Price Discrimination in Broadway Theater

Phillip Leslie
Stanford University

Rand Journal of Economics
Volume 35, No. 3
Autumn 2004

Content

- Price discrimination and Variation
- Behavioral Model and Econometric Model
- Welfare analysis under price discrimination
- Alternative experiments and the empirical implications

Price Discrimination

- 2nd PD

  Different prices for different seat qualities(H, M, L)
- 3rd PD

  Different prices for different individuals.

  (Discount mail coupons or being members of specific organizations or groups)
- *Full Price Ticket*: sold via telephone
- *Discount Price Ticket*:

  1. Coupon: sold under various conditions such as mail-in-coupon and happen-to-come-across-in- restaurant coupon

  2. TKTS: will incur non-pecuniary time cost of waiting

Abstract

- **Behavior model:** random-utility discrete choice with endogenously random choice sets
- **Data:** 199 performances of *Seven Guitar (1996),* 17 different ticket categories

  daily prices and quantities
- **Experiment:** price discrimination

  uniform pricing

  non-sticky prices over time

  abolishing the discount booth.
- **Results:** *Firms*<>increase profits of 7% under PD*;*

  consumers<> insignificant in change of aggregate CS

Identification of demand system ----price variation

- ***Sources of Price Variation***:
  1. across different ticket categories (e.g. balcony <>orchestra)
  2. across time (performances) in each ticket category
- pre-determined peak-load pricing(Sat. evening orchestra price is higher) ; →+ time-of-week dummies*
- availability of medium-quality tickets from 133rd performance

  →included into utility function**;
- time-of-week peak load pricing →+*;
- 50% off the top full price at booth varied from day to day→**;

TABLE 1: Summary of Attendances and Revenues for Each Sales Category of *Seven Guitars*

	Price ($)		Attendance		Revenue ($)	
	Mean	Std Dev.	Mean	Std Dev.	Mean	Std Dev.
Full-price:						
Orchestra	55.08	4.22	162.74	77.22	9,112.29	4,765.14
Front mezzanine	55.08	4.23	40.04	41.70	2,262.27	2,462.55
Rear mezzanine	29.20	1.85	34.80	18.91	1,007.10	533.49
Balcony	16.93	4.91	38.60	17.26	679.26	421.85
Boxes	55.76	4.17	4.97	4.88	281.36	279.95
Standing	22.27	2.55	6.14	4.50	134.77	96.24
Discount-price:						
10%-off	49.40	3.88	6.71	5.55	335.74	286.61
Two-fer one	27.23	2.06	16.65	20.17	467.28	591.53
TKTS	27.53	2.11	158.87	71.29	4,358.12	1,956.91
MTC	22.00	0	258.99	60.28	5,697.71	1,326.18
AENY	50.36	1.81	3.81	2.46	193.07	128.17
Direct mail	39.51	2.28	48.43	36.80	1,925.78	1,461.92
Group	36.26	10.80	89.91	63.84	3,309.46	2,688.23
Student	26.21	2.01	68.35	56.38	1,775.98	1,440.68
TDF	16.46	5.81	153.72	90.67	2,306.93	1,163.35
Wheelchair	26.94	2.23	2.02	0.66	54.56	17.67
Complimentary	0	0	38.91	75.57	0	0

Identification of demand system
---other variables

- Advertising

  * positive effect on utility

  * Moving Average of daily ad expenditure—due to time lag from ad to attend the performance
- Income (e.g. TKTS)
- Number of other shows in Broadway theater (shocks from tourism, whether. etc)

Behavioral Model– Utility Function

- **Individual is characterized as pair** (y_i, ξ_i)

$$U_{ij} = \begin{cases} q_{ij}[B(y_i) - p_j]^{\eta} & : \quad j \in \{l, m, h\} \\ q_{ih}[B(y_i) - p_j]^{\eta} & : \quad j = c \\ q_{ij}[B(y_i) - p_j - \tau(y_i)]^{\eta} & : \quad j = b \\ \xi_i^{-1}[B(y_i) - p_j]^{\eta_o} & : \quad j = o. \end{cases}$$

- **Where** q_{ij} **is the quality view of person i toward seat quality j**
- $B(y_i) \le y_i$ **is the budget for entertainment expenditures** $B(y_i) = \delta_1 y_i^{\delta_2}$

  $\delta_1 > 0$ and $\delta_2 \in (0, 1]$
- **And disutility come from** $\tau(y_i) = \tau_1 y_i + \tau_2$
- **With Probability** $\lambda(y_i|\gamma)$ **, consumer i receives a coupon**

Behavioral Model–Demand Function

- Expected demand for ticket in category j:

$$S_j(\cdot) = M \int_{(y,\xi)\in A_j} dF(y)dG(\xi);$$

Where $A_j = [(y_i, \xi_i) : U_{ij} \geq U_{ik}, \forall k \in \Omega] \subset \Re^2_+,$

and $\Omega = \{l, m, h, c, b, o\}$

M is the number of people attending Broadway theater in the same week/8

Econometric Model

$$U_{ijt} = \begin{cases} q_{ijt}(\delta_1 y_i^{\delta_2} - p_{jt})^{\eta} & : \quad k_{ijt} < C_j \quad \text{and} \quad j \in \{l, m, h\} \\ q_{iht}(\delta_1 y_i^{\delta_2} - p_{jt})^{\eta} & : \quad k_{ijt} < C_h \quad \text{and} \quad j = c \\ q_{ijt}(\delta_1 y_i^{\delta_2} - p_{jt} - \tau_1 y_i - \tau_2)^{\eta} & : \quad k_{ijt} < C_h \quad \text{and} \quad j = b \\ \xi_{it}^{-1}(\delta_1 y_i^{\delta_2} - p_j)^{\eta_o} & : \quad j = o. \end{cases}$$

