iv). *Robustness Tests*

We offer a brief discussion of robustness tests in this section. All the results are largely consistent with our main findings and are reported in tables in the Appendix.

First, we conduct a set of analyses by incrementally increasing the size of radius to define a market. Our results are consistent for alternative radii of 0.3, 0.4, and 0.5 miles. We choose only to report the results for a radius of 0.3 miles in Table A.I (Column 1).

Second, we adopt a set of alternative competition measures, including a non-weighted count of rivals' garages (Column 2), a weighted count of rivals' parking spots (Column 3), HHI by ownership (Column 4), and the number of rival companies as opposed to rival garages (Column 5).

Third, we provide a study of pricing and curvature for an 8 A.M. entering time. The results (Column 6) are consistent, although the magnitude of the competitive effect on curvature is smaller as compared to the case of a 12 noon entering. The results seem to be in line with the fact that price curvature parameters are on average smaller for an 8 A.M. entering time.

Last, we investigate whether our results are robust to other functional forms regarding the relationship between competition and price curvature. In addition to a log-linear specification that we use in Equation (7), Column 1 of Table A.II in the Appendix uses price instead of logged price as the dependent variable; Column 2 adopts a linear functional form; and Column 3 is based on a semi-log specification.

V. DISCUSSIONS

In order to conclude whether competition enhances or diminishes price discrimination in the parking garage industry, we first relate price discrimination to price-cost margin, and assume that a larger degree of price discrimination exists if the variance of the price-cost margin increases.[25] We then explain how we draw a conclusion regarding competition and price discrimination via empirical analysis of the relationship between competition and price curvature. In the discussion below, we assume that costs do not change with competition in a market.

Figure 2 provides a simple illustration of our empirical findings: prices of short term parking drop proportionally more than those of long term parking when competition increases. Anecdotal evidence suggests that

[25] Both price-cost markup and price-cost margin have been used to define price discrimination in the literature. See Clerides [2004] for a comprehensive discussion and comparison of these two definitions. In this paper, we focus our discussion using price-cost margin.

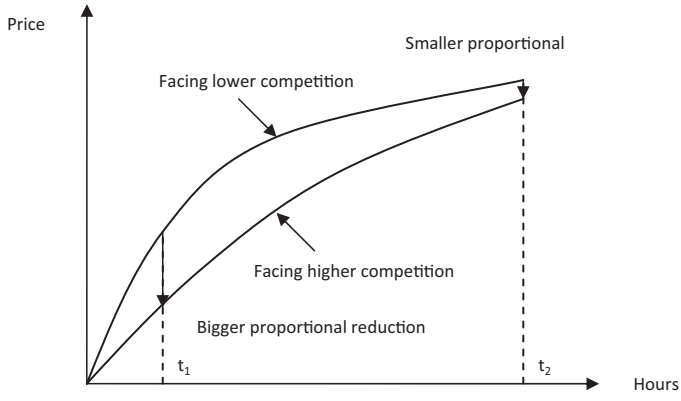

Figure 2
Price Reduction Not Uniform according to Parking Hours

most garages do not reach full capacity in Manhattan.[26] When the capacity constraint is not binding, the marginal cost of parking for each additional hour is zero.[27] Consequently, per-hour price differences reflect differences in price-cost margins. When competition increases, a larger drop in low-end prices reduces differences in per-hour prices across parking durations, leading to less variation in price-cost margins. This suggests that competition is negatively associated with a firm's capacity to exercise price discrimination, lending support to the classic textbook theory.

We acknowledge that the costs of parking may be more complicated as there are often attendants who perform valet parking in garages in Manhattan. To take this into consideration, the marginal costs for per hour parking might be lower for high duration parking, as labor costs could be spread over more hours. However, our findings regarding variance in the price-cost margin are robust as long as the labor costs per car are relatively small, which is likely to be the case given that the average hourly salary for a parking attendant is less than $7 (based on reports from the Bureau of Labor Statistics, 2007).

[26] For example, according to the 2006 North America Central Business Districts Parking Rate Survey conducted by Colliers International, the availability of parking in Downtown and Midtown Manhattan New York City is considered to be fair. Parking garages are 60–80% full during weekends and special events.

[27] We do not specifically consider cases in which capacity constraints are met. Based on our conversations with industry experts, we note that in most cases, no parking service is offered beyond a garage's capacity constraint. Relaxing the capacity constraint essentially amounts to expanding garage space, which can be prohibitively expensive or outright unfeasible.

