Platform Pricing at Sports Card Conventions *

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Abstract

We study a new data set of US sports card conventions from the perspective of the pricing theory of two-sided markets. Conventions are two-sided because organizers must set fees to attract both consumers and dealers. We present several findings: first, consumer pricing decreases with competition, but pricing to dealers is insensitive to competition and in longer distances even increases with competition. Second, when consumer price is zero (and thus constrained), dealer price decreases more strongly with competition. These results are compatible with existing models of two-sided markets, but are difficult to explain without such models.

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1 Introduction

This paper analyzes sports card conventions in the US, which must attract both buyers and sellers of cards to be successful. We provide a series of empirical results, particularly about the relationship between competition and pricing on each side of the market. Our results would be difficult to rationalize with a standard market model, but we argue that our results can be naturally generated by a model based on two-sided markets.

This paper contributes to the study of platform competition and two-sided markets, an important recent development in industrial organization (see Armstrong, 2006; Caillaud & Jullien, 2003; Rochet & Tirole, 2006; Rysman, 2009; Weyl, 2010; Hagiu & Wright, 2011). While the empirical literature in this area is growing, we argue that significant gaps remain. In particular, there is little research that focuses on descriptive analysis of data sets with a large number of platforms or in relatively simple settings that are easily interpretable by theory. We do not seek to test theory per se; the theory of two-sided markets is difficult to test in the sense of falsifiability because it is very flexible. Rather than a direct test, our aim is to provide descriptive results from a market that appears to be two-sided, and discuss our results in the context of theoretical models. Also, our results go beyond existing theoretical models in that we consider markets with many platforms, whereas existing theoretical research considers markets with at most two.

By definition, two-sided markets involve two (or more) groups of agents in which agents interact through an intermediary and participation or usage of each group affects the utility of the other groups. The intermediating firm is often referred to as a "platform" and each group of agent is referred to as one "side" of the market. The economics of two-sided markets focusses on agent's choice of platform and the pricing decisions of possibly competing platforms.[1] Hagiu & Wright (2011) argue that this literature would be better termed the study of "multi-sided platforms."[2]

For example, consumers value video game consoles that are served by many game developers, and developers value consoles that attract many consumers. In this case, the console producer is the platform firm, accounting for interactions between game players and game developers. Similarly, a local sports card convention provides a platform for dealers of sports cards (most time acting as sellers) to interact with consumers that visit the convention. Sports card dealers prefer conventions with many consumers (holding dealer competition constant) and consumers prefer conventions with many dealers. Crucially, there is no sense in which one side is more important to the convention than the other. The convention needs both consumers and dealers to be successful. Our modeling and empirics reflect this symmetry.

For several reasons, sports card conventions provide an excellent environment to study the theory of

[1]This focus differentiates the literature on two-sided markets from the literature on network effects. The definition of a two-sided market is very similar to the definition of a market with indirect network effects. However, the literature on network effects tends to focus on technology adoption and network size, rather than the choices of the intermediary (although this distinction is not perfect). For more on network effects, and definitional issues in two-sided markets, see Farrell & Klemperer (2007), Rochet & Tirole (2006), Rysman (2009) and Hagiu & Wright (2011).

[2]We agree, as evidenced by our title.

two-sided markets, particularly for the relationship between platform pricing and platform competition. First, conventions are two-sided markets. A successful convention requires attendance by both buyers and dealers, and a convention organizer must take this into account in setting prices. Second, pricing is very simple and observable. Dealers and consumers pay separate entrance fees only. There are no transaction fees or other complicating issues. We observe these fixed fees in a set of uniformly formatted classified advertisements in a trade magazine. Third, there were a huge number of conventions in the United States, more than two thousand per month at the height of their popularity, which gives us tremendous leverage for econometric estimation, as well as important panel variation in market structure.

In comparison, many two-sided markets (e.g. yellow pages directories, radio, internet search engine) have zero price on one side and therefore restrict platform pricing to the other side only. Contexts in which we see pricing on both sides are often complex. For example, video games consoles are a canonical example of a two-sided market, but the number of important platforms and game developers together is less than 25, contracts are complex and secret, and technological change makes time series variation difficult to interpret.

We highlight several empirical results. We show that consumer pricing responds to increases in competition at any reasonable distance. However, pricing to dealers is more complex: it does not respond to competition within relatively long distances, from 25 to 100 miles. As we consider even longer distances, past 100 miles, dealer prices actually increase in competition. We also distinguish between dealer pricing by conventions that allow free consumer admission and those that charge consumers. We interpret conventions that charge free admission, about half of our data set, to be constrained on the consumer side. We show that conventions with free consumer admission reduce the price to dealers in response to competition, whereas conventions with positive consumer admission do not change dealer prices in response to competition.

We argue that these results are difficult to explain in a one-sided model: why would price for one of a firm's products increase in or not respond to competition if the firm's other price decreases? In contrast, these results arise naturally in reasonable models of two-sided markets. For instance, if dealers multi-home (i.e. attend multiple conventions) and consumers single-home (i.e. attend a single convention), increased competition between conventions (for instance, exogenously moving them closer together) leads to lower prices for consumers but not for dealers. The result that the single-homing side benefits more from competition than the multi-homing side is a common result and appears in a number of set-ups (see Rochet & Tirole, 2003; Armstrong, 2006; Gomes, 2014). A second result is that if both sides single-home, and consumers face higher travel costs than dealers, competition leads prices to fall on the consumer side but to actually increase on the dealer side. Intuitively, since increased competition lowers the ability to extract rents from consumers, the value of attracting dealers goes down, and the platforms raise the price to dealers. This result can be inferred from Weyl (2010) and we present a model in the appendix that makes this point explicitly. Thus, a model in which consumers single-home and dealers multi-home when competing conventions are nearby but both consumers and dealers single-home when conventions are far apart (i.e. greater than 100 miles) generates the pricing pattern we observe. Our discussions with industry participants suggest that this is a reasonable description of behavior.

Armstrong & Wright (2007) and Gomes (2014) provide an interesting extension to the result that if one side multi-homes, competition does not affect prices on the multi-homing side. They consider the case in which price is constrained on the single-homing side. In that case, increases in competition do cause price to fall on the multi-homing side. This result is consistent with our finding that dealer prices fall in response to competition at conventions with free admission, but do not do so for conventions with positive admission fees when dealers are likely to multi-home (within 100 miles).

Several papers seek to empirically evaluate two-sided markets. Rysman (2004) estimates the positive feedback loop between advertising and entry in the Yellow Pages market and evaluates the welfare effects of entry. Kaiser & Wright (2006) study pricing in the German magazine market, Argentesi & Filistrucchi (2007) study market power in the Italian newspaper market, and Fan (2013) studies quality choice in the U.S. newspaper market. Chandra & Collard-Wexler (2009) study newspaper pricing in the context of mergers. Jeziorski (2013) analyzes merger behavior by U.S. radio stations. Seamans & Zhu (2014) study the effect of Craigslist, a substitute for classified advertisements, on newspaper pricing. Lee (2013), Derdenger (2013) and Corts & Lederman (2009) evaluate exclusive contracting in the video-game market. Cantillon & Yin (2008) study tipping in financial exchanges. Genakos & Valletti (2011) show that lower call termination revenue for cellular phone providers leads to higher fees to subscribers. Rysman (2007) evaluates multi-homing and network effects in payment card usage. Carbo-Valverde, Chakravorti & Rodriguez-Fernandez (2013) study the effects of interchange fee regulation in the Spanish payment card market.

Our paper differs from previous research in that we directly study pricing decisions using a descriptive (or "reduced-form") framework. These empirical results are useful because predictions about pricing choices are, in our view, the major results of the two-sided markets literature so far. By taking a reduced-form approach, we seek to shed light on whether correlations in the data are consistent with the proposed theories.[3] In contrast, most other papers that analyze pricing estimate an explicit theoretical model using structural techniques, which makes it difficult to detect if the model does not hold. A descriptive approach seems natural given that both the theoretical and empirical literatures are at such an early stage.[4]

[3]Genakos & Valletti (2011) also uses reduced-form techniques.

[4]A related empirical literature focuses on indirect network effects, such as Gandal, Kende & Rob (2000), Saloner & Shepard (1995) and Ackerberg & Gowrisankaran (2006). Consistent with the theoretical literature on network effects, these papers focus on technology adoption rather than pricing by an intermediary.

2 Industry and Data

Collecting sports cards and sports memorabilia is a popular pastime in the United States. Sports cards are small cards with a picture of a professional player and the player's statistics. Baseball cards are the most popular. Collectors value cards of top players in top or rookie years, as well as complete sets and well-produced cards. Collectors are often interested in other types of memorabilia, such as game balls, jerseys or player signatures. The popularity of collecting cards can vary a great deal, including seasonally with whether a sport is in season, and regionally with the success of the local team. A major event in our data set is the labor strike in Major League Baseball in 1994, which hurt the popularity of the league and of collecting baseball cards.[5]

Sports card conventions provide short events for dealers and consumers to come together. While a number of dealers establish retail shops, many dealers trade entirely at conventions. A small convention may last one day and consist of 10 tables set up at a mall. The largest conventions have more than 250 tables, last a week, and take over a large convention center in a major city. Convention organizers rent the location, advertise the convention and charge fees to dealers and consumers. Conventions sometimes contract for the appearance of professional athletes who will provide signatures for free. Organizers primarily profit from the entrance fees, although some organizers are also dealers who will trade cards at the convention. Both the organizer and dealer markets are extremely unconcentrated and are characterized by many small participants, many of whom have separate full-time jobs unrelated to sports cards.

