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A Test of Monopoly Price Dispersion Under Demand Uncertainty

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Abstract

Dana (2001) developed a model of price dispersion under demand uncertainty. The model predicts that, in the face of uncertain demand and inflexible prices, monopolists maximizes profits using *ex ante* price discrimination. We test the predictions of this model using a unique data set from Major League Baseball (MLB). Estimation of a two-way fixed effects model indicate that ticket price dispersion changes systematically with demand uncertainty in MLB, verifying the predictions of the model.

JEL Codes: D42, L12, L83

Key words: Price dispersion; demand uncertainty; sports

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1 Motivation

Price dispersion exists for many reasons. Stigler (1961) identified three sources of price dispersion: costs to determining the prices of rival producers, instability in supply and demand, and knowledge obsolescence from entry and exit of buyers and sellers. Dana (2001) developed a model of price dispersion under monopoly where a monopolist faces uncertain demand and must set prices in advance of sales. Dana's (2001) model predicts that profits increase when the monopolist offers multiple prices, so long as the *ex post* monopoly price increases when demand increases. The intuition in this model is that different demand states have different price elasticities, and the monopolist exploits these in the face of uncertainty about demand by offering the same or similar goods at different prices.

Major League Baseball (MLB) teams are monopolists, or duopolists in the case of the four metropolitan areas with two MLB teams, and set ticket prices in advance. Ticket sales represent the largest source of revenues for MLB teams. Dana's (2001) model applies directly to MLB; ticket price setting in sports motivated the model.

Price dispersion can also result from a firm's attempt to capture consumer surplus. Salop and Stiglitz (1982) concluded that when entry costs exist, "the *only* possible equilibria in the market involve price dispersion" (p. 1121). Changes in competition in a market also may generate price dispersion. Dana (1999) developed a model of price dispersion and market structure that predicts price dispersion increases as the market becomes more competitive. Stahl (1989) developed a model of price dispersion and market structure that predicts price dispersion decreases as the market becomes more competitive. The difference between these two models is that Dana (1999) assumes that uncertain demand and price setting before demand is known leads to price dispersion while Stahl (1989) assumes that costly consumer search and information asymmetries leads to price dispersion.

Not all of the observed differences in ticket prices at professional sporting events represent price dispersion. Each seat in baseball stadium provides the spectator with a different view, and a different experience. There are important quality differences between seats, and some observed price differences can be attributed to the heterogeneity. Differential pricing based on differences in quality can be found in sports, theater, concerts, and other markets (Courty, 2003). However, at some level all spectators attending a baseball game consume the same good, the game played on the field. Dana's (2001) model explains how observed price dispersion in MLB can be interpreted as a monopolist charging different prices for similar goods in the face of uncertain demand. Fort (2004) summarizes the existing literature on price setting in professional sports.

We analyze ticket price dispersion in Major League Baseball (MLB) using a unique data set. MLB produces two annual publications, the *Red Book* for the American League and the *Green Book* for the National League. These publications contain a wealth of data, including player statistics, the location of team hotels in various cities, club front office personnel contact information, and other facts. These publications also contain a list of all ticket prices set by each club in advance of the season. The price data from these publications provides detailed information about team pricing decisions, and price dispersion, over a long period of time, giving us a unique setting in which to analyze monopoly price dispersion. MLB operates as a legal monopoly, variation in on-field performance gives us an measure of demand uncertainty, and the total number of tickets sold, a good measure of output, is known.[1]

2 Data

We obtained detailed ticket price data from the *Red Book* and *Green Book* for the 1975 through 2007 seasons. The *Red* and *Green* books contain ticket prices for each section in each stadium. In 2008 MLB made the *Red* and *Green* books available only as PDFs. In 2009 and 2010, MLB denied us access to the PDFs. The sample contains 994 team-season observations. Table 1 contains summary statistics on number of distinct prices offered,

[1] No publicly available data exist on the number of tickets sold at each price point listed in the *Red* and *Green* books.

defined as the number of different ticket prices listed, including general admission tickets. The minimum and maximum ticket prices are in 2008 US Dollars, deflated by the CPI. We omit data for the Montreal and Toronto because of a lack of data for Canadian cities before 1987.