V(i). *Possible Explanations*

Below we offer a discussion of possible explanations for our empirical finding. We acknowledge that there might be other explanations; ruling them out, however, would be beyond the scope of our study.

One explanation is offered by some of the existing literature on competitive price discrimination with perfect information. For example, Armstrong and Vickers [2001] and Rochet and Stole [2002] suggest that under some conditions, enhanced competition would induce firms to adopt more linear pricing strategies.

Another possible explanation, for which we find some support in the data, relates to imperfect and heterogeneous consumer information about prices in the spirit of Lach and Moraga-González [2012]. We hypothesize that long term parking customers are more likely to be informed of prices as compared to short term parking customers. This is because long term customers, such as commuters who park for work, are more familiar with the area (so they bear lower search costs) and more likely to be repetitive users (so they have a greater incentive to price shop). In contrast, short term parking customers are more likely one-time users and are thereby less incentivized to drive around to find the lowest priced parking.

With an increase in competition (through new entry of garages or more gathered garage locations), it becomes less costly to canvass more garages due to shortened travel distance between garages. Lowered search costs are likely to lead to an increase in search intensity and therefore an increase in informed customers and an overall decrease in prices.

Although the decrease in search costs holds true generally, it does not affect customers equally. Customers who have already been informed of the price distribution before the change in competition will not be affected by the decrease in search costs, while customers who have not been informed of the prices will likely increase their search efforts. The implication is that customer groups with a larger fraction of informed customers before the change in competition will be affected to a lesser degree than customer groups with a smaller faction of informed customers. Since long term parking customers are more likely better informed than short term parking customers, as discussed above, we should expect that short term customers' search intensity responds more readily to changes in competition than that of long term customers. As a result, short term prices are more responsive to competition than long term prices are.

V(ii). *Some Empirical Evidence*

In order to support our hypothesis that short and long term customers differ in search intensities, we examine degrees of price dispersion for various parking durations through the coefficient of variation (CV), a

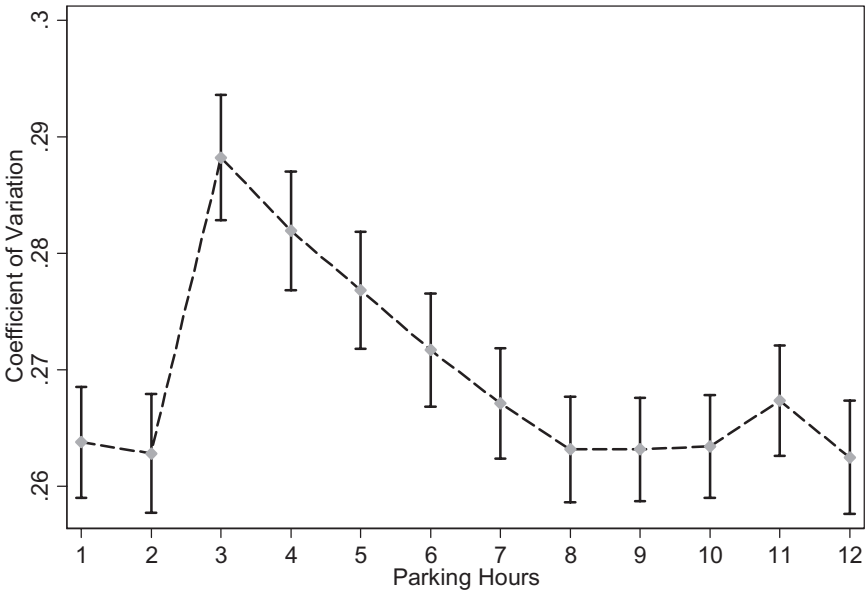

Figure 3
Coefficient of Variation according to Parking Hours

commonly used measure for relative price dispersion. If short term parking users search less than long term users, then we should expect to observe larger price dispersion for short term parking. This strategy has been used in a study by Sorensen [2000], which shows that prices for repeatedly purchased prescriptions exhibit significant reduction in price dispersion. Similarly, Dahlby and West [1986] find that insurance premiums are least dispersed in driver classes in which a search is most likely to occur.