Pricing at conventions is very simple. Consumers and dealers pay a fixed fee to the convention organizer. Typically, consumers pay less than $2, with about half of the conventions in our data set offering free admission. Dealers pay the *table fee*, typically $25 to $100. The table fee allows the dealer to set up a table at the convention. Prices at multi-day events may be more complicated, with prices varying by day (for instance, weekend prices are typically higher) or with lower per-day fees for admission over multiple days. Also, we observe some discounts from the table fee for purchasing multiple tables.[6]

Our data set is based on the trade magazine *Becket Baseball Card Monthly.* This magazine provides articles on baseball and collecting, market prices for a huge number of cards, and most importantly for our purpose, listings for sports card conventions (the "Convention Calendar"). Listing is free and, as we

[5] Jamieson (2010) provides a very useful history of baseball cards and collecting. Jamieson reports that at the height of its popularity in the early 1990s, some consumers valued cards not only as collector's items, but actually as investments into a financial portfolio, and incorporated card collecting into their retirement planning. Jamieson dates the end of a bubble in card prices to a radio host who, in protest of the 1994 labor strike in baseball, promised to hold a public burning of any cards people sent in. The host received many times the number of cards expected, to the point that local fire authorities intervened.

[6] In practice, dealers can buy from consumers and dealers can trade with other dealers, as can consumers with other consumers. Hence, the important distinction is not who buys cards and who sells cards but who pays the table fee and who pays the consumer fee. There could be substitution between entering with a table and not doing so. Such substitution could be problematic for our theoretical predictions since it does appear in existing theoretical work, but should bias our results away from finding the differences between the two sides that we show.

understand it, every convention would be sure to place a listing in this magazine. The magazine requires that listed conventions have at least 10 tables, although this does not appear to be binding (see below). Each calendar covers the month of the issue, so the October 1997 issue has listings for all conventions in that October.

Our data set consists of the convention listings from a selection of issues of this magazine. Convention organizers fill out a standard form and listings follow a uniform pattern, which is amenable to computer interpretation. To create our data set, we scanned all of the listings and used an Optimal Character Recognition (OCR) program (in particular ABBYY PDF Transformer 1.0) to convert these scans to text files. Then we wrote computer programs to parse the results into a usable data set. To ensure data quality, we compared the original copy with each parsed listing and corrected errors by hand.

Each convention lists the city or town in which it occurs. We match these towns to a list of towns from the U.S. Census and assign the longitude and latitude of the town to the convention. Hence, we assume that each convention is located in the population center of the town in which it occurs.[7] We drop conventions that do not occur in the continental United States. We dropped some listings that did not provide town names that we could reliably match to a location in the census. Altogether, we have data on 50,450 conventions in 36 months over 9 years.

For each listing, we use the dates of the convention, the town and state, the number of tables, the admission fee for consumers and the table fee for dealers.[8] For prices, we always took the price for a single day of admission if there were discounts for multi-day admission. We used the simple average of prices if there were different prices for different days. We took the price for a single table if there were discounts for multiple tables.

Our selection of magazines range from April, 1989 to December, 1997, for a total of 36 issues. As the magazines are drawn from a personal collection, it is not a continuous set of magazines.[9] We purposely stopped collecting data after 1997, which coincides with the popularity of the World Wide Web. There is a significant decline in the number of conventions during the late 1990s which makes our approach difficult since we rely on the presence of competition to create our tests.[10] Table 1 lists the issues of the magazine in the data set, along with the number of conventions in each issue. Figure 1 graphs this series. There is a peak in activity in the Summer and Fall of 1992 when there are regularly more than

[7] The listings provide addresses which in principle could be used to more accurately identify locations. However, many addresses are descriptive ("VFW Hall" or "Westgate Mall") and therefore are difficult to geocode. Even for the entries that provide a street address, cleaning them would be an enormous task.

[8] We discarded some information: the exact location, the times of day of each convention and the contact name and number. The contact names are potentially very interesting but difficult to clean reliably.

[9] Our collection of magazines is drawn from those we found for sale at several conventions, and some contributions from John List (for which we are very grateful). We made a number of attempts to find missing issues, for instance at public libraries. We believe that our selection of magazines is random.

[10] The impact of the Web on the convention market represents an interesting topic in its own right, as in Goldmanis, Hortascu, Syverson & Emre (2010) for booksellers and travel agents. Jin & Kato (2007) present a detailed study on the online and offline trading of sports cards. Here we shy away from the post-Internet months because it would be difficult to determine the channel by which the Web affects conventions. Not only does the Web represent an alternative method for trading cards, the Web represents an alternative leisure activity which substitutes for card collecting altogether.

Date		mean	count	Date		mean	count
1989	Apr.	1.90	497	1994	Oct.	3.30	1701
	Aug.	1.80	386	1995	Feb.	2.78	1250
1990	Nov.	2.80	1276		Apr.	2.99	1457
	Dec.	2.84	1278		May.	2.71	1196
1991	Nov.	3.97	2206		Aug.	2.72	1169
1992	Jan.	3.90	1805		Nov.	2.97	1216
	Apr.	4.23	2477	1996	Feb.	2.56	1051
	Jul.	4.35	2294		Jun.	2.69	1217
	Oct.	3.99	2233		Sep.	2.61	1098
	Nov.	4.16	2294		Oct.	2.56	918
1993	Feb.	3.57	1797	1997	Feb.	2.39	933
	Mar.	3.75	1950		Apr.	2.48	989
	Apr.	3.70	2084		May.	2.41	957
	Jul.	3.64	1840		Jun.	2.40	942
1994	Feb.	3.41	1646		Jul.	2.31	746
	May.	3.63	1827		Aug.	2.41	862
	Jul.	3.38	1563		Oct.	2.37	946
	Aug.	3.32	1516		Dec.	2.43	832

Table 1: Number of conventions and average by 3 digit zip code for each month in data set.

2000 conventions in a month. There is a steady decline afterwards, presumably due to the baseball strike in 1994 and the popularity of the Internet. In 1997, there are less than 1000 conventions per month.

We are interested in oligopoly interactions, so it is useful to get a sense of the number of conventions in any given region. Table 1 provides the mean number of conventions per 3-digit zip code by month for zip codes that have at least one convention. The overall average is 3.15, and this ranges from 1.90 to 4.35 in months with low and high activity. Not surprisingly, the distribution underlying these means is highly skewed. Table 2 displays the number of 3-digit zip code-months with each count of the number of conventions. For instance, there are 6,886 zip code-months in which we observe only 1 convention in a month, which represents 43.04 percent of the data. Zip code-months with three or less conventions represent almost 75% of the data, and 10 or less represents 95% of the data. There is a tail of observations with a large number of conventions, the maximum being 49 conventions in a 3 digit zip code in a single month.

The number of tables at a convention is an important explanatory variable for price. We treat the number of tables as an exogenous measure of the quality of the convention. Clearly, the quantity of dealers that purchase a table at the convention may be endogenous to the price of a table. However, the "number of tables" listed in the calendar is determined well before the final count of how many dealers will appear. We regard the posted number as "cheap talk" that serves to inform readers of the expected size of the event. Consider that the "number of tables" variable falls disproportionately on multiples of 5 (like 10, 15, 20 etc.), unlike a true measure of quantity. The variable is also highly correlated

Figure 1: Number of conventions by date.

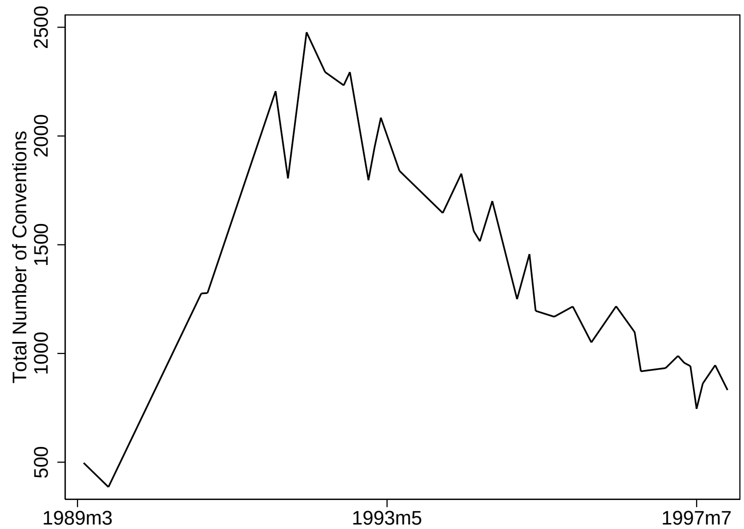

Table 2: Number of conventions per 3-digit zip code.

Count	Number	Perc.	Cum. Perc.
1	6,886	43.04	43.04
2	3,285	20.53	63.57
3	1,745	10.91	74.48
4	1,154	7.21	81.69
5	717	4.48	86.17
6	458	2.86	89.04
7	376	2.35	91.39
8	243	1.52	92.91
9	207	1.29	94.2
10	169	1.06	95.26
11	135	0.84	96.1
12	88	0.55	96.65
13	91	0.57	97.22
14	65	0.41	97.62
15	52	0.33	97.95
16	49	0.31	98.26
17	46	0.29	98.54
18	23	0.14	98.69
19	25	0.16	98.84
>19	185	1.2	100

Perc.	Tables	Perc.	Tables
1	10	75	50
5	15	90	70
10	20	95	90
25	25	99	160
Median	35	Mean	41.6

Table 3: Distribution of the number of tables.

with other measures of quality, such as the number and quality of athletes that will be available to sign autographs.[11] Thus, we interpret the number of tables to capture in reduced form both the effect of the number of tables and the effect of other correlated quality variables. As the number of tables is not verified by our data source, organizers could choose it in a misleading way. Our approach assumes the extent of misrepresentation does not vary systematically with competition.

Table 3 describes the distribution of the number of tables. The mean is 41.6 and the median is 35. The distribution is approximately log normal. The 99th percentile is 160. The magazine states that conventions have at least 10 tables to be listed but this does not appear to be binding. A number of conventions list less than 10 tables and the number of conventions listing 10 is not large compared to surrounding numbers. For instance, 589 conventions list 10 tables and 1,502 list 15, and 4,212 list 20. We find missing listings or listing of 0 number of tables at 1,853 observations and drop these in our statistical work.

Most conventions, 77.1%, last only one day. Almost all (98.8%) last three days or less. Most take place on weekends. In our data, 49% cover a Saturday, 53.7% cover a Sunday, and 81% cover Saturday or Sunday.

The dependent variables in our empirical work are the fees. Table 4 displays the distribution of the table fee. The mean is $43.7 and the median is $35. The distribution is approximately log normal, with a long tail of expensive conventions. The 99th percentile is $165 but we observe a few with table fees greater than $1000.

A striking feature of the distribution of the admission fee is that 52.9% of conventions feature free admission. A further 29.6% charge a fee of $1. There is little further variation, with much of it falling on multiples of 50 cents. The 95th percentile is $2. These features lead us to model the admission fee as a binary variable, so we predict only whether admission is free or not. With more than 80% of the observations choosing 0 or 1, this seems like a decent approximation. Figure 2 graphs the distribution of admission fees in a histogram.

We compute the number of competitors that a convention faces by counting the number of conven-

[11] We do not observe other measures of quality. However, some conventions take out display advertisements in the calendar section, and from these it is clear that larger conventions offer extra features such as autograph sessions with athletes, door prizes and free raffles.

Perc.	Table Fee	Perc.	Table Fee
1	10	75	50
5	15	90	80
10	20	95	102.5
25	25	99	165
Median	35	Mean	43.7

Table 4: Distribution of table fee

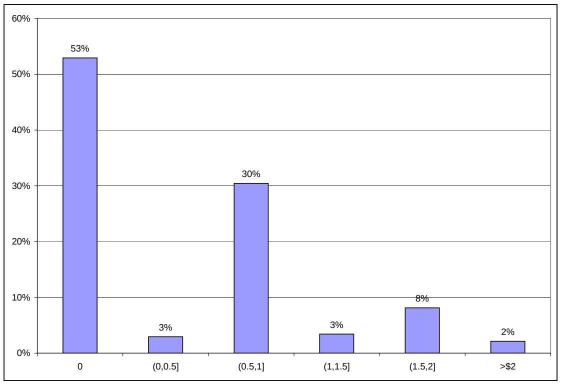

Figure 2: Admission fee distribution

	Distance in Miles								
	5	10	25	50	75	100	150	200	obs.
Same Day	1.24	1.44	2.5	4.27	5.93	7.77	11.87	16.84	50450
	(0.57)	(0.88)	(2.54)	(4.74)	(6.40)	(7.94)	(11.39)	(15.56)	
Within	1.68	2.39	5.80	11.03	15.45	20.06	30.02	42.10	38801
3 Days	(1.12)	(2.11)	(6.84)	(12.30)	(15.70)	(18.62)	(24.94)	(32.90)	

Table 5: Average number of competitors by distance

tions within a given range of time and geographic distance. For example, we calculate the number of conventions on the same day within 25 miles. To do so, we count any competing convention that has at least one day that overlaps with the convention in question. As stated above, we calculate distance based on the latitude and longitude of the relevant towns in the U.S. Census. Table 5 provides the average number of competitors by different distances. Note that when computing the "within three days" variable, we treat the observation as missing for any convention for which we do not have data on conventions within three days. So for instance, a convention on April 30, 1989 would be problematic since we do not have the May, 1989 issue so we cannot count all conventions within three days. Hence, Table 5 displays a lower number of observations for the "within three days" row than the "same day" row. Given that the great majority of conventions appear on the weekends, we interpret "within three days" as essentially meaning "same weekend." Because of these small numbers and the very local nature of the organizing market, we expect organizers to know with some accuracy in advance the number of conventions they will face on any given day. Hence, prices respond to competition although prices and competition are announced publicly at the same time.[12]

A central element to our approach is that the number of competitors is exogenous to price. Naturally, we are concerned that there is the potential for endogeneity. The number of conventions varies across locations and time due to the popularity of collecting cards, the success of local teams, and the availability of space. The personal schedules of local dealers and convention organizers will also play a role. In our main results, we use location fixed effects at the level of the 3-digit zip code to address the endogeneity of entry. Doing so accounts for cross-sectional variation in entry, and relies on local variation over time in competition, which is hopefully at least largely exogenous.

As a robustness check, we also use location-year-month fixed effects, in which case identification relies on within-month, within 3-digit zip code variation in competition and pricing. We view this as a fairly stringent test, particularly for consumer pricing which we treat as binary. Interestingly, the interaction of location with time provides little explanatory power beyond just using uninteracted time and location fixed effects alone. Consider competition measured as the number of conventions on the same day within 50 miles, one of the measures of competition that we focus on below. The standard deviation of this

[12] Interestingly, in Section 4, we find that large conventions have a larger effect in some cases than smaller ones. One explanation is that larger conventions are easier to learn about in advance.

variable after accounting for location-time fixed effects is 2.99, whereas accounting for only location fixed effects is only 3.58.[13] Thus, the interaction with time accounts for only 16.4% of the variation in competition. This is striking, since there are on average only 3.15 observations per location-time, and 61.97 observations per location. Thus, this initial look at variation suggests that location fixed effects capture most of the variation of location-time fixed effects, and thus location fixed effects account for a great deal of any endogeneity problem.

A final element of our data set is our contact with card convention organizers. We interviewed several convention organizers via e-mail. Their answers were similar and were sufficient to get a sense of how our issues were regarded by industry participants. Our questions were focused on the nature of competition between conventions, as well as competition with other sources of memorabilia. We asked about strategies that organizers used to maintain successful conventions and we were particularly interested in whether consumers and dealers were likely to be attending multiple conventions. The basic results were consistent with how we characterize the theoretical models of the market. Dealers are likely to travel further than consumers, which supports our modeling assumption that consumers have higher travel costs. For a dealer, 100 miles was feasible but more than 200 miles of travel was unlikely, similar to how we set up our competition variables. Larger dealers might attend multiple conventions in the same weekend, but would probably not be willing to do so if it meant long travel times. Also, our participants regard the *Becket* magazine as a very reliable data source.

3 Empirics

In this section and the next, we present a series of regressions that further explore this data set. In the following section, we interpret the results from the perspective of the theory of two-sided markets.

In addition to considering issues of two-sided markets, we must also address econometric issues of unobserved heterogeneity and omitted variable bias. These issues are important when we consider the relationship between pricing and competition. Demand factors are not entirely observable, and we expect that high unobservable demand will lead both to high prices and to more conventions, which creates bias in our estimates. We address this issue by including location fixed effects, where locations are indicated by 3-digit zip codes.

To see how our strategy works, we start with regressions of price on nearby competition. These regressions do not address any issues raised by two-sided markets but rather serve to verify that our fixed effects strategy works appropriately. Results appear in Table 6. In the first two columns, we have results from Chamberlain's conditional logit model (Chamberlain, 1980) predicting when admission fees are not zero, as a function of the number of nearby competitors.

[13] For these computations, we compute the mean of the competition variable at the level of location and location-time. We then subtract the mean variable from the competition variable and take the standard deviation, weighting each convention equally.

We do not include location fixed effects in the first two columns. We do however include time fixed effects at the level of the month-year, and a set of dummies that control for the days of the week.[14] We include time fixed effects and day-of-the-week controls in all specifications in this paper, although we do not report their effects. We include one control variable in all of the regressions: the log of the number of tables. We interpret this variable as a control for the quality of the convention and, not surprisingly, it is positive and both economically and statistically significant in every specification.