- Where $\xi_{it} \sim \exp(X_t \beta)$ and $\lambda_{it} = 1 - \frac{\exp(\alpha y_i - Z_t \gamma)}{1 + \exp(\alpha y_i - Z_t \gamma)}$

Econometric Model

- Demand

$$s_{jt}(p_t, X_t, Z_t, \Theta) = \int_{(y,\xi)\in A_{jt}} dF(y)dG(\xi|X_t\beta); \quad \text{where}$$

$$A_{jt} = [(y_i, \xi_i) : U_{ijt}(p_t, X_t, Z_t; \Theta) \geq U_{ikt}(p_t, X_t, Z_t; \Theta), \forall k \in \Omega].$$

- Maximum likelihood estimator $l(\cdot, \Theta) = \sum_{t=1}^{T} \sum_{j\in\Omega} N_{jt} \log s_{jt}(\cdot, \Theta).$

$$\Theta = \{q_l, q_m, Q_{max}, \delta_1, \delta_2, \tau_1, \tau_2, \eta, \eta_o, p_o, \alpha, \beta, \gamma\}$$

N_{jt} is the actual number of individuals choosing j at period t

Empirical Results

- Highest/lowest quality = 3.3 <>Price ratio= 3.66
- There exists disutility of buying at booth
- Budget on entertainment is only 3% of income
- High quality ticket sales more sensitive to income
- Negative cross-elasticity with capacity constraint

…

TABLE 4: Demand Elasticities

Price elasticities with capacity constraints:						
	low	medium	high	booth	coupon	high and booth
low	-0.2468	-0.0032	-0.0390	0.2194	-0.1920	0.2175
medium	-0.0087	-4.3119	2.8448	5.1226	0.4904	7.3497
high	-0.0668	0.1141	-2.5142	0.9310	1.1274	-1.5859
booth	0.1619	0.3623	1.3204	-2.8745	0.7304	-1.5051
coupon	-0.0320	0.0170	0.9841	0.5510	-1.5202	1.5352
outside	0.0004	-0.0000	0.0008	0.0009	0.0014	0.0019
Price elasticities without capacity constraints:						
	low	medium	high	booth	coupon	high and booth
low	-5.4539	0	0	10.5382	3.0179	10.5382
medium	0	-9.2957	5.9170	6.2060	0.0301	12.1230
high	0	0.1967	-4.0583	0.4150	0	-3.6523
booth	0.1007	2.4070	4.0942	-8.4894	0.6894	-4.4629
coupon	0.0036	0	0	0.0634	-2.1766	0.0634
outside	0.0013	0.0085	0.0950	0.0370	0.1129	0.1332
Income elasticities with capacity constraints:						
low	0.1224		booth	-0.1659		
medium	0.4707		coupon	-0.9125		
high	1.2209		outside	-0.0009		

Counterfactual Experiments

- **optimizing prices** $p_t = \{p_{lt}, p_{mt}, p_{ht}, p_{bt}, p_{ct}\}$

Max $$R = \sum_{t=1}^{T} \sum_{j \in \Omega \setminus \{o\}} p_{jt} q_{jt}(p_t, \cdot)$$

where $q_{jt} = M_t s_{jt}(p_t, X_t, Z_t, \hat{\theta})$

- **2 benchmark cases**:

1. *Base-A* : uses empirical prices and provides a prediction of consumer behavior
2. *Base-B*: uses predicted optimal prices

→ Very close of predicted prices and actual prices(Table 5)

→ Well-specified Demand and well-specified firm behavior

Counterfactual Experiments

- Uniform: Optimal P=$50.04, Revenue ↗ Attendance ↘

- No-Booth-A: Revenue ↗ Attendance ↘
- No-Booth-B: Revenue ↗ Attendance ↗
- Booth-lower- than-50%: Revenue ↗ Attendance ↘

- Non-sticky: Only small increase in revenue

TABLE 5: Results of Counterfactual Experiments

Experiment	Revenue ($'million)	Utility	Ave. Attendance	p_l	p_m	p_h	p_b	p_c
Actual	4.6951	NA	661.56	16.93	29.20	55.08	27.53	31.01
Base-A	6.2698	3.5859	906.86	16.93	29.20	55.08	27.53	31.01
Base-B	7.8965	3.5775	864.11	23.90	29.80	60.22	30.11	45.26
Uniform	8.0204	3.6039	809.57	50.04	50.04	50.04	NA	NA
No-Booth-A	6.7301	3.5837	873.01	16.93	29.20	55.08	NA	31.01
No-Booth-B	8.3495	3.5925	873.73	22.28	38.33	51.53	NA	43.23
Booth not 50%	8.4516	3.5900	850.30	24.47	40.86	54.21	38.05	46.32
Non-sticky	8.0194	3.5800	887.37	24.11	30.11	59.73	29.87	46.03