We first calculate the CV of price by parking duration for each market. We then calculate the average CV across markets for each parking duration. Figure 3 plots the average CV according to parking duration and their 95% confidence intervals. This figure shows that the CV is relatively small for 1-hour and 2-hour parking, but at the 3-hour parking mark, it declines gradually as parking duration increases. Although the relationship is not strictly monotonic, price dispersion does show an overall decreasing trend for parking lasting longer than 3 hours. We also conduct a regression of the CV on the corresponding parking durations and find a significantly negative relationship. The above observations provide evidence that long term customers search more intensely than short term customers.

Our search explanation is grounded on heterogeneity in search behaviors. Based on our theory, competition should have a smaller impact on price curvature in markets where the majority of the customers are informed of price distributions (such as residential areas) than in markets

TABLE VI
PRIMARILY RESIDENTIAL VS PRIMARILY COMMERCIAL AREAS

	(1)	(2)
	Upper East	Mid Upper East
ln(competition)*ln(hour)	0.004	0.061***
	(0.004)	(0.006)
ln(hour)	0.199***	0.145***
	(0.010)	(0.012)
Garage-fixed effects	Yes	Yes
Number of garages	55	97
Number of observations	660	1159

Notes: ***P < 0.01, **P < 0.05, *P < 0.1.

with a more even mixture of informed and uninformed customers (such as commercial areas). We rely on a zoning variable (whether a garage belongs to a commercial, residential or manufacturing zone) in order to identify markets that are primarily residential or commercial. We examine zoning distribution by neighborhood. Most neighborhoods are comprised of a relatively even mixture of commercial and residential zones. One exception is the Upper East Side, which has a much larger ratio of garages in residential zones than in commercial zones (73% vs. 27%). The other exception is the Midtown Upper East Side, which has a much larger ratio of garages located in commercial zones than in residential zones (72% vs. 27%). We consider the Upper East Side as a neighborhood with a higher proportion of informed customers than other neighborhoods, and the Midtown Upper East Side as one with a larger proportion of uninformed customers. We study how competition affects price curvatures for garages located in these two neighborhoods. The results are reported in Table VI. As expected, we find a small and insignificant impact of competition on price curvature on the Upper East Side, but a large and significant impact on the Midtown Upper East Side.[28] The above findings lend additional support to our search explanation.

V(iii). *Comparison to Busse and Rysman [2005]*

We find that an increase in competition causes low-end prices to drop proportionally more than high-end prices in the parking garage industry, which contrasts with the findings in the *Yellow Pages* advertising industry by Busse and Rysman [2005]. Several factors may have contributed to the difference of our findings. First and most importantly, the parking garage

[28] Another approach we take is to calculate residential ratios using the fraction of garages that belong to a residential zone in a market as measures for whether a market is relatively residential. We study markets with residential ratios at the top 20th percentile (mainly informed customers) and markets at the bottom 20th percentile (a mix of both informed and uniformed customers). We find similar patterns of results, which are not reported in the interest of paper length.

industry sees a combination of second and third degree price discrimination, with the latter likely playing a bigger role. In contrast, the *Yellow Pages* advertising industry only exhibits second degree price discrimination. Second, differences in search behaviors across consumer groups that might play an important role in parking garage pricing are not characteristic of the *Yellow Pages* advertising industry. Finally, Busse and Rysman [2005] cite network effects as one possible explanation for their results, but the parking garage industry does not exhibit network externality.

VI. CONCLUSIONS

This paper adds to the empirical literature on price discrimination and competition by examining nonlinearity in hourly price schedules in the parking garage industry. We find that prices of short term parking drop proportionately more than those of long term parking as competition intensifies. This finding leads us to conclude that enhanced competition is associated with a lower degree of price discrimination, confirming the conjecture of the classic textbook theory. We offer a possible explanation for our finding through differences in search behaviors between short and long term customers, along with some supporting evidence from the data.

This paper also sheds light on an important limitation in previous theoretical literature on consumer search (imperfect information) and equilibrium prices. Existing theories generally do not allow search costs to vary with market competition. However, search costs may be negatively related to market density, especially in cases where firm heterogeneity is largely geographical. In such cases, increased competition lowers search costs, encouraging less informed consumers to engage in more searches. If such a change in search costs is taken into account, it should be expected that, in addition to a decrease in uninformed consumers per firm due to an increase in the number of competitors, the segment of uninformed consumers would shrink with increased competition. This result could strengthen the business stealing effect, inducing firms to attach more weight to the informed group. If this effect is large enough, it would dominate the surplus-appropriation effect and lead to a reduction in the expected equilibrium price.