In column 1 of Table 6, we define competition to be the log of the number of competitors within 25 miles, and in column 2 we use 50 miles. We add one to the number of competitors to address log zero issues. We define competition as the number of conventions on the same day, and we consider alternatives in the next section. For both the cases of 25 and 50 miles, we see that competition is positive and statistically significant, as if competition caused higher prices. However, this result appears to be driven by unobserved geographic heterogeneity. In columns 3 and 4, we include location fixed effects. In this specification, we see that competition has a negative effect on the likelihood of setting a non-zero admission fee and that this effect is significantly different from zero at a confidence level of 99%. We conclude from this regression that our measure of competition and our fixed effects strategy address the omitted variable problem, at least in part.

We see similar results when we use the log of the table fee as the dependent variable. We use a linear model for the log of the table fee and estimate with linear panel data techniques. In the first two columns of the second panel in Table 6, we present results without location fixed effects. In these cases, the effect of competition on price is estimated to be statistically insignificant, and is very close to zero. However, the next two columns include location fixed effects, and here we see that competition has a negative and statistically significant effect for distances of both 25 and 50 miles. The effect is not large – the elasticity is around -0.02. But we believe this to be an upper bound due to the positive correlation induced by remaining unobserved heterogeneity.[15]

Note that the number of observations is slightly lower when we use the table fee because the table fee is missing for a number of observations. Restricting the admissions fee regressions to observations in which the table fee is present does not change results. For both admission fee and table fee regressions with location fixed effects, some observations are dropped because the dependent variable does not vary within a zip code.

The focus of our interest is on the asymmetric effect of competition on the two sides of the market.

[14] Our controls for the days of the week consist of dummy variables for each combination of days that appear in our data set more than 500 times. For instance, there is a dummy variable for Saturday-only conventions, one for Sunday-only conventions, and a separate dummy for conventions that are on both Saturday and Sunday. The full set of dummy variables capture 97% of the data set. We also include the duration of the convention (1, 2 or 3 days), which serves to better match the remaining 3% of conventions. We do not report any of these results in the paper. In all regressions, we reduce heterogeneity by dropping conventions that last more than three days, although we still use those conventions for purposes of computing the number of competitors.

[15] Note that the negative coefficient on dealer prices is not predicted by the theory of two-sided markets, but we show below that it is explained by the conventions that do not charge admission, consistent with theory.

Dependent Variable	Admission Fee > 0					Ln Table Fee			
Mileage	25	50	25	50		25	50	25	50
ln(Competition)	0.086 *	0.094 *	-0.135 *	-0.113 *		-0.001	-0.001	-0.021 *	-0.015 *
	(0.015)	(0.012)	(0.026)	(0.024)		(0.003)	(0.002)	(0.004)	(0.003)
ln(# of tables)	0.647 *	0.638 *	0.826 *	0.825 *		0.263 *	0.263 *	0.281 *	0.281 *
	(0.021)	(0.021)	(0.028)	(0.028)		(0.004)	(0.004)	(0.004)	(0.004)
Location FE's	No		Yes			No		Yes	
Observations	48,123		47,606			45,965		45,965	
Standard errors in parenthesis, * indicates significant at 99% confidence level									

Notes: Admission fee is estimated by a logit or conditional logit model. Log table fee is estimated in a linear model. Location fixed effects are 3 digit zip codes. All models include fixed effects for time (monthly) and days-of-the-week the convention covers. Competition is the number of conventions within the "Mileage" number that overlap in the calendar (plus 1 to address log zero).

Table 6: Regressions with and without location fixed effects

We focus on distance to allow for this effect. Distance is important for two reasons. First, distance is important because dealers are willing to travel further than consumers. This is both intuitive and confirmed by our conversations with industry participants. Thus, consumers perceive a convention that is 100 miles away as "farther" than a dealer would in the sense that the real cost of travel is higher. As a result, the convention exerts less of a competitive effect over the consumer than the dealer. The second reason that distance is important is that we believe dealers will attend multiple nearby conventions but will attend only one when choosing between far conventions. Attending multiple conventions requires splitting the collection, and hiring staff who must travel to the convention. As proprietors often want to check in on their tables throughout the day, this is made easier when conventions are closer together. Thus, dealers will multi-home between conventions at short distances but single-home at greater distances. Overall, competition at different distances affects prices on each side differently, and we use this feature to leverage insights from the theory of two-sided markets into our empirical application.

To the extent that distance affects consumers and dealers differently, we capture the asymmetry by distinguishing between "near competition" and "far competition." We define near to be those conventions within 25 or 50 miles, and far to be those within 100 or 150 miles, not including near competitors. Again, we require all competitors to overlap in calendar time by at least one day.

We report the results of near and far competition in Table 7. In the first panel, we see that for all definitions of distance, an increase in both near and far competition makes free admission more likely. All effects are significant at 1% confidence levels.

In the second panel, we see that near competition also drives down table fees, and does so with effects similar to what we found in Table 6. However, far competition measured within a 100 mile radius has no significant effect on table fees, and far competition measured within 150 miles has a *positive* effect on prices. The key feature of our empirical result is the pairing of the negative coefficient on one side of the market with the zero or positive coefficient on the other side.

Obviously, a positive effect of competition or even a zero effect is hard to explain with standard models. We argue below that it is consistent with a reasonable model of two-sided markets. An alternative explanation for the positive coefficient on far competition is that it is due to endogenous entry, so that unobserved temporal-geographic heterogeneity causes this result. However, this idea is hard to formulate because we include time and location fixed effects and because we find a negative coefficient on nearby competition. While it is plausible that there is heterogeneity that varies over time and space jointly, it must also somehow operate in a wider area more strongly than a local area, and affect the two sides of the market in an asymmetric way.

Dependent Var.	Admission Fee>0				Ln Table Fee				Ln Table Fee			
Near Mileage	25	25	50	50	25	25	50	50	25	25	50	50
Far Mileage	100	150	100	150	100	150	100	150	100	150	100	150
ln(Near Comp)	-0.121 *	-0.124 *	-0.097 *	-0.099 *	-0.021 *	-0.022 *	-0.015 *	-0.016 *	-0.002	-0.003	-0.005	-0.007
	(0.026)	(0.026)	(0.025)	(0.025)	(0.004)	(0.004)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)
ln(Far Comp)	-0.094 *	-0.084 *	-0.090 *	-0.080 *	-3.74E-06	0.009 *	-0.001	0.009 *	0.0003	0.009 *	-0.0002	0.010 *
	(0.025)	(0.026)	(0.025)	(0.025)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)
Free Admission									-0.032 *	-0.033 *	-0.039 *	-0.039 *
									(0.005)	(0.005)	(0.006)	(0.006)
ln(Near Comp)									-0.039 *	-0.038 *	-0.018 *	-0.017 *
X(Free Admit)									(0.005)	(0.005)	(0.004)	(0.004)
ln(# of tables)	0.826 *	0.827 *	0.826 *	0.827 *	0.281 *	0.281 *	0.281 *	0.280 *	0.273 *	0.273 *	0.273 *	0.273 *
	(0.028)	(0.028)	(0.028)	(0.028)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Observations	47,606				45,965				45,965			
Standard errors in parenthesis, * indicates significant at 99% confidence level												

Notes: Admission fee is estimated by a conditional logit model. Log table fee is estimated in a linear model. All models include fixed effects for location (3 digit zip codes), time (monthly) and days-of-the-week that the convention covers). Near competition is the number of conventions with the "Near Mileage" number that overlap in the calendar. Far competition uses the "Far Mileage" number, and is not inclusive fo near competition. We add 1 to each number to address log zeros.

Table 7: Main results

We also study whether conventions that allow free admission to consumers set dealer prices differently in response to competition than conventions that charge admission. For these purposes, we additionally project dealer price onto a dummy variable for whether the convention offers free consumer admission, and importantly, the interaction of the dummy with the log of nearby competition. We interpret conventions that allow free admission to be price-constrained. Presumably these conventions would not reduce their fee in response to small changes in exogenous variables. There is a sense in which every convention is constrained as they tend to use round numbers for the admission fee so it does not appear to be a truly continuous choice variable. However, we view the conventions with free admission as the "most constrained" conventions: they would be least likely to adjust their admission fee in response to changes in market variables. In theory, conventions could use raffle tickets or door prizes to implement a sort of negative price, but these are inefficient instruments by which to pay consumers relative to actual price, so we still view conventions with free admission as price constrained. We discuss the theoretical treatment of price constraints in Section 5, but as we argue, the theoretical models do not depend on competition affecting one side more than the other, which is why we focus the interaction term on "near" competition, which affects both sides of the market.

Results appear in the third panel of Table 7. In these columns, the coefficient on nearby competition becomes insignificant and precisely estimated near zero. Instead, we see a negative and significant coefficient on the interaction term, with a substantially higher magnitude than we found on nearby competition in panel 2. That is, the negative effect of nearby competition that we observed earlier appears to be coming from the constrained firms. Thus, constrained firms respond more strongly to competition than unconstrained firms.[16] As before, we see no effect of far competition when measured at 100 miles and a positive and significant effect at 150 miles.

These set of results motivate us to try a final, more ambitious regression that captures our "entire story" in a single regression. We predict table fees with separate variables to control for near competition (less than 50 miles), far competition (50-100 miles), very far competition (100-250 miles) and out-of-range competition (250-400 miles). We also interact near competition with a dummy for free admission. Results for the table fee appear in Column 3 of Table 8. Results are largely consistent with our earlier findings. We find no effect of competition more than 250 miles away, which we interpret as being too far to be in the relevant market. We find a positive effect on competition for the 100-250 mile range, and we find competition has no effect on dealer prices in the 50-100 mile range. We find a negative effect in the nearby range (less than 50 miles) for conventions that do not charge admission. Unlike in the previous regression, we find that competition within 50 miles has a negative effect even for conventions that charge admission.

For our story to be complete, we should also find that the effect of competition on admission fees is negative over the 0-250 mile range and zero outside of that range. Column 1 of Table 8 estimates

[16]Note that both admission and table fees are determined simultaneously so there is a potential endogeneity problem with including admission fees on the right-hand side. We discuss this further below.

	Admission Fee>0	Admission Fee>0	log Table Fee
free admit			-0.025 *
			(0.006)
<50	-0.103 *	-0.025 *	-0.005
	(0.025)	(0.006)	(0.004)
<50*free			-0.020 *
			(0.004)
50-100	-0.098 *		-0.001
	(0.026)	-0.079 *	(0.004)
100-250	-0.047	(0.030)	0.020 *
	(0.028)		(0.004)
250-400	0.072 *	0.056	0.001
	(0.030)	(0.029)	(0.004)

Standard errors in parenthesis
* indicates significant at 99% confidence level

Note: Columns 1 and 3 reestimate column 3 of panels 1 and 3 of Table 7, but with four competition distances instead of two. Column 2 restricts the parameters on 50-100 and 100-250 to be the same.

Table 8: Results with four competition distances

Chamberlain's conditional logit model predicting admission fee for the same four competition ranges as we used for the table fee. We find significantly negative coefficients for 0-50 and 50-100. However, we find a zero coefficient for 100-250 and a positive coefficient for the 250-400 range. As an alternative, we present column 2, in which we restrict the model to have the same coefficient for 50-100 and 100-250. In this case, we find the expected results of negative coefficients on 0-250 and zero for 250-400. Thus, under this specification, all eight coefficients in the table fee and admission fee regressions are consistent with our theoretical description of the market.

Note that all results in Tables 6, 7 and 8 are robust to using standard errors that are clustered at the level of the location-month. The one exception is the surprising positive coefficient on the 250-400 range in Column 1 in Table 8. Under clustering, this coefficient is not significantly different from zero, which conforms to our expectations for this coefficient. One issue that clustering addresses is that location-months with many conventions count more in the regression results.

Note that we do not address the magnitudes of the coefficients in our estimation. Because Chamberlain's conditional logit model is non-linear, an evaluation of magnitude requires that we know all of the coefficients. However, this method does not identify the fixed effects, and so we cannot consider magnitudes in this model. We consider a linear probability model in the next section, which gives some insight into magnitudes.

One interesting question is how competition for dealers affect admission fees when admission fees are constrained to be free or one dollar. Presumably, only a subset of conventions are on the margin between charging free admission or not, and it is these conventions that are driving the empirical results. Thus, there is a sense in which the coefficients represent an underestimate of the true effect on marginal conventions, or the effect we would observe if admission fee was set in a continuous fashion.

4 Robustness

Our results are robust to several different specifications. We report the results of four robustness experiments here. For each one, we present results for the regression on near and far competition, which we consider our core results. These correspond to the left and middle panels of Table 7. That is, we do not report results for the treatment of dealer prices when admission fee is zero, and we do not present results for the case with four definitions of distance. Many of our results are robust in these other regressions, but we do not present them for the sake of space. For each robustness experiment, we present results from all four combinations of distance, that is, 25 and 50 miles for near competition and 100 and 150 miles for far competition. All results appear in Table 9. At the end of this section, we also consider a linear probability model of admission fee in order to assess magnitude.

The first robustness check addresses the exogeneity of the level of competition. Above, we argue that location fixed effects substantially address this issue. However, it probably does not eliminate the problem. We believe that finding a suitable instrument in our context is unlikely. Rather, as a robustness check, we experiment with including more fixed effects. In the first panel of Table 9, we present results for location-month-year fixed effects. We get similar results when we use location-year fixed effects. As above, location is defined as 3-digit zip codes. Our results appear reasonably robust to this case. Near and far competition are negative and significant for admission fee in all four specifications at least at a 90% level of significance, and in most cases at a higher level of confidence. For the table fee, near competition is always negative and significant, and at a 99% level of confidence in three of the four specifications. As above, far competition has no significant effect when defined at 100 mile distance. When defined at 150 miles, we previously found positive coefficients. In this specification, they are still positive, but insignificant when near is 25 and significant at only a 90% level of confidence when near competition includes 50 miles. Note that both of these are positive and significant at a 95% level of confidence when using location-year fixed effects rather location-month-year fixed effects. We view this as a stringent test in the sense that even if there did exist an instrumental variable, it is unlikely to vary at a higher level than the location-month-year.

Our second robustness check relaxes the definition of competition. Rather than counting the competitors as conventions that start on the same day, the next panel presents results when we define competition as any convention that starts or ends within three days of the start or end of the convention in question. As most conventions are on the weekend, this definition effectively counts conventions on the same weekend rather than the same day. For these results, we have returned to using zip code fixed effects, rather than further time interactions. The admission fee results are all insignificant even at a 90% confidence level, except one of the eight parameters (far competition is negative and significant, as hoped, for the case of 50 miles, 100 miles). For the table fee, near competition is still negative and significant, and far competition is insignificant when far competition is defined at 100 miles. For the case of 150 miles, both parameters are positive but they are smaller in magnitude than in the main results. Neither is significant at a confidence level above 90%. We find similar (unreported) results when defining competition at the level of the week. Taking admission and table fees together, we find little meaningful variation when competition is at the level of the weekend, and we conclude that it makes more sense to define competition as being on the same day.

Our third robustness check relaxes the linear specification of competition. We consider whether the switch away from monopoly should be treated differently than other changes in competition. We do so by including a dummy variable indicating that a firm faces at least one competitor, in addition to our log linear term in the number of competitors. Thus, we allow for a non-linearity in competition around the monopoly case. We do this for both near and far competition. The results appear in panel 3 of Table 9. For the admission fee, the dummy coefficient is positive and significant for both near and far competition in most of the specifications. However, the magnitude is lower or similar in value to the linear term, so that we cannot say that the overall effect of moving from zero to one competitor is positive. The linear terms are still negative and significant. Thus, these regressions suggest that the negative coefficients for the admission fee regressions in the main specifications were driven by conventions that faced multiple competitors. The results for the table fee regression are similar. The parameters for the linear terms are as in the main specification: negative for near competition, zero for far competition defined at 100 miles, positive for far competition defined at 150 miles. The competition dummies are either insignificant or small enough in magnitude to change the interpretation only for a firm facing zero or one competitor. Note that the theory of two-sided markets predicts that if effects are different for monopoly conventions on the consumer side, they should differ in an analogous way on the dealer side. Overall, our experiment with non-linear competition effects finds enough significant coefficients to suggest that it is an appropriate description of the industry, but our overall conclusions about the link between competition for consumers and dealers, as well as the signs of the competitive effects, remain the same.

The next robustness check recognizes that all competitors are not symmetric. Large competitors may have a different effect on pricing, both because they represent more serious competition, and because they are easier to learn about in advance so that announced pricing is affected. To implement this test, we include the number of large near and far competitors. We include these two variables in addition to our standard counts of near and far competition, We define large as having more than 47 tables, the top quartile of table size in our data set. Note that to maintain symmetry with the other regressions, we still define our standard measures to include all competitors, both large and small. Thus, adding a large competitor 10 miles away affects two variables, the number of nearby competitors and the number of large nearby competitors. Results are in the last panel of Table 9. For the admission fee regression, the number of near competitors is now insignificant and the number of near large competitors is negative and significant, with a higher magnitude than in the main specification. Thus, the result in the main specification was driven by large competitors. For far competition, we still find negative and significant coefficients, with coefficients for large, far competition negative but typically insignificant. On the table fee side, near competition is negative and insignificant as above, and near large competition has a further negative effect. For far competition defined at a 100 miles, regular competition and large competition are insignificant (especially when summed together in the case of 50-100 miles). For 150 miles, regular competition is insignificant and large competition is positive and significant. Thus, the positive effect that we focused on in the main specification was driven by large competitors. Overall, accounting for large competitors suggests that several of the interesting effects we were finding were driven by large competitors, but support the overall conclusions that are the focus of our paper.

A further issue may be that locations with many competitors could be very different from the majority of locations, and furthermore, there may be overweighting in these locations since many conventions are responding to the same competitors. However, results are robust to dropping all conventions in zip codes with a very large number of conventions. In particular, for a final unreported robustness check, we ran these regressions dropping conventions in month-year-zip codes with more than 20 conventions, which is the 99th percentile of month-year-zips. We lose about 3,000 observations in this case, more than 6% of the sample.

Lastly, we consider magnitudes in the regressions predicting admission fee. In order to do so, we estimate a linear probability model of whether admission fee is zero or not. The advantage of a linear probability model relative to Chamberlain's conditional logit model is that we can interpret the magnitudes of the coefficients. A drawback is that the linear probability model is not constrained to predict a number between zero and one, and so it is sometimes difficult to interpret what the magnitude means. As they are different models, the magnitude from the linear probability model does not necessarily correspond to the relevant magnitude in the conditional logit model. Nonetheless, the linear probability model provides some evidence about the magnitudes in the data.

We repeat the regressions in the first panel of Table 7 using a linear probability model. That is, we form a linear projection of a dummy for whether the admission fee is greater than zero on the same explanatory variables in Table 7, including time and location fixed effects, and estimate via linear panel data techniques. Results appear in Table 10. As expected, parameter estimates on log competition are small but statistically significant, ranging around 1.4 to 2 percentage points. Note that the average log number of near competitors a convention faces in column 1 is 0.61. Doubling the log number of competitors a convention faces would mean adding about 1.4 competitors per market.[17] Adding 1.4 seems reasonable – the average of number of near competitors 2.49, with a standard deviation of 2.54. Doing so would decrease the probability of charging an admission fee by 1.9 percentage points. Since the

[17]That is, adding 1.4 to the number of near competitors in each market, taking the log and then the mean would about double the mean of the log near competitors.

Dependent Var.	Admission Fee > 0				Ln Table Fee			
Near Mileage	25	25	50	50	25	25	50	50
Far Mileage	100	150	100	150	100	150	100	150
Zip-year-month FEs								
ln(near comp)	-0.065 **	-0.064 **	-0.056 *	-0.056 *	-0.013 ***	-0.015 ***	-0.007 *	-0.010 ***
	(0.032)	(0.032)	(0.033)	(0.033)	(0.004)	(0.004)	(0.004)	(0.004)
ln(far comp)	-0.114 ***	-0.120 ***	-0.128 ***	-0.121 ***	-0.004	0.007	-0.006	0.008 *
	(0.032)	(0.034)	(0.032)	(0.034)	(0.004)	(0.004)	(0.004)	(0.004)
3-day competition window								
ln(near comp)	-0.0003	-0.004	0.042	0.033	-0.015 ***	-0.015 ***	-0.013 ***	-0.014 ***
	(0.025)	(0.025)	(0.027)	(0.028)	(0.003)	(0.003)	(0.004)	(0.004)
ln(far comp)	-0.046	0.001	-0.072 ***	-0.019	0.0005	0.005	0.002	0.007 *
	(0.028)	(0.032)	(0.027)	(0.030)	(0.004)	(0.004)	(0.004)	(0.004)
Non-linear competition effect								
ln(near comp)	-0.274 ***	-0.277 ***	-0.192 ***	-0.192 ***	-0.020 ***	-0.023 ***	-0.019 ***	-0.022 ***
	(0.039)	(0.039)	(0.032)	(0.032)	(0.005)	(0.005)	(0.004)	(0.004)
ln(far comp)	-0.093 ***	-0.098 ***	-0.116 ***	-0.112 ***	-0.0003	0.014 ***	0.006	0.020 ***
	(0.030)	(0.029)	(0.032)	(0.029)	(0.004)	(0.004)	(0.004)	(0.004)
near comp>0	0.251 ***	0.254 ***	0.214 ***	0.219 ***	-0.001	0.0001	0.007	0.009
	(0.047)	(0.046)	(0.044)	(0.043)	(0.006)	(0.006)	(0.006)	(0.006)
far comp>0	0.029	0.097 *	0.092 **	0.152 ***	0.001	-0.020 ***	-0.015 ***	-0.040 ***
	(0.047)	(0.055)	(0.046)	(0.051)	(0.006)	(0.008)	(0.006)	(0.007)
Separate effect for large conventions								
ln(near comp)	-0.016	-0.020	0.021	-0.024	-0.015 ***	-0.017 ***	-0.009 **	-0.011 ***
	(0.033)	(0.033)	(0.030)	(0.030)	(0.004)	(0.004)	(0.004)	(0.004)
ln(far comp)	-0.066 **	-0.080 ***	-0.050 *	-0.074 ***	-0.002	-0.0003	-0.005	-0.003
	(0.029)	(0.031)	(0.029)	(0.030)	(0.004)	(0.004)	(0.004)	(0.004)
ln(near large comp)	-0.224 ***	-0.226 ***	-0.147 ***	-0.151 ***	-0.013 **	-0.013 **	-0.012 ***	-0.014 ***
	(0.042)	(0.042)	(0.035)	(0.035)	(0.006)	(0.006)	(0.005)	(0.005)
ln(far large comp)	-0.050	-0.002	-0.078 **	-0.005	0.004	0.017 ***	0.009 **	0.023 ***
	(0.032)	(0.030)	(0.034)	(0.031)	(0.004)	(0.004)	(0.005)	(0.004)

Note: Standard errors in parenthesis. Asteriks imply confidence levels of significance: * is 90%, ** is 95% and *** is 99%.
All specifications are otherwise the same as Table 7. Large conventions have more than 47 tables.

Table 9: Robustness results.

Dependent Var.	Admission Fee>0			
Near Mileage	25	25	50	50
Far Mileage	100	150	100	150
ln(Near Comp)	-0.019 *	-0.020 *	-0.016 *	-0.016 *
	(0.004)	(0.004)	(0.004)	(0.004)
ln(Far Comp)	-0.016 *	-0.015 *	-0.015 *	-0.014 *
	(0.004)	(0.004)	(0.004)	(0.004)
ln(# of tables)	0.130 *	0.130 *	0.130 *	0.130 *
	(0.004)	(0.004)	(0.004)	(0.004)
Observations	48,124			
Standard errors in parenthesis, * indicates significant at 99% confidence				

Table 10: Linear probability model of a positive admission fee.

probability of charging admission is slightly less than 50%, that means about a 4% drop in the probability of charging admission. While we do not view this effect as very large, it still affects market outcomes and is reasonable, given the setting for our research.

5 Interpretation

So far, the paper has established a set of stylized facts drawn from a two-sided market. We find that competition at any relevant distance decreases consumer admission prices. However, prices for dealers are more complex. In this section, we argue that this set of results is consistent with the theory of two-sided markets. These theories are very flexible and perhaps could generate a variety of results. However, we argue that the set of assumptions that generate our results are natural for this market.

Among the most widely accepted implications of the theoretical literature on competition in two-sided markets is that competition between platforms affects the side that single-homes much more than the side that multi-homes. For instance, this result appears in Armstrong (2006), Rochet & Tirole (2003), and Gomes (2014). Assuming that dealers are more likely to multi-home than consumers, that implies that competition affects consumer prices more than dealer prices. Intuitively, the only way for dealers to reach consumers is through the convention that the consumer chooses. Hence, the convention has monopoly power over the dealer for access to its consumers. This makes competition to attract consumers particularly intense. There is no competition to attract dealers, since multihoming implies that the decision of dealers is separable across conventions. Thus, an increase in competition among conventions (for instance, by exogenously moving conventions closer together or by adding one to the market) creates lower prices for consumers but much less so, or not at all for dealers.[18]

Interestingly, Armstrong (2006) provides a similar result in the case in which both consumers and dealers single-home. In that case, increasing competition on one side of the market but not the other lowers prices on that side, but does not affect prices on the other.[19] However, this result is driven by the assumption that both sides of the market are fully served by the conventions. Thus, there is no market-expansion effect to lower prices.

To capture a more realistic case in which some agents choose not to attend either convention, we present a formal theoretical model in the appendix. In our model, consumers and dealers are distributed uniformly on separate "Hotelling" lines. Two conventions have separate locations on each line. The conventions are not at the end points of the lines. Rather, the lines extend far enough past the conventions in both directions that there is always a market expansion effect to lower prices. Conventions choose fees simultaneously, separately setting both a consumer and dealer admission fee. Then, consumers and dealers simultaneously decide which convention to attend, accounting for their travel costs, the fees, and the number of agents on the other side. We consider parameters such that in equilibrium, agents between the conventions are fully served whereas some agents on the sides choose not to participate. Thus, our model extends Armstrong (2006) to allow for a market expansion effect. While the model does not generate easily interpretable equations, numeric solutions replicate all of the theoretical results that we discuss for both single-homing and multi-homing dealers.

Our presentation in the appendix focuses on the case in which consumers and dealers both single-home since this generates a striking result that does not appear in the preceding theoretical literature: An increase in competition for consumers leads to lower prices for consumers and *higher* prices for dealers. Intuitively, as competition increases for consumers, the ability of conventions to extract rents from consumers diminishes. Since part of the value of attracting dealers is that it allows the convention to raise price to consumers, dealers become less valuable as competition eliminates the ability to raise consumer price. The decreased marginal benefit of attracting a dealer causes the conventions to raise the price to dealers. This effect was masked in the model of Armstrong, which assumed that quantity stayed constant on both sides (via the "fully served" assumption).[20] [21] In our model, the only difference between consumers and dealers is that consumers have higher travel costs.

Thus, our basic empirical result that competition causes prices to fall for consumers but to remain

[18]Existing theoretical work on platform competition considers cases with only two conventions. These papers study changes in competition by varying the distance between conventions. Naturally, our empirical specification is designed to handle much more varied market structures. We interpret an increase in the number of competing conventions as the theoretical equivalent of moving a platform from a really far distance that has a minimal competitive effect (say more than 300 miles away) to a distance that counts for near or far competition.

[19]For example, see Equation 12 in Armstrong (2006).

[20]Armstrong's model is fairly simple, so the ability to extract rents on one side is captured simply by the number of agents on that side.

[21]One can see our result in the model of Weyl (2010), which models only the monopoly case but with more general demand functions than we have here. Weyl shows that the equilibrium price to one side depends on rent extracted on the other side (see equation 4). If the rent on the other side goes down, for instance because of competition, so does the price.

unchanged or increase for dealers can be rationalized by the theory of two-sided markets. In fact, we can say more. Competition does not affect dealer prices in a model in which dealers multi-home and competition causes prices to increase in a model in which dealers single-home. Thus, our empirical result that competition between conventions less than 100 miles apart has no effect on dealer price and competition greater than 100 miles away causes dealer prices to increase is consistent with a model in which dealers multi-home between conventions at lower distances but single-home at greater distances.

We have no direct data on the extent to which dealers single-home or multi-home. Presumably, there is a mix of each. It is difficult to say when multi-homing is more prevalent. Certainly, it seems natural to think that dealers would be more likely to split their collection among two conventions when the conventions are not very far apart. Furthermore, our interviews with industry participants were suggestive of our interpretation. They confirm that dealers travel further than consumers, and generally treat travel as less important. Also, dealers are capable of splitting their collection. One example where this might come up would be if a dealer regularly appeared at a monthly card show that happened to overlap with a very large annual show. Without further data, which we do not believe is available, we cannot further explore this issue. Indeed, while the huge number of observations on both prices in a simple two-sided context represents the great strength of the data set, the lack of data on participation or transactions represents its greatest weakness.[22] Thus, we simply note that our interpretation of the empirical results is consistent with a reasonable description of market behavior.

To be clear, there are no theoretical models we know of that endogenize the change from single-homing to multi-homing – it is always imposed by the model. However, it is straightforward to think about how this might work. Recall that most dealers are very small businesses. Multi-homing probably means that the dealer attends one convention and hires an employee or family member to attend another. Whereas the dealer may regard his own travel costs as very low, paying an employee for time and car usage may make distant conventions more costly. Alternatively, a dealer may hire employees to go to both conventions (perhaps for only part of the day) and then the dealer would visit both conventions himself as well. In either case, we could imagine increasing the distance between conventions endogenously switching the dealer's preferences from a multi-homing model, where the dealer's decision at each convention is independent of the other, to a single-homing model, where the dealer must choose which one of a set of conventions to attend.

Recall that in Table 8, we found that price responded negatively to competition within 50 miles even for conventions that charged for admission. This result is not consistent with our story in which dealers purely multi-home, consumers single-home and agents never substitute between being consumers and dealers, which would predict no effect of competition on dealer price. However, we do not view this as particularly troubling. First, we did obtain the result of no significant effect in Table 7, so this

[22] One might imagine beginning a similar data collection effort today when it would be possible to learn about more than just admission and table fees. However, the number of conventions has decreased so much since the time period in the data that variation in market structure is likely to be much smaller, so we do not think such a project is promising.

problematic result is not entirely robust. Furthermore, it seems reasonable that at close distance, the market may deviate from the assumptions in a two-sided model, which leads to a standard one-sided result like prices falling in competition. For instance, some agents may substitute between being a consumer and being a dealer, and also, consumers may multi-home, both of which are deviations from the two-sided models we consider here. If these phenomena are more prevalent at short distances (which we believe is reasonable), then that could explain this outcome.

An additional empirical result is that competition affects price-constrained platforms differently. Armstrong & Wright (2007) study how a constraint on one side affects pricing on the other. Writing in terms of the sports card application, they show that conventions that choose free admission reduce dealer prices in response to increases in competition more strongly than do conventions that use positive admission fees. Intuitively, competition induces firms to set lower consumer fees. When consumer fees reach zero, conventions must find another method to attract consumers as competition increases, and so conventions turn towards attracting dealers. Thus, pricing to dealers is more aggressive in competition when consumer prices are constrained.[23]

Gomes (2014) also finds that competition has a bigger effect on seller prices when the platform cannot price to consumers, with similar intuition. His approach is notable because he uses a mechanism design approach, and so in this sense considers very general pricing functions.[24]

A potential issue in the empirical model is that admissions and dealer prices are set simultaneously, which in some cases brings up an issue of endogeneity. However, the theoretical relationship between the two prices is an equilibrium correlation rather than a causal effect of admission fee on the table fee. That is, in Armstrong & Wright (2007) as well as in the model in our appendix, competition is the exogenous variable. As competition increases, consumer prices drop until they hit their boundary, at which point dealer prices fall. Thus, we do not seek the exogenous effect of setting the admission to zero on the table fee.[25] Rather, we look only for a correlation between the two fees. There may still be more standard empirical problems to worry about, in particular omitted variables may affect both prices simultaneously. For instance, unobserved location heterogeneity could lead to low consumer and dealer prices and high competition, which would generate our empirical result. We find this possibility unlikely – standard intuition suggests that unobserved heterogeneity generates a positive correlation

[23] Armstrong & Wright (2007) make this point in the context of their model in which agents are fully served by conventions. We have confirmed these predictions in our model which allows for a market expansion effect. Also, they generate asymmetry by allowing the "network effect" parameters (what we label α in the appendix) to differ across consumers and dealers. We have confirmed these results allowing for heterogeneity in the other parameters, such as the travel cost (t) and stand-alone utility (v). We also have checked these results when dealers single-home and multi-home. Results are available on request.

[24] Gomes (2014) is motivated by Internet search auctions but the model is still relevant for our context. In considering implementation, Gomes focuses on a platform that auctions access to users. In his model, the platform sets the weight it will put on the seller's bid relative to the quality the seller will provide to the consumers. While Gomes does not study price explicitly, raising the weight on the bid causes sellers to bid more aggressively, which is analogous to raising price in our setting. He finds that the auction is not affected by competition between platforms when the platform can subsidize consumers, but that the weight on the bid goes down in competition when pricing to consumers is constrained.

[25] Indeed, in our model, both prices are a deterministic function of exogenous variables. Thus, if we fully controlled for all exogenous variables, the admission fee would have no statistical effect in the table fee.

between prices and entry, not negative. Furthermore, our extensive fixed effects are meant to control for unobserved heterogeneity.[26]

Overall, theory provides a consistent interpretation of our regression results. Dealers multi-home and so competition between conventions has no effect on dealer prices over some middle range. When conventions are very close, admission fees are driven to zero and then conventions compete by lowering dealer fees. When conventions are far from each other, dealers switch to single-homing, in which case dealer prices increase in competition, since competition for consumers is more intense than competition for dealers.

Clearly, we have not established that the theory of two-sided markets is the *only* theory that could generate these results, but we believe that it is difficult to find an alternative, particularly for the result about increased prices. There are a variety of ways that someone might model this market but without specifying an explicit model, it is surely true that most multi-product oligopoly models predict that prices fall in competition, rather than increase. Our empirics do not provide a test of two-sided market theories in the sense of developing falsifiable predictions from the theory of two-sided markets. Rather, our goal is to provide a set of stylized facts from the industry and argue that they can be rationalized with these theories.

A theory that generates prices that increase in competition exists for prescription drugs, in which we have seen brand-name drugs raise prices after entry by a generic drug (for instance, see Ching, 2010). These models rely on the entrant successfully capturing the high elasticity customers, leaving the incumbent to exploit the remaining low elasticity customers, where elasticity is driven by the type of insurance that a consumer has. That kind of differentiation between platforms and heterogeneity in elasticity seems unlikely to be relevant for the card convention market.

6 Conclusion

We provide a set of empirical results drawn from a new data set on sports card conventions in the U.S. in the mid-1990s. These conventions are a two-sided market since convention organizers must set admission and table fees to attract consumers and dealers. This setting is compelling for the study of two-sided markets because we observe many, many conventions and thus variation in market structure, and the pricing is simple and easily interpretable.

We show that consumer prices respond to the number of conventions both nearby and far. In contrast, dealer prices at conventions up to 100 miles do not respond to competition between conventions, except for a negative effect for conventions that do not charge admission. Also, competition that is more than

[26] An alternative approach that circumvents endogeneity would be to estimate equations that explain each price only as a function of exogenous variables and then look for correlation in the error terms to test for our issue. This should find the same result. Our approach is more direct, especially for analyzing the correlation of table fee with the interaction between competition and free admission.

100 miles away (when dealer single-homing is likely) causes prices to increase. We argue that this set of results is consistent with the existing theories of two-sided markets. Thus, we find that empirical evidence from the sports cards market supports the recent theoretical literature on two-sided markets. Existing theoretical work considers no more than two competing conventions, whereas our empirical setting is much more varied. Therefore, our results suggest that intuition obtained in a duopoly market structure can be extended to more complicated market structures.