Table 1: Ticket Price Summary Statistics, 1975-2008

Team Name	Average # of Prices	Largest # Offered	Smallest # Offered	Avg P	Min P	Max P	Median P	StDev P
Arizona	13.55	15	8	37.46	1.07	215.00	23.40	32.22
Atlanta	5.82	10	4	16.92	1.04	70.00	15.59	9.52
Baltimore	7.97	13	4	18.25	3.22	80.00	13.81	8.09
Boston	5.91	7	4	25.18	4.46	125.00	20.85	12.29
California	6.71	12	3	16.71	4.79	150.00	11.96	8.76
Chicago Cubs	5.79	10	4	17.77	4.45	58.15	14.08	7.06
Chicago White Sox	5.38	8	3	18.06	5.93	51.92	16.29	6.34
Cincinnati	6.29	11	4	15.62	3.96	77.88	13.05	7.11
Cleveland	6.06	12	4	16.22	3.30	66.15	11.78	8.88
Colorado	12.25	15	8	17.21	1.22	48.80	13.39	11.18
Detroit	5.62	11	4	17.10	5.00	93.77	13.73	9.62
Florida	7.69	10	4	24.50	2.50	103.84	20.85	15.50
Houston	7.38	12	5	16.35	1.04	52.00	13.61	8.19
Kansas City	5.76	9	4	16.36	3.35	167.55	15.01	8.62
Los Angeles	4.97	13	3	16.72	4.00	207.68	11.74	8.28
Milwaukee	7.59	11	5	17.25	1.07	88.26	15.53	8.44
Minnesota	5.03	9	2	16.08	4.74	106.00	15.22	7.73
New York Mets	4.38	6	3	20.01	3.92	74.76	17.05	8.04
New York Yankees	5.94	14	3	28.05	3.00	415.36	18.27	16.96
Oakland	5.65	9	4	20.08	4.32	213.59	16.19	14.78
Philadelphia	4.94	9	4	16.22	4.46	50.00	14.36	5.84
Pittsburgh	5.71	12	3	15.25	4.74	54.00	13.06	6.41
San Diego	6.26	12	3	15.38	5.00	62.69	13.11	6.97
San Francisco	6.32	13	4	19.10	2.37	95.00	15.00	9.56
Seattle	5.94	12	4	17.98	3.11	62.69	13.66	8.86
St. Louis	6.24	13	4	17.99	4.79	88.26	11.69	8.34
Tampa	9.91	11	9	52.36	1.94	257.57	29.25	61.82
Texas	6.76	13	4	18.07	2.39	88.19	14.81	9.34

Table 1 reveals significant variation in price setting behavior. The maximum number of ticket price points offered by teams is more than ten, suggesting that price dispersion is high league wide. The table reveals considerable dispersion in the minimum and maximum ticket prices offered, with some teams offering maximum prices four times higher than other teams. Table 1 shows large variation in within-team price dispersion. The standard deviation of ticket prices offered by Tampa (61.82) is more than 10 times that of Philadelphia (5.84). Most teams offer a skewed distribution of prices, as the average ticket price is higher than the median. Recent expansion teams offer tickets at more price points than older franchises.

Table 2 contains summary statistics for on-field performance, market, and stadium characteristics. Table 2 shows quite a bit of variation in market size, stadium size, and on-filed performance in the sample. The market size variable exhibits considerable variation even when accounting for the fact that the four largest markets have two teams.

Table 2: Team Performance and Market Sample Means

Team Name	Years	Capacity	Population	Std. Dev. Win %
Arizona	11	48,989	3,648,595	0.101
Atlanta	34	51,613	3,436,008	0.050
Baltimore	33	50,667	2,419,758	0.049
Boston	34	34,176	4,195,981	0.039
California	34	53,940	11,167,046	0.052
Chicago Cubs	34	38,618	8,564,970	0.054
Chicago White Sox	34	44,344	8,564,970	0.052
Cincinnati	34	49,951	1,899,599	0.055
Cleveland	34	61,152	2,144,724	0.055
Colorado	16	53,572	2,171,183	0.036
Detroit	34	49,005	4,357,631	0.064
Florida	16	40,237	5,023,931	0.058
Houston	34	46,737	4,080,806	0.048
Kansas City	34	40,600	1,697,239	0.046
Los Angeles	34	56,000	11,167,046	0.046
Milwaukee	34	50,582	1,454,159	0.047
Minnesota	34	51,110	2,628,857	0.048
New York Mets	34	55,917	17,436,310	0.057
New York Yankees	34	57,355	17,436,310	0.046
Oakland	34	46,394	3,734,664	0.063
Philadelphia	34	59,829	5,514,464	0.046
Pittsburgh	34	49,445	2,505,991	0.049
San Diego	34	53,806	2,427,989	0.056
San Francisco	34	54,578	3,734,664	0.055
Seattle	32	55,802	2,665,462	0.054
St. Louis	34	51,476	2,619,958	0.051
Tampa	11	43,311	2,536,503	0.031
Texas	34	44,864	4,281,016	0.052