APPENDIX: AN EXAMPLE OF CONSTRUCTING PRICE SCHEDULES USING APPROPRIATE RATES

Suppose that a garage operates from 6 A.M. to 12 A.M. and posts the following rates:

Parking Duration	Rate
1 hour	10
2 hours	15
5 hours	18
10 hours	22
Maximum rate	25
Overnight rate	30
Early bird special (enter b/w 6 A.M. and 10 A.M., leave before 6 P.M., max stay 8 hours)	12

The maximum rate only applies during the current day, which is before closing time. Once someone parks past closing time, the overnight rate applies until the duration reaches 24 hours. Suppose that a customer enters the garage at 8 A.M. The price schedule she faces looks like the following:

	Exiting time	Price	Explanation
1 hour	9 A.M.	$10	1 hour rate applies
2 hours	10 A.M.	$12	Early bird special overrides 2-hour rate
3 hours	11 A.M.	$12	Early bird special overrides 5-hour rate
4 hours	12 P.M.	$12	Early bird special overrides 5-hour rate
5 hours	1 P.M.	$12	Early bird special overrides 5-hour rate
6 hours	2 P.M.	$12	Early bird special overrides 10-hour rate
7 hours	3 P.M.	$12	Early bird special overrides 10-hour rate
8 hours	4 P.M.	$12	Early bird special overrides 10-hour rate
9 hours	5 P.M.	$22	10-hour rate applies
10 hours	6 P.M.	$22	10-hour rate applies
11 hours	7 P.M.	$25	Maximum rate applies
12 hours	8 P.M.	$25	Maximum rate applies
13 hours	9 P.M.	$25	Maximum rate applies
14 hours	10 P.M.	$25	Maximum rate applies
15 hours	11 P.M.	$25	Maximum rate applies
16 hours	12 A.M.	$25	Maximum rate applies
17 hours	1 A.M.	N/A	Garage closed
18 hours	2 A.M.	N/A	Garage closed
19 hours	3 A.M.	N/A	Garage closed
20 hours	4 A.M.	N/A	Garage closed
21 hours	5 A.M.	N/A	Garage closed
22 hours	6 A.M.	$30	Overnight rate applies
23 hours	7 A.M.	$30	Overnight rate applies
24 hours	8 A.M.	$30	Overnight rate applies

Appendix Table A.I
Robustness Tests on Competition Measures and Sample Selection

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Price						
ln(competition)	–0.134**	–0.094**	–0.162***	–0.480**	–0.170**	–0.133***
	(0.059)	(0.043)	(0.054)	(0.215)	(0.071)	(0.041)
% own company	0.003	0.024	0.025	0.330***	0.163*	0.029
	(0.119)	(0.107)	(0.094)	(0.106)	(0.098)	(0.086)
Panel B: Curvature						
ln(competition)*ln(hour)	0.042***	0.029***	0.027***	0.119**	0.041***	0.020***
	(0.004)	(0.002)	(0.001)	(0.047)	(0.011)	(0.004)
ln(hour)	0.200***	0.199***	0.250***	0.266***	0.127***	0.160***
	(0.006)	(0.005)	(0.004)	(0.009)	(0.032)	(0.005)

Notes: ***P < 0.01, **P < 0.05, *P < 0.1. The sample includes 602 parking garages with a total of 7104 observations. Column 1 uses a 0.3-mile radius to define a market; Columns 3–5 use alternative competition measures, including a non-weighted count of rivals' garages, a weighted count of rivals' parking spots, HHI by ownership (-HHI), and the number of rivals; Column 6 studies price and curvature for 8 A.M. entering.

Appendix Table A.II
Robustness Tests on Functional Forms

	(1)	(2)	(3)
ln(competition)*ln(hour)	0.447***		
	(0.038)		
ln(hour)	4.380***		
	(0.097)		
ln(competition)*hour		0.279***	0.017***
		(0.014)	(0.001)
Hour		0.721***	0.034***
		(0.022)	(0.001)

Notes: ***P < 0.01, **P < 0.05, *P < 0.1. The sample includes 602 parking garages with a total of 7104 observations. As opposed to the main specification, which takes a log-linear form, Column 1 uses price as the dependent variable; Column 2 adopts a linear functional form; and Column 3 takes a semi-log specification.

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