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A Appendix: An illustrative model of sports card conventions

Competition among sports card conventions can be summarized as the number of competitors that a convention faces in the same time frame within a specific distance. However solving a theoretical model that allows for variation in both the number of platforms and distance between platforms is a challenge. Like the existing theoretical literature on two-sided markets, we restrict our model to have two platforms and and we use the distance between platforms to proxy for the level of competition. In Section 5 , we explain how we interpret predictions from this model in the context of sports card conventions. See footnote 18 as well.

We base our work closely on the model of Armstrong (2006). This model is useful for representing the sports card convention market because it addresses competition between two platforms that charge only a fixed fee to each agent and do not charge based on the number of trades made through the platform. We extend this model to allow for a market expansion effect from lowering prices. While doing so complicates the model, it also provides more realistic results to take to data.

Consider two sides of a market, with one set of agents on each side. Side C is made up of consumers and side D is make up of dealers. We index sides by m. Consumers and dealers are distributed along separate real number lines with density one. They are distributed across the entire line.[27] Agent i in market m is located at l_i (we do not index l_i by market for notational convenience). Consumer i bears no relationship with dealer i in side D. That is, they make their choices independently. There are two conventions, or "platforms", 1 and 2, indexed by j. Throughout, we assume that platforms have no costs. The platforms sell to consumers and dealers simultaneously. The location of platform j in side m is l_j^m. In this set-up, we can consider comparative static in l_j^C but not l_j^D, as if a platform could change its location with respect to consumers but not dealers. Clearly, this is an abstraction since an actual change in geographic location would affect all types of agents, but we think of this is an approximation to a situation in which one set of agents cares about location much more than the other. Alternatively, one may assume conventions have the same location on each side of the market (that is, $l_j^C = l_j^D$) but with consumers having higher travel costs than dealers ($t^C > t^D$). We solve this alternative model and find the same qualitative results, although the equations are much more complicated and we must resort to numerical analysis to a greater degree. For this reason, we only present the model that assumes equal travel cost but allows platforms to change locations on the two sides asymmetrically.

Agents value a platform based on how many agents the platform serves in the other side. Suppose platform j sells to n_j^C consumers and n_j^D dealers. The utility to agent i in side m is u_{ij}^m, defined to be:

$$u_{ij}^C = v + \alpha n_j^D - p_j^C - t|l_i - l_j^C|$$
$$u_{ij}^D = v + \alpha n_j^C - p_j^D - t|l_i - l_j^D|$$

where v represents the stand-alone utility of purchase to consumers and dealers, α determines the value conferred by sales in the other side of the market, p_j^m is the price of platform j in side m, and t parameterizes the travel cost. We assume that agents could instead use some outside good with utility of zero. Figure 3 displays our model visually.

Note that we are treating dealers symmetrically with consumers. We do not model price-setting, competition or other externalities between dealers. Doing so would complicate our analysis unnecessarily. Wright (2010) presents a model with within-group competition that turns out to be just a change of

[27] The important assumption is not that agents extend forever across each line but that they extend past whatever location would generate sales for zero prices, so there is always a demand expansion effect to lower prices.

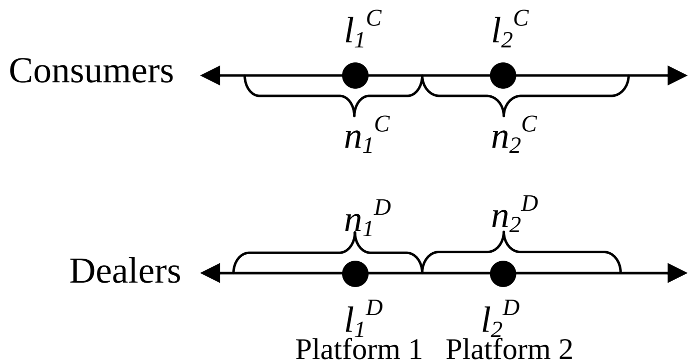

Figure 3: Consumers, dealers, platform locations and quantities.

variables from the model we consider. Also, we assume there is agent heterogeneity in l_i but not α. Weyl (2010) explores a model with heterogeneity in both terms but we have not done so as we believe that geographic heterogeneity is the most important issue in our application.

Throughout, we parameterize the model as follows, which we regard as without loss of generality:

Assumption 1 $\quad l_1^C = -1 \quad l_1^D = -1 \quad l_2^D = 1 \quad t = 1.$

We want to consider comparative statics of prices in l_2^C. An alternative would be to allow t to be heterogeneous across markets and consider comparative statics in consumer t. However, note that reductions in t bring conventions closer together *and* increase the responsiveness to the number of agents on the other side, like increasing α. We wish to isolate the competitive effect, and so focus on l_2^C.

We assume that the two platforms choose prices simultaneously and we solve for a Nash equilibrium of the game. Platforms are symmetric and we find only symmetric equilibria. Hence, we always find that $P_1^m = P_2^m$ for $m = \{C, D\}$.

We consider the case in which consumers and dealers both single-home. That is, agents pick the single platform that gives the highest utility, or choose no platform if the value of purchase does not exceed their reservation value of zero.

We are interested in cases in which there is a strategic interaction between the two platforms, so we consider cases in which all consumers located between the two platforms prefer purchasing from either platform to no purchase. Armstrong (2006) obtains simple analytic solutions to a similar model in which agents are assumed to be on finite lines and platforms are at the ends of these lines. However, the lack of a demand expansion effect leads to some unrealistic implications. The principal innovation of our model is to incorporate a demand expansion effect by allowing agents to be located on both sides of the platforms. While our solutions are less elegant, they are more relevant for our empirical work.

For each platform, profit is $\pi_j = p_j^C n_j^C + p_j^D n_j^D$. Demand for each platform on each side of the market is:

$$n_j^m = \frac{\left(\alpha n_j^{-m} - p_j^m\right) - \left(\alpha n_{-j}^{-m} - p_{-j}^m\right)}{2} + \frac{l_2^m - l_1^m}{2} + v + \alpha n_j^{-m} - p_j^m$$

where n_{-j}^{-m} refers to the number of agents purchasing the other platform's product in the other side. The first two terms refer to the profit drawn from agents between the two platforms. The first term will be zero in a symmetric equilibrium and the second term increases as the platforms become farther apart. The last term captures the profits drawn from agents on the other sides of the platforms.

We take first-order conditions from the profit functions for each price and we solve for prices by solving the four first-order conditions simultaneously.[28] Algebraic manipulation shows that:

$$\frac{dp_1^D}{dl_2^C} < 0 \quad \texttt{if} \quad 0 < \alpha < \frac{5}{8}$$

This result implies that p_1^D decreases as platform 2 becomes farther away on side C, if the network effect is not too large.[29] That is, higher competition on one side increases prices in the other. We consider the finding that prices increase in competition to be very surprising. It would be difficult to replicate in a model with only single-sided interaction.

The condition that the network effect be not too large turns out to be non-binding. As is well-known in the network effects literature, large network effects lead to intense price competition. There exists a critical value of α such that prices become zero. It takes on a particularly simple form in our model: when $l_2^C = 1$, prices are greater than zero if $\alpha < 1/2$. Obviously, this lies below 5/8. Hence, we would never consider values of α such that $dp_1^D/dl_2^C > 0$.

To get a sense of the whole set of prices, consider the specification with $v = 1$ and $\alpha = 0.3$. These parameters imply that for $l_2^C = 1$, all consumers and dealers between the platforms purchase. Then, prices are:

$$\begin{aligned} p_1^C &= 0.27 + 0.19 l_2^C \qquad & p_1^D &= 0.49 - 0.03 l_2^C \\ p_2^C &= 0.27 + 0.19 l_2^C \qquad & p_2^D &= 0.49 - 0.03 l_2^C \end{aligned}$$

Not surprisingly, platform 1 increases its price to consumers as platform 2 becomes farther away on that side. However, we also see that platform 1 *decreases* its price to dealers as platform 2 becomes *farther away* on the consumer side.

What is the intuition for this surprising result? As platforms become closer together, they serve fewer consumers. Thus dealers, who are attractive in part because they allow the platform to raise price on consumers, are less attractive. Hence, platforms raise price to dealers. Note that this result is unique to our setting because we have a demand expansion effect. Armstrong (2006) finds that changing the distance between platforms on one side does not affect prices on the other. This follows from Armstrong's assumption that consumers are fully served.

As noted in footnote 23, we have also solved versions of our model when assuming that dealers can multi-home, and when v, α or t differ for consumers and dealers, inducing platforms to set a price of zero to one side. As these results are consistent with existing theory, we do not present them here, although they are available upon request.

[28] All derivations in this paper are available in Mathematica files and PDF output on our web site, at `http://people.bu.edu/mrysman/research/`.

[29] It turns out that this condition also implies that all agents between the two platforms are served as long as v is high enough, in particular $v > 7/6$. For lower values of v, we require α to be above some low value, but this requirement could be eliminated by lowering t.