3 Empirical Analysis and Discussion

We estimate a reduced form linear regression model of the price dispersion chosen by each team

$$PD_{it} = \alpha_{1i} + \alpha_{2t} year_t + \beta_1 DU_{it} + \beta_2 M_{it} + \epsilon_{it} \tag{1}$$

where PD_{it} is the standard deviation of ticket prices set by MLB team i in season t, α_{1i}

a team fixed effect, $year_t$ a vector of indicator variables for each year in the sample, DU_{it} a measure of demand uncertainty, M_{it} a vector of variables reflecting market and stadium conditions, and α_{2t}, β_1, and β_2 unknown parameters to be estimated. The equation error term ϵ_{1it} captures all other factors that affect price dispersion and $\epsilon_{it} \sim (0, \sigma_\epsilon^2)$. Equation (1) is a two way fixed effects model. We estimate the unknown parameters of equation (1) using OLS.

We proxy demand uncertainty with the variation in each teams' winning percentage over the past 5 seasons. Winning percentage reflects team quality, a factor that affects demand for tickets. The more variable past winning percentage, the more uncertain the team will be about current demand for tickets. M_{it} contains variables controlling for other factors affecting price dispersion, including the number of competitors in the market, and stadium characteristics that affect quality differences across seats in each stadium. The team fixed-effect also controls for stadium-specific seat quality differences, like sightlines and distance from the upper deck to the field, as these factors do not change over time in a given stadium.

Table 3 contains the parameter estimates and p-values for Equation (1). The fixed effects parameter estimates are not reported, although they are generally significant. The model explains 61% of the observed variation in price dispersion in MLB. Correcting the standard errors for heteroscedasticity using the standard White-Huber "sandwich" method had no effect on the results.

Competition in the local market, in the form of another MLB team, but not other professional sports teams, leads to lower price dispersion, consistent with the predictions of Stahl's (1989) model. Larger markets are associated with more price dispersion, probably because larger markets have more fans and more variation in elasticity of demand, providing an incentive to offer tickets at more prices. Stadium characteristics, in terms of capacity, have no effect on price dispersion. Teams playing in older stadiums have greater price dispersion, because older stadiums lack modern profit-enhancing amenities like wide concourses, premium concessions, and conveniently located team shops.

Table 3: Regression Results - Parameter Estimates and P-Values

Variable	Coefficient	Std. Error	p-value
Standard Deviation of Winning %, last 5 seasons	-27.51	13.481	0.04
MSA Population (000)	0.002	0.001	0.01
Stadium Age	0.046	0.020	0.02
Stadium Capacity (000)	-0.018	0.056	0.75
MLB Franchise	-19.25	3.016	<0.001
NBA Franchise	-1.884	1.439	0.19
NFL Franchise	0.729	0.795	0.36
NHL Franchise	0.334	1.143	0.77
R^2	0.61	N	857

The parameter of interest is on the standard deviation of each team's winning percentage over the last five season, a proxy for uncertainty of demand. Teams with more past variation in on-field success will have more demand variability. The estimated parameter on this variable is negative, and statistically significant. Dana's (2001) model predicts that monopolists facing uncertain demand and setting prices before knowing the actual state of demand increase profits by offering multiple prices, but the model does not generate a prediction about the exact relationship between demand uncertainty and the number of prices offered. The model predicts that the larger the *ex post* monopoly price – the sport price the monopolist would set at differing levels of demand – the larger the variation in *ex ante* prices offered, and links this difference to the elasticity of demand at different demand states. The negative sign on this parameter is consistent with a relatively small, but positive elasticity of demand across different demand states, in the context of the model developed by Dana (2001). This sign is also consistent with the idea that teams with relatively little variation in demand have to offer tickets at a wider variety of prices to exploit differences in demand elasticity. This sign is also consistent with the idea that teams with larger variation in demand are able to learn more about their customers from this variation, and can offer tickets at fewer price points to exploit differences in demand elasticity.

The results confirm the predictions made in the monopoly price dispersion model developed by Dana (2001), and indicate that this model explains observed price dispersion even when other factors that affect price dispersion are controlled for. Price discrimination, and variable quality of seats, are not the only reason that monopoly MLB teams charge different prices for tickets. Uncertain demand also explains observed price dispersion in MLB. The results also suggest that additional modeling work should be done in this area. Dana's (2001) model does not make specific predictions about the sign of the relationship between price dispersion and demand uncertainty, but the results indicate a negative relationship. Since the model identifies the elasticity of demand for different realized demands levels as the key factor, additional modeling should proceed in this direction